ACADEMIC CURRICULA

UNDERGRADUATE DEGREE PROGRAMMES

Bachelor's Degree in Technology

(B.Tech - Four Years)

(Choice Based Flexible Credit System)

Regulations - 2018

Volume – 3

(Detailed Syllabus for Second Year Courses)

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Kancheepuram 603203, Tamil Nadu, India

Contents (Volume –III)

ACADEMIC CURRICULA

Humanities and Social Sciences

including Management Courses

Regulations - 2018

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Kancheepuram, Tamil Nadu, India

Course Code	18PDH102T	Course Name	MANAGEMENT PRINCIPLES FOR ENGINEERS	Course Category	H	*Humanities and Social Sciences including Management*	L	T	P	C
							2	0	0	2

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Career Development Centre*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Acquire knowledge about the fundamental concepts of organization and management*
CLR-2 :	*Make decision strategies, planning process, tools and techniques*
CLR-3 :	*Inculcate the traits needed to be an effective leader and familiarize with the organizational structures and design*
CLR-4 :	*Gain valuable insights into strategic process, formulation and implementation*
CLR-5 :	*Utilize the intricacies involved in cultural and ethical issues of people*
CLR-6 :	*Utilize the dimensions of the planning-organizing-leading-controlling (P-O-L-C) framework*

		Learning			**Program Learning Outcomes (PLO)**														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	*Observe and evaluate the various influencing factors on the current practice of organization and management*	3	80	75	-	H	-	-	-	L	-	H	H	M	-	M	-	-	-
CLO-2 :	*Use the techniques and tools of planning and make prudent decisions*	2	80	75	-	M	-	-	-	H	-	H	H	M	-	H	-	-	-
CLO-3 :	*Identify how organizations adapt to uncertain environment, identify techniques managers use to influence and control the internal environment*	2	80	75	-	L	-	-	-	M	-	H	H	H	-	M	-	-	-
CLO-4 :	*Apply and execute management goals*	2	80	75	-	L	-	-	-	M	-	H	M	H	-	M	-	-	-
CLO-5 :	*Manage people and deal with cultural and ethical issues*	3	80	75	-	H	-	-	-	H	-	H	H	H	-	H	-	-	-
CLO-6 :	*Utilize the basic fundamentals of managing organizations and utilize optimal resources*	3	80	75	-	H	-	-	-	M	-	M	M	H	-	M	-	-	-

Duration (hour)		**6**	**6**	**6**	**6**	**6**
S-1	SLO-1	*Organization*	*Information technology and the new workplace*	*Organisational control*	*Strategic management*	*People Management*
	SLO-2	*The Individual and the Organization*	*Precautious Measures*	*Control in the Business Setting*	*Role of Strategy in Management*	*Importance of people*
S-2	SLO-1	*Management*	*Information and decision making*	*Motivation*	*Evaluating the Business Environment*	*Attracting a Quality Workforce*
	SLO-2	*Primary Functions of Management*	*Styles of Decision Making*	*Importance of Employee Motivation*	*Common Frameworks for Situational Analysis*	*Recruiting process*
S-3	SLO-1	*Role of management in organisation*	*The decision-making process*	*Leadership*	*Goals and Process*	*Employee Diversity*
	SLO-2	*Advantages of Managing People Well*	*Barriers to Individual Decision Making*	*Effective Leader*	*strategic competitiveness*	*Conflict Management*
S-4	SLO-1	*Types of Managers*	*Planning*	*Organising*	*Different Strategies*	*Organisational Culture*
	SLO-2	*Role of managers*	*Planning and Mission*	*Purpose of Organization*	*Stages and Types of Strategy*	*Influences on Organizational Culture*
S-5	SLO-1	*management Thought*	*The planning process*	*organisational design*	*Strategy formulation*	*Initiating and Fostering Cultural Change*
	SLO-2	*Management Roles*	*The Planning Cycle*	*Common Organizational Structures*	*Bridging the Gaps*	*Putting It Together: Culture and Diversity*
S-6	SLO-1	*Environmental Factors*	*tools, techniques and processes*	*Factors Impacting Organizational Design*	*Strategy implementation*	*Ethics*
	SLO-2	*Internal and External Factors*	*Putting It Together: Planning and Mission*	*Contingencies*	*Overcoming Hindrances*	*Cultural Issues*

Learning Resources	1. *Schermerhorn, J.R., Introduction to Management, 13th ed., Wiley; 2017* 2. *Harold Koontz, Heinz Weihrich, Essentials of management: An International & Leadership Perspective, 10th ed., Tata McGraw -Hill Education, 2015*	3. *Stephen Robbins, Mary Coulter, Fundamentals of Management , 9th ed., Pearson Education, 2016* 4. *Samuel C. Certo, Tervis Certo, Modern management: concepts and skills, 12th ed., Pearson, 2012* 5. *Charles W. L. Hill, Steven Mcshane, Principles of Management McGraw Hill Education, 2017*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
Level 2	Apply Analyze	*40%*	-	*40%*	-	*40%*	-	*40%*	-	*40%*	-
Level 3	Evaluate Create	*20%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Pratap Iyer, Study Abroad Mentors, Mumbai, pratap.iyer30@gmail.com	*1. Dr. A.K. Sheik Manzoor, Anna University, sheikmanzoor@annauniv.edu*	*1. Mr. Mohamed Ibrahim. A. U., SRMIST*
2. Mr. Ajay Zenner, Career Launcher, ajay.z@careerlauncher.com	*2. Dr. Devamainthan, University of Madras*	*2. Mr. Muthu Manivannan, SRMIST*

Course Code	18PDH103T	Course Name	SOCIAL ENGINEERING	Course Category	H	*Humanities and Social Sciences including Management*	L	T	P	C
							2	0	0	2

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Career Development Centre*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*create personal awareness and responsibility*
CLR-2 :	*learn about environment and approach towards social issues*
CLR-3 :	*train students on social competencies to become self reliant, resourceful and industrious*
CLR-4 :	*understand social entrepreneurship*
CLR-5 :	*develop a mindset to contribute to the society*
CLR-6 :	*apply knowledge, passion and skills in the pursuit of humanitarian goals*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO – 3
CLO-1 :	*identify and addresses needs of social responsibilities*	2	80	75	-	-	-	-	-	M	M	H	H	H	-	-	-	-	-
CLO-2 :	*resolve social problems*	3	80	75	-	-	-	-	-	H	L	M	H	M	-	-	-	-	-
CLO-3 :	*understand social responsibility competencies and CSR activities*	2	80	75	-	-	-	-	-	M	L	L	H	H	-	-	-	-	-
CLO-4 :	*build a business plan to meet social needs*	3	80	75	-	-	-	-	-	M	L	H	H	M	-	-	-	-	-
CLO-5 :	*gain real time experience through student social responsibility project and presentation*	3	80	75	-	-	-	-	-	H	M	H	H	M	-	-	-	-	-
CLO-6 :	*possess an in-depth knowledge of social engineering and effect a social change in the society*	3	80	75	-	-	-	-	-	H	M	M	M	M	-	-	-	-	-

Duration (hour)		6	6	6	6	6
S-1	SLO-1	*Introduction*	*Environment and society*	*Social responsibility competencies*	*Social entrepreneurship*	*Student Social responsibility*
	SLO-2	*Importance of Social Engineering*	*Contribution towards environment*	*Social responsibility competencies*	*Social entrepreneurship*	*Student Social responsibility*
S-2	SLO-1	*Personal awareness*	*Social issues*	*Social responsibility competencies- Profiles*	*Social Entrepreneur*	*Project Presentation*
	SLO-2	*Types of responsibilities*	*Social issues*	*Social responsibility competencies- Facets*	*Types of Social Entrepreneurs*	*Project Presentation*
S-3	SLO-1	*Social Change*	*Group discussion on social Issues*	*Contributing to community*	*Success stories of social entrepreneur*	*Project Presentation*
	SLO-2	*Social Change*	*Group discussion on social Issues*	*Contributing to community*	*Impact of social entrepreneurs in society*	*Project Presentation*
S-4	SLO-1	*Vision towards society*	*Group discussion on social Issues*	*Value diversity and Building relationships*	*Business Plan*	*Project Presentation*
	SLO-2	*Mission towards society*	*Group discussion on social Issues*	*Value diversity and Building relationships*	*Business Plan*	*Project Presentation*
S-5	SLO-1	*Individual social responsibility(ISR)*	*Social Marketing*	*Corporate social responsibility*	*Business Plan*	*Report Analysis*
	SLO-2	*Individual social responsibility(ISR)*	*Social Marketing*	*Types of CSR*	*Business Plan*	*Report Analysis*
S-6	SLO-1	*Case study*	*Non profitable organizations*	*Government Policies on CSR*	*Business Plan*	*Report Analysis*
	SLO-2	*Case study*	*Types of NGO*	*Government Policies on CSR*	*Business Plan*	*Report Analysis*

Learning Resources	1. *Joel Makeower, Beyond The Bottom Line: Putting Social Responsibility to work for your Business and the World,Oct,1995* 2. *Simen Sinek, Start with Why, How great leaders Inspire Everyone to Take Action, Penguin UK, 2011* 3. *Adam Grant, Give and Take: Why Helping others drives our success, Orion Publishing Group, 2014* 4. *David Bornstien, How to change the world, Oxford University Press, 2007*	5. *Nicholls,Alex,ed., Social Entrepreneurship – New Models of Sustainable Social Change, Oxford University Press, 2008* 6. *Ronald R. Sims, Ethics and Corporate Social Responsibility: Why Giants fall, 2003* 7. *Robert A. Rohm, Positive Personality Profiles, Personality Insights, Inc, 2006*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember / Understand	*40%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
Level 2	Apply / Analyze	*40%*	-	*40%*	-	*40%*	-	*40%*	-	*40%*	-
Level 3	Evaluate / Create	*20%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Vijay Nair – Director, Education Matters, vijayn@edmat.org	*1. Dr. A.K. Sheik Manzoor, Anna University, sheikmanzoor@annauniv.edu*	*Mrs. Kavitha Srisaran, SRMIST*
2. Mr. Ajay Zenner, Career Launcher, ajay.z@careerlauncher.com	*2. Dr Vanitha. J., Loyola College, vanithaj@loyolacollege.edu*	*Mr. Priyanand P., SRMIST*

ACADEMIC CURRICULA

Basic Science Courses

Regulations - 2018

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Kancheepuram, Tamil Nadu, India

Course Code	18BTB101T	Course Name	BIOLOGY	Course Category	B	Basic Sciences	L	T	P	C
							2	0	0	2

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Recall the cell structure and function from its organization*
CLR-2 :	*Discuss molecular and biochemical basis of an organism*
CLR-3 :	*Compare enzyme reaction and photosynthesis*
CLR-4 :	*Explain different types of biosensors*
CLR-5 :	*Analyze the different types of bioremediation*
CLR-6 :	*Relate the concept of nervous and immune system* pertaining to diseases

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1 Level of Thinking (Bloom)	2 Expected Proficiency (%)	3 Expected Attainment (%)	PLO 1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	13 PSO - 1	14 PSO - 2	15 PSO – 3
CLO-1 :	*Describe the cell growth, metabolism and reproduction.*	1	80	80	L	H	H	H	-	M	L	H	H	H	-	H	L	H	H
CLO-2 :	*Explain the concepts and experiments in biochemistry*	2	85	75	M	H	H	M	-	-	M	H	L	H	-	H	L	H	H
CLO-3 :	*Recognize the significance of photosynthesis*	2	75	80	M	H	M	H	M	M	-	M	H	H	-	H	L	H	H
CLO-4 :	*Discuss the different methods in enzyme catalytic functions*	2	85	80	L	H	H	H	-	-	H	L	L	H	-	H	M	H	H
CLO-5 :	*Analyze the role of biosensors and its applications*	3	85	75	L	H	H	M	-	M	H	H	H	L	-	H	H	H	H
CLO-6 :	*Explain the concepts of nervous system disorder and the diseases associated with it*	2	80	80	M	H	H	H	L	H	M	M	H	H	-	H	H	H	H

Duration (hour)		6	6	6	6	6
S-1	SLO-1	*Basics of cell biology: Relevance to Engineers*	*Biochemistry: Macromolecules, Biodiversity and its importance*	*Bioenergetics and metabolism*	*Molecular machines and motors*	*Nervous system:History of neuroscience*
	SLO-2	*Cell basic unit of life, Evidence for cell theory*	*Chemistry of life*	*Enzymes as biological catalysts, Significance of enzymes*	*Properties of ATP based protein molecular machines*	*Glial cells, Neurons*
S-2	SLO-1	*Cell structure and function*	*Biochemistry and human biology, DNA replication*	*Thermodynamics of enzymes*	*F0F1 ATP synthase motors, Coupling and coordination of motors*	*Action potential, Organization of nervous system*
	SLO-2	*Genetic Information, Protein structure*	*Transcription, Protein synthesis*	*Factors affecting enzyme activity, Effect of inhibitors on enzyme activity*	*Bacterial flagellar motor, Cytoskeleton*	*Central Nervous system, Peripheral nervous system*
S-3	SLO-1	*Cell metabolism*	*Eukaryotic and prokaryotic protein synthesis difference*	*Mechanism of enzyme action*	*Microtubules*	*Diseases of nervous system*
	SLO-2	*Carbohydrate metabolism, Fatty acid metabolism*	*Concept of genetic code, Stem cells*	*Enzyme strategies, Restriction enzymes*	*Microfilaments, Intermediate filaments*	*Computer- based neural networks*
S-4	SLO-1	*Homeostasis*	*Source of stem cells, Classification of stem cells*	*NMP kinases, Photosynthesis*	*Kinesin linear motor, Dynein motor*	*Immune system*
	SLO-2	*Pathways that alter homeostasis, Cell growth*	*Human embryonic stem cell, Importance and applications of stem cells*	*Light reactions, Photosystems*	*Biosensor*	*Fluid systems of the body, Innate immune system*
S-5	SLO-1	*Reproduction*	*Therapeutic cloning*	*ATP synthesis in chloroplasts*	*Resonant biosensors, Glucose biosensors*	*Cells of innate immune system, Adaptive immunity*
	SLO-2	*Eukaryotic cell division, Mitosis*	*Regenerative medicine*	*Calvin cycle*	*Bio detectors, Biosensor detection in pollutants*	*Diseases of immune system, Immune engineering*
S-6	SLO-1	*Meiosis, Cell differentiation*	*Bone tissue engineering*	*Significance of photosynthesis*	*Bioremediation*	*Cell signaling*
	SLO-2	*Neural crest*	*Gene therapy*	*Metabolism, Glycolysis*	*Bioventing and bio augmentation*	*Cell- surface receptors*

Learning Resources	1. *S. Thyagarajan, N.Selvamurugan, R.A.Nazeer et.al., Biology for engineers McGraw Hill Education. 2012*	2. *Norman Lewis, Gabi Nindl Waite, Lee R. Waite et.al., Applied Cell and Molecular Biology for Engineers. McGraw-Hill Education. 2007*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
Level 2	Apply Analyze	*40%*	-	*40%*	-	*40%*	-	*40%*	-	*40%*	-
Level 3	Evaluate Create	*20%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. C. N. Ramchand, Saksin Life sciences,ramchand@saksinlife.com	*1. Dr. K Subramaniam, IITM Chennai, subbu.iitm.ac.in*	*Dr. S. Thyagarajan, SRMIST*
2. Dr. Karthik Periyasamy, Aurobindo Pharma Limited, Hyderabad, karthikmpk@gmail.com	*2. Dr. R. B. Narayanan, SVCE Chennai, rbn@svce.ac.in*	*Dr.S.Barathi, SRMIST*

Course Code	18BTB103T	Course Name	HUMAN PHYSIOLOGY AND HEALTH	Course Category	B	Basic Sciences	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	18BTC102J -Cell biology, 18BTC106J -Immunology
Course Offering Department	Biotechnology	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Devise understanding of human physiological systems for a better comprehension of the problems faced by human
CLR-2 :	Create an understanding about nervous system that controls and maintains homeostasis
CLR-3 :	Analyze about circulatory and respiratory system
CLR-4 :	Analyze about digestive and excretory system
CLR-5 :	Create an understanding about endocrine and reproductive system
CLR-6 :	Create an understanding about how human body functions

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)
CLO-1 :	Describe the structure and function of cell, communication and gene expression and homeostasis	1	80	70
CLO-2 :	Describe the classification of nervous system, function and diseases associated with it	2	80	70
CLO-3 :	Discuss the structure and function of heart, lung, abnormal functioning	2	80	70
CLO-4 :	Describe anatomy and function of digestive system and urinary system and its disturbances	2	80	70
CLO-5 :	Describe the types of endocrine system, its role in maintaining homeostasis and reproductive biology	2	80	70
CLO-6 :	Explain how human body function and reproduce with maintaining homeostasis	2	80	70

Program Learning Outcomes (PLO)

	1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	13 PSO - 1	14 PSO - 2	15 PSO – 3
CLO-1	H	H	H	H	-	M	L	H	H	H	-	H	H	H	H
CLO-2	H	H	H	H	-	H	M	H	H	H	-	H	H	H	H
CLO-3	M	H	M	H	M	M		M	H	H	-	H	H	H	H
CLO-4	H	H	H	H	-	L	H	L	H	H	-	H	H	H	H
CLO-5	H	H	H	H	-	M	H	H	H	L	-	H	H	H	H
CLO-6	H	H	H	H	L	M	M	M	H	H	-	H	H	H	H

Duration (hour)		6	6	6	6	6
S-1	SLO-1	Cell structure and function	Classification of Nervous System	Heart: Structure, Chambers, valve	Anatomy of Digestive system	Endocrine organs and structure
	SLO-2	Adaptation, Degeneration and aging	Neuron structure and function	Cardiac cycle and Electro cardio gram	Mouth and Salivary glands	Pituitary gland: Parts
S-2	SLO-1	Cell junctions – Gap, Tight and contact	Nerve fibers classification and properties.	chronotropic, ionotropic agents, dromotropic, bathmotropic agents	Stomach: Parts, Structure, Glands, Functions, Properties	Pituitary gland: Regulation, Histology
	SLO-2	Active, Passive transport	Glial cells types, structure and function	Blood vessels – thromboembolism	composition and functions of gastric juice	Pituitary gland: Hormones secreted, functions
S-3	SLO-1	Types of transport	Synapse – Classification	atherosclerosis and arteriosclerosis	Pancreas, Liver	Thyroid gland: Histology and function
	SLO-2	Special type of transport of molecules across biological membranes	Synapse - Anatomy	Septal and valvular defects.	Gall bladder – Role in digestive system	Thyroid gland: Hormones
S-4	SLO-1	Homeostasis– Chemical equilibrium	Synapse - Functions (IPSP and EPSP	Circulation – Systemic and Pulmonary	Small intestine, large intestine	Synthesis of Thyroxine
	SLO-2	Tonicity and osmolality	Synapse - properties	Properties of cardiac muscle: Excitability – electrical potential and action potential	Digestion of Biomolecules	Parathyroid gland structure and function
S-5	SLO-1	control of homeostasis	Neurotransmitters synthesis	Rhythmicity – Natural and artificial pacemakers	Movements of gastrointestinal tracts and disorders	Mode of action and function - disorders
	SLO-2	Role of ions in homeostasis	Neurotransmitters – Types and function	Conductivity, Contractility and Refractory period	Digestion of carbohydrates protein and lipid.	Adrenal gland structure
S-6	SLO-1	Positive feedback regulation of Homeostasis	Action potential	Cardiac cycle and heart sounds and Heart disease	Gastrointestinal hormones	Cortical and medullary - functions
	SLO-2	Negative feedback regulation of Homeostasis	graded potential	Respiratory system: Introduction	Digestive system disorders	Endocrine functions of pancreas

S-7	SLO-1	*Acid-Base Balance: Hydrogen Ion and pH.*	*Brain anatomy and function*	*Types – external and internal respiration*	*Kidney structure and function*	*Insulin and glucagon*
	SLO-2	*Regulation by buffer systems*	*Spinal cord anatomy– Grey and White matter*	*Inspiration and expiration, Anatomy, functional unit*	*nephron structure*	*Diabetes*
S-8	SLO-1	*Acidosis*	*Limbic system: Autonomic Nervous System*	*Non-respiratory functions of respiratory tract*	*Role of hormone in urinary system.*	*Male reproduction organ structure*
	SLO-2	*Alkalosis.*	*Effects on various organ systems.*	*Mechanics of respiration, Pulmonary function tests: Lung volume – Tidal*	*Juxtaglomerular apparatus functions*	*Female reproduction organ structure*
S-9	SLO-1	*Regulation of gene expression*	*Nervous system disease and disorders*	*Inspiratory, Expiratory, Residual volumes; Lung capacities*	*Process of urine formation*	*Oogenesis*
	SLO-2	*Cell signaling and Signal transduction*	*Parkinson's disease,*	*Inspiratory, vital, Functional residual, Total lung capacities.*	*Factors affecting urine formation*	*Spermatogenesis*

Learning Resources	1. *K. Sembulingam, Prema Sembulingam, Essentials of Medical Physiology, Jaypee brothers medical publishers, 7th ed., 2016*	2. *Guyton and Hall, Textbook of Medical Physiology, (Guyton Physiology), Saunders, 13th ed., 2015)*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
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Level 2	Apply Analyze	*40%*	-	*40%*	-	*40%*	-	*40%*	-	*40%*	-
Level 3	Evaluate Create	*20%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. C. N. Ramchand, Saksin Life sciences, ramchand@saksinlife.com	*1. Dr. K Subramaniam, IITM Chennai, subbu.iitm.ac.in*	*Dr. S. Thyagarajan, SRMIST*
2. Dr. Karthik Periyasamy, Aurobindo Pharma Limited, Hyderabad, karthikmpk@gmail.com	*2. Dr. Tamil Selvan, Anna University,Chennai, tamilselvan@annauniv.edu*	*Dr. S. Nageswaran, SRMIST*

Course Code	18MAB201T	Course Name	TRANSFORMS AND BOUNDARY VALUE PROBLEMS	Course Category	B	Basic Sciences	L	T	P	C
							3	1	0	4

Pre-requisite Courses	18MAB102T	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mathematics	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Describe types of Partial differential equations interpret solutions relate PDE to the respective branches of engineering
CLR-2 :	Relate Fourier series expansion in solving problems under RMS value and Harmonic Analysis.
CLR-3 :	Infer the most general form to the PDE and relate to half range sine and cosine series, as the case may be
CLR-4 :	Evaluate the various types of integral transforms
CLR-5 :	Conclude that the purpose of studying z transform is to solve linear difference equations having constant coefficients
CLR-6 :	Predicting the importance of PDE, Fourier series, Boundary value problems and Fourier ,Z – transform applications

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO – 3
CLO-1 :	Determine Partial differential equation	2	85	80	M	H	L	-	-	-	-	-	M	-	-	H	-	-	-
CLO-2 :	Explain the expansion of a discontinuous function as an infinite form of trigonometric sine and cosine series.	2	85	80	M	H	-	M	M	-	-	-	M	L	-	H	-	-	-
CLO-3 :	Decide a proper form of solution for the differential equations which are of hyperbolic and parabolic type	2	85	80	M	H	-	-	-	-	-	-	M	-	-	H	-	-	-
CLO-4 :	justify the relationship between aperiodic signals and linear combination of exponentials.	2	85	80	M	H	-	M	-	-	-	-	M	L	-	H	-	-	-
CLO-5 :	Relate signal analysis with that of z transform	2	85	80	M	H	L	-	-	-	-	-	M	-	-	H	-	-	-
CLO-6 :	Relate PDE, Fourier series, Boundary value problems, Fourier and Z transforms	2	85	80	L	L	L	H	H	H	L	H	H	H	-	H	-	-	-

Duration (hour)		12	12	12	12	12
S-1	SLO-1	Formation of partial differential equation by eliminating arbitrary constants	Introduction of Fourier series - Dirichlet's conditions for existence of Fourier Series	Classification of second order partial differential equations	Introduction of Fourier Transforms	Introduction of Z-transform
	SLO-2	Formation of partial differential equation by eliminating two or more arbitrary constants	Fourier series –related problems in $(0,2\pi)$	Method of separation of variables	Fourier Transforms- problems	Z-transform-elementary properties
S-2	SLO-1	Formation of partial differential equation by eliminating arbitrary functions	Fourier series –related problems in $(-\pi,\pi)$	One dimensional Wave Equation and its possible solutions	Properties of Fourier transforms	Z-transform- change of scale property, shifting property
	SLO-2	Formation of partial differential equation by eliminating two or more arbitrary functions	Change of interval Fourier series –related problems in $(0,2l)$	One dimensional Wave Equation-initial displacement with zero initial velocity-type 1 Algebraic function	Standard results of Fourier transform	Z-transform of $a^n, \frac{1}{n}, \frac{1}{n+1}$
S-3	SLO-1	Formation of partial differential equation by eliminating arbitrary functions of the form $\phi(u,v)=0$	Fourier series –related problems in $(-l,l)$	One dimensional Wave Equation-initial displacement with zero initial velocity-type 2 Trigonometric function	Fourier Sine Transforms - problems	Z-transform of $\frac{1}{n^2}, \frac{1}{(n+1)^2}$
	SLO-2	Solution of first order non-linear partial differential equations-standard type I F(p,q)=0	Fourier series –half range cosine series related problems$(0,\pi)$	One dimensional Wave Equation-initial displacement with zero initial velocity-type 3 – Midpoint of the string is displaced	Fourier Cosine Transforms - problems	Z-transform of $r^n \cos n\theta$
S-4	SLO-1 SLO-2	Problem solving using tutorial sheet 1	Problem solving using tutorial sheet 4	Problem solving using tutorial sheet 7	Problem solving using tutorial sheet 10	Problem solving using tutorial sheet 13
S-5	SLO-1	Solution of first order nonlinear partial differential equations-standard type –II Clairaut's form	Fourier series –half range cosine series related problems$(0,l)$	One dimensional Wave Equation-initial displacement with non-zero initial velocity Type 1 Algebraic function	Properties of Fourier sine Transforms	Z-transform of $r^n \sin n\theta$
	SLO-2	Solution of first order non-linear partial differential equations-standard type III F(z, p, q)=0	Fourier series –half range sine series related problems$(0,\pi)$	One dimensional Wave Equation-initial displacement with non-zero initial velocity Type 2 Trigonometric function	Fourier sine Transforms applications	Initial value theorem

S-6	SLO-1	Solution of first order non-linear partial differential equations-standard type-IV separation of variable f(x, p) = g(y, q)	Fourier series –half range sine series related problems $(0, l)$	Wave Equation-initial displacement with non-zero initial velocity Type 3 split function	Properties of Fourier cosine Transforms	Finial value theorem
	SLO-2	Lagrange's linear equation: Method of grouping	Parseval's Theorem (without proof)-related problems in Fourier series	One dimensional heat equation and its possible solutions	Fourier cosine Transforms applications	Inverse Z-transform- long division method
S-7	SLO-1	Lagrange's linear equation: Method of multipliers	Parseval's Theorem (without proof)-related problems in cosine series	One dimensional heat equation related problems	Convolution of two function	Inverse Z-transform, related problems, long division method
	SLO-2	More problems in Lagrange's linear equation: Method of multipliers	Parseval's Theorem (without proof)-related problems in sine series	One dimensional heat equation -Steady state conditions	Convolution Theorem	Inverse Z-transform, Partial fraction method
S-8	SLO-1 SLO-2	Problem solving using tutorial sheet 2	Problem solving using tutorial sheet 5	Problem solving using tutorial sheet 8	Problem solving using tutorial sheet 11	Problem solving using tutorial sheet 14
S-9	SLO-1	Linear Homogeneous partial differential equations of second and higher order with constant coefficients-CF and PI Type 1: e^{ax+by}	Introduction to Harmonic Analysis	One dimensional heat equation -Steady state conditions more problems	Parseval's Identity for Fourier transform	Inverse Z-transform, Partial fraction method related problems
	SLO-2	PI Type2.: sin(ax+by) or cos(ax+by)	Harmonic Analysis for finding harmonic in $(0,2\pi)$	One dimensional heat equation -Steady state conditions with zero velocity	Parseval's Identity for Fourier sine & cosine transforms	Inverse Z-transform - residue theorem method
S-10	SLO-1	Type 3: PI of polynomial	Harmonic Analysis for finding harmonic in $(0,2l)$	One dimensional heat equation -Steady state conditions with zero velocity more problems	Parseval's Identity for Fourier sine & cosine transforms applications	Inverse Z-transform - residue theorem method-problems
	SLO-2	Type 4 Exponential shifting $e^{ax+by}f(x,y)$	Harmonic Analysis for finding harmonic in periodic interval $(0,T)$	One dimensional heat equation -Steady state conditions with zero velocity more related problems	Fourier Transforms Using Differentiation property	Convolution theorem (without proof)
S-11	SLO-1	Linear Homogeneous partial differential equations of second and higher order with constant coefficients type 5 General rule	Harmonic Analysis for finding cosine series	Steady state conditions and Non-zero boundary conditions- related problems	Solving integral equation	Convolution theorem applications
	SLO-2	Applications of Partial differential equations in Engineering	Harmonic Analysis for finding sine series	Steady state conditions and Non-zero boundary conditions- more problems	Self-reciprocal using Fourier Transform, sine and cosine transform	Solution of linear difference equations with constant coefficients using Z-transform
S-12	SLO-1	Problem solving using tutorial sheet 3	Problem solving using tutorial sheet 6	Problem solving using tutorial sheet 9	Problem solving using tutorial sheet 12	Problem solving using tutorial sheet 15
	SLO-2	Problem solving using tutorial sheet 3	Problem solving using tutorial sheet 6	Problem solving using tutorial sheet 9	Problem solving using tutorial sheet 12	Problem solving using tutorial sheet 15

Learning Resources	1. B. H. Erwin kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons,2006 2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 43rd Edition, 2015 3. Veerarajan T., Transforms and Partial Differential Equations, Tata McGraw-Hill, New Delhi,2012	4. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 3rd Edition, 2010 6. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, for third semester, Laxmi Publications, 3rd Edition, 2014

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
Level 2	Apply Analyze	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
Level 3	Evaluate Create	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. V. Maheshwaran, CTS, Chennai, maheshwaranv@yahoo.com	1. Dr. K. C. Sivakumar, IIT, Madras, kcskumar@iitm.ac.in	1. Dr. A. Govindarajan, SRMIST
2. Dr. Sricharan Srinivasan, Wipro Technologies, sricharanms@gmail.com	2. Dr. Nanjundan, Bangalore University, nanzundan@gmail.com	2. Prof. Ganapathy Subramanian K S, SRMIST

Course Code	18MAB202T	Course Name	NUMERICAL METHODS FOR ENGINEERS	Course Category	B	Basic Sciences	L	T	P	C
							3	1	0	4

Pre-requisite Courses	18MAB102T	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mathematics	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Acquire ability in solving mathematical problems numerically as applied to the respective branches of Engineering
CLR-2 :	Apply the concept of interpolation for finding intermediate values of a well-known data
CLR-3 :	Study the concept of numerical differentiation and integration
CLR-4 :	Apply the numerical techniques for solutions of ordinary differential equations
CLR-5 :	Apply the numerical techniques for solutions of partial differential equations
CLR-6 :	Acquire analytical ability in solving mathematical problems numerically applied to the respective branches of Engineering

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1 Level of Thinking (Bloom)	2 Expected Proficiency (%)	3 Expected Attainment (%)	PLO 1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	13 PSO - 1	14 PSO - 2	15 PSO – 3
CLO-1 :	Solve the algebraic, transcendental and simultaneous equations.	2	85	80	L	-	L	-	-	-	-	-	M	-	-	H	-	-	-
CLO-2 :	Find the finite differences and interpolation.	2	85	80	L	-	-	M	M	-	-	-	-	-	-	-	-	-	-
CLO-3 :	Solve numerical Differentiation and integration.	2	85	80	-	M	-	-	-	-	-	-	M	-	-	H	-	-	-
CLO-4 :	Solve the numerical solutions of ordinary differential equations.	2	85	80	L	M	-	M	-	-	-	-	M	-	-	H	-	-	-
CLO-5 :	Solve the numerical solutions of partial differential equations	2	85	80	-	M	L	-	-	-	-	-	M	-	-	H	-	-	-
CLO-6 :	Solve the problems numerically in science and engineering	2	85	80	H	-	H	-	-	-	-	-	H	-	-	H	-	-	-

Duration (hour)		12	12	12	12	12
S-1	SLO-1	Method of Least Squares – Curve fitting.	First and Higher order differences.	Numerical Differentiation.	Numerical solutions for ordinary differential equations.	Numerical solutions for partial differential equations.
	SLO-2	Fitting a straight line.	Forward differences and backward differences.	Newton's forward difference formulae to compute first and higher order derivatives.	Solution by Taylor's series method.	Classification of partial differential equations.
S-2	SLO-1	Fitting a parabola.	Central Differences.	Newton's backward differences formulae to compute first and higher order derivatives.	Solutions of First order simultaneous differential equations by Taylor's series method.	Solution of Elliptic Equations.
	SLO-2	Calculation of the sum of the squares of the residuals of straight line and parabola.	Operators– Relations between the operators.	Problems by Newton's forward and backward differences formulae.	Euler's method.	Solution of Laplace Equations by Leibmann's Iterative process.
S-3	SLO-1	Solution of Algebraic and Transcendental equations.	Interpolation – Newton-Gregory Forward Interpolation formulae.	Applications of Newton's forward difference formulae to compute first and higher order derivatives.	Applications of Euler's method.	Solution of Laplace Equations by Leibmann's Iterative process.
	SLO-2	Newton-Raphson method.	Interpolation – Newton-Gregory Backward Interpolation formulae.	Applications of Newton's backward difference formulae to compute first and higher order derivatives.	Improved Euler's method.	Solution of Poisson Equations.
S-4	SLO-1 SLO-2	Problem solving using tutorial sheet 1.	Problem solving using tutorial sheet 4.	Problem solving using tutorial sheet 7.	Problem solving using tutorial sheet 10. Modified Euler's method	Problem solving using tutorial sheet 13.
S-5	SLO-1	Bisection method and its applications.	Additional problems using Newton-Gregory Forward Interpolation formulae.	Additional problems for Newton's forward formulae to compute the application problems.	Applications of Improved and Modified Euler's method.	Problems for Poisson Equations.
	SLO-2	Problems using bisection method.	Additional problems using Newton-Gregory Backward Interpolation formulae.	Additional problems for Newton's backward formulae to compute the application problems.	Runge-Kutta method of fourth order.	Additional problems for Poisson Equations.
S-6	SLO-1	Regula-Falsi method.	Divided differences.	Numerical Integration.	Solution by Runge-Kutta method of fourth order.	Solution of Parabolic equations.

	SLO-2	*Problems using false position method.*	*Formation of divided difference table.*	*Trapezoidal rule.*	*Additional problems using Runge-Kutta method of fourth order.*	*Bender-Schmidt formula*
S-7	SLO-1	*Solution of system of equations Direct Method - Gauss Elimination method.*	*Properties of Divided differences.*	*Simpson's one third rule.*	*Predictor-Corrector Methods.*	*Bender-Schmidt formula*
	SLO-2	*Solution of system of equations Direct Method – Gauss-Jordan method.*	*Properties of Divided differences.*	*Simpson's three eighth rule.*	*Milne-Thomson Method.*	*Bender-Schmidt formula*
S-8	SLO-1 SLO-2	*Problem solving using tutorial sheet 2.*	*Problem solving using tutorial sheet 5.*	*Problem solving using tutorial sheet 8.*	*Problem solving using tutorial sheet 11. Problems for Milne-Thomson Method.*	*Problem solving using tutorial sheet 14.*
S-9	SLO-1	*Solution of system of equations Iterative Method – Gauss- Jacobi method.*	*Newton's Divided difference formula.*	*More problems using Trapezoidal rule.*	*Application of Milne-Thomson Method.*	*Crank-Nicolson formula.*
	SLO-2	*Problems using Gauss-Jacobi method.*	*Problems by Newton's Divided difference formula.*	*More problems using Simpson's one third rule.*	*Adam's Bashforth method.*	*Crank-Nicolson formula.*
S-10	SLO-1	*Solution of system of equations Iterative Method – Gauss-Seidal method.*	*Additional problems by Newton's Divided difference formula.*	*More problems using Simpson's three eighth rule.*	*Problems using Adam's Bashforth method.*	*Crank-Nicolson formula.*
	SLO-2	*Problems using Gauss- Seidal method.*	*Lagrange's Interpolation formula.*	*Applications of Trapezoidal rule – Simpson's one third rule and Simpson's three eighth rules.*	*Application of Adam's Bashforth method.*	*Solution of Hyperbolic equations.*
S-11	SLO-1	*Power method.*	*Problems by Lagrange's Interpolation formula.*	*Application problems for Trapezoidal rule – Simpson's one third rule and Simpson's three eighth rules.*	*Additional problems for Milne-Thomson Method.*	*Solution of Hyperbolic equations by Explicit formula.*
	SLO-2	*Finding Eigen values by power method.*	*Inverse interpolation.*	*Applications problems for Trapezoidal rule – Simpson's one third rule and Simpson's three eighth rules.*	*Additional problems for Adam's Bash forth Method*	*More problems in Hyperbolic equations using Explicit formula.*
S-12	SLO-1	*Problem solving using tutorial sheet 3.*	*Problem solving using tutorial sheet 6.*	*Problem solving using tutorial sheet 9.*	*Problem solving using tutorial sheet 12.*	*Problem solving using tutorial sheet 15.*
	SLO-2	*Applications of numerical techniques to solve algebraic, transcendental and simultaneous equations*	*Application of interpolation for finding intermediate values of a well-known data*	*Applications of Numerical integration.*	*Applications of ordinary differential equation.*	*Applications of partial differential equation.*

Learning Resources	*1. B.S. Grewal, Numerical Methods in engineering and science, Khanna Publishers, 42nd edition, 2012* *2. S.S. Sastry, Introductory Methods of Numerical Analysis, PHI, 4th edition, 2005* *3. E. Balagurusamy, Computer Oriented Statistical and Numerical Methods – Tata McGraw Hill., 2000*	*4. M.K.Jain, SRK Iyengar and R.L.Jain, Numerical Methods for Scientific and Engineering Computation, Wiley Eastern Ltd., 4th edition, 2003* *5. Dr. M.K. Venkataraman, Numerical Methods in Science and Engineering, National Publishing Co., 2005*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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2. Dr. Sricharan Srinivasan, Wipro Technologies, sricharanms@gmail.com	*2. Dr. Nanjundan, Bangalore University, nanzundan@gmail.com*	*2. Dr. Sundarammal kesavan, SRMIST*

Course Code	18MAB203T	Course Name	PROBABILITY AND STOCHASTIC PROCESSES	Course Category	B	Basic Sciences	L	T	P	C
							3	1	0	4

Pre-requisite Courses	18MAB102T	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mathematics	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	*Describe the applications on discrete and continuous random variables.*
CLR-2 :	*Assess the applications of two dimensional random variables.*
CLR-3 :	*Infer the various modes of convergence of random variables and their limit theorems.*
CLR-4 :	*Relate the specialized knowledge in random processes in signals and systems.*
CLR-5 :	*Determine the applications of spectral density functions and linear time invariant systems*
CLR-6 :	*Interpret random variables and stochastic processes in the application of practical engineering problems.*

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO – 3
CLO-1 :	*Compare the fundamentals between discrete and continuous random variables.*	3	85	80	M	H	L	-	-	-	-	-	M	L	-	H	-	-	-
CLO-2 :	*Choose the model and analyze systems using two dimensional random variables.*	3	85	80	M	H	-	M	M	-	-	-	M	-	-	H	-	-	-
CLO-3 :	*Describe limit theorems using various inequalities.*	3	85	80	M	H	-	-	-	-	-	-	M	-	-	H	-	-	-
CLO-4 :	*Interpret the characteristics of random processes.*	3	85	80	M	H	-	M	-	-	-	-	M	L	-	H	-	-	-
CLO-5 :	*Evaluate problems on spectral density functions and linear time invariant systems.*	3	85	80	M	H	L	-	-	-	-	-	M	-	-	H	-	-	-
CLO-6 :	*Explain how random variables and stochastic processes can be described and analyzed.*	3	85	80	M	H	-	-	-	-	-	-	M	-	-	H	-	-	-

Duration (hour)		12	12	12	12	12
S-1	SLO-1	*One dimensional random variable: Discrete Case-Probability function, Cumulative Distribution Function*	*Two dimensional random variables-Discrete case*	*Limit theorems--Markov's inequality*	*Random Processes-Introduction*	*Power spectral density function- properties*
	SLO-2	*Continuous random variable-Probability density function*	*Probability function of (X,Y)-Marginal probability distribution*	*Chebyshev's inequality without proof*	*Classification of random processes*	*Proof of properties*
S-2	SLO-1	*Cumulative distribution function-properties*	*Conditional probability distribution of (X,Y)*	*Chebyshev's inequality - Applications*	*Distribution of the process*	*Problems on power spectral density function*
	SLO-2	*Problems on one dimensional random variables*	*Problems on discrete random variables*	*Chebyshev's inequality – Applications using Binomial distribution*	*Averages of the process*	*Problems on power spectral density function*
S-3	SLO-1	*Expectation, variance*	*Continuous random variables-Joint PDF*	*Chebyshev's inequality– Applications using Exponential distribution*	*Stationary, SSS,WSS processes*	*Power density spectrum*
	SLO-2	*Moments-raw and central moments*	*Marginal Probability distributions*	*The weak law of large numbers*	*Problems on stationary and SSS processes*	*Problems based on power density spectrum*
S-4	SLO-1 SLO-2	*Problem solving using tutorial sheet 1*	*Problem solving using tutorial sheet 4*	*Problem solving using tutorial sheet 7*	*Problem solving using tutorial sheet 10*	*Problem solving using tutorial sheet 13*
S-5	SLO-1	*Characteristic function - properties*	*Conditional probability distribution of (X,Y)*	*Central limit theorem without proof*	*Problems on WSS process*	*Linear system with random inputs*
	SLO-2	*Characteristic function*	*Problems on continuous two dimensional random variables*	*Central limit theorem - Applications*	*Problems on WSS process*	*Representation of system in the form of convolution*
S-6	SLO-1	*Binomial distribution -moments*	*Independent random variables*	*Central limit theorem- Applications using Poisson random variables*	*Autocorrelation function -properties*	*Unit impulse response of the system*
	SLO-2	*Binomial distribution-Applications*	*Cumulative distribution function-properties of F(x,y)*	*Central limit theorem- Applications using Exponential random variables*	*Proof of properties*	*Properties*
S-7	SLO-1	*Poisson distribution-moments*	*Expected values of two dimensional random variables*	*The strong law of large numbers*	*Problems on autocorrelation function*	*Applications of unit impulse function*

	SLO-2	*Poisson distribution -Applications*	*Covariance and correlation*	*The strong law of large numbers*	*Application of autocorrelation function*	*Einstein Weiner- Khinchine Relationship*
S-8	SLO-1 SLO-2	*Problem solving using tutorial sheet 2*	*Problem solving using tutorial sheet 5*	*Problem solving using tutorial sheet 8*	*Problem solving using tutorial sheet 11*	*Problem solving using tutorial sheet 14*
S-9	SLO-1	*Exponential distribution-moments*	*Conditional expected values*	*One sided Chebychev's inequality*	*Cross correlation- properties*	*Problems on Khinchine relationship*
	SLO-2	*Exponential distribution-Applications*	*Problems on uncorrelated random variables*	*Cauchy Schwartz inequality*	*Proof of properties*	*Cross power density spectrum-properties*
S-10	SLO-1	*Normal Distribution-moments*	*Functions of two dimensional random variables*	*Chernoff bounds*	*Problems on cross correlation function*	*Properties of Power Spectral Density*
	SLO-2	*Normal Distribution-Applications*	*Probability density functions of the type Z=XY*	*Chernoff bounds for the standard normal variate*	*Ergodicity*	*Cross power density spectrum-problems*
S-11	SLO-1	*Function of a random variable*	*Probability density functions of the type Z=X-Y*	*Chernoff bounds for the Poisson random variate*	*Mean ergodic process*	*Cross power density spectrum*
	SLO-2	*Function of a random variable*	*Probability density functions of the type Z=X/Y*	*Jenson's inequality*	*Mean ergodic theorem*	*Cross power density spectrum*
S-12	SLO-1	*Problem solving using tutorial sheet 3*	*Problem solving using sheet 6*	*Problem solving using tutorial sheet 9*	*Problem solving using tutorial sheet 12*	*Problem solving using tutorial sheet 15*
	SLO-2	*Applications of random variables in engineering*	*Application of two dimensional random variables in Engineering*	*Applications of Central limit Theorem in engineering*	*Applications of random process in engineering*	*Applications of Power spectral density functions in engineering*

Learning Resources	1. *A. Papoulis, S. Uniikrishna Pillai, Probability, Random Variables and Stochastic Processes 4th ed., Mcgraw Hill, 2002* 2. *Henry Stark, Probability and Random Processes with Applications to Signal Processing, 3rd ed., Pearson, 2002* 3. *Sheldon Ross, A first course in Probability, 6th ed., 2011*	4. *S.C. Gupta, V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, 11th ed., 2015* 5. *Veerarajan T., Probability, Statistics and Random Processes with Queueing Theory and Queueing Networks, 4th ed., McGraw-Hill Education, 2015*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. V. Maheshwaran, CTS, Chennai, maheshwaranv@yahoo.com	*1. Dr. K. C. Sivakumar, IIT, Madras, kcskumar@iitm.ac.in*	*1. Dr. A. Govindarajan, SRMIST*
2. Dr. Sricharan Srinivasan, Wipro Technologies, sricharanms@gmail.com	*2. Dr. Nanjundan, Bangalore University, nanzundan@gmail.com*	*2. Dr. V. Srinivasan, SRMIST*

Course Code	18MAB204T	Course Name	PROBABILITY AND QUEUEING THEORY	Course Category	B	Basic Sciences	L	T	P	C
							3	1	0	4

Pre-requisite Courses	18MAB102T	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Mathematics*	Data Book / Codes/Standards	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Apply and evaluating probability using random variables*
CLR-2 :	*Gain the knowledge and acquire the application of distribution to find the probability using Theoretical distributions*
CLR-3 :	*To Assess the appropriate model and apply and soling any realistic problem situation to determine the probability*
CLR-4 :	*To interpret the decision using Markov queueing applications*
CLR-5 :	*To construct chain of decisions from the past situations using Monrovians*
CLR-6 :	*Interpret random variables and Queuing theory in engineering problems.*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO – 3
CLO-1 :	*Solving problems on Discrete and Continuous Random variables*	3	85	80	M	H	L	-	-	-	-	-	M	-	-	H	-	-	-
CLO-2 :	*Identifying Distribution and solving the problems in Discrete and Continuous Distribution*	3	85	80	M	H		M	M	-	-	-	M	L	-	H	-	-	-
CLO-3 :	*Decision Models using sampling techniques in Large and Small samples*	3	85	80	M	H	-	-	-	-	-	-	M	-	-	H	-	-	-
CLO-4 :	*Solving Queuing problems using Kendall's notation*	3	85	80	M	H	-	-	-	-	-	-	M	L	-	H	-	-	-
CLO-5 :	*To Evaluate the probability in uncertain situations using Markov chain rule*	3	85	80	M	H	L	M	-	-	-	-	M	-	-	H	-	-	-
CLO-6 :	*Solving and analyzing the problems in random variables and Queuing theory.*	3	85	80	M	H	-	-	-	-	-	-	M	-	-	H	-	-	-

Duration (hour)		12	12	12	12	12
S-1	SLO-1	*Probability Basic concepts and Axioms*	*Discrete Probability distribution*	*Sampling distribution, Null Hypothesis, Alternate Hypothesis*	*Introduction to F-test*	*Markov Process and Introduction of a Markov Chain*
	SLO-2	*Conditional probability, Multiplication theorem*	*Introduction to Binomial distribution*	*One tailed test, two tailed test*	*Problems on F-test*	*Past and Future - Step and State*
S-2	SLO-1	*Discrete and continuous Random variables*	*MGF, Mean, Variance of Binomial distribution*	*Level of significance, Critical region*	*Chi square test -Goodness of fit*	*One step Transition Probability N step transition Probability*
	SLO-2	*Probability mass function, cdf*	*Applications of Binomial distribution*	*Large samples test*	*Problems on Chi square test -Goodness of fit*	*Chapman-kolmogorov theorem definition*
S-3	SLO-1	*Continuous Random variables*	*Fit a Binomial distribution.*	*Student - t test Single Proportion*	*Problems on Chi-square test Independent-Attributes*	*Initial Probability distribution problems Using Markov Chain*
	SLO-2	*pdf and cdf applications*	*Introduction to Poisson Distribution*	*Two Sample proportions*	*Problems on Chi-square test Independent-Attributes with standard distributions*	*Initial Probability distribution problems Using Markov Chain*
S-4	SLO-1 SLO-2	*Problem solving using tutorial sheet 1*	*Problem solving using tutorial sheet 4*	*Problem solving using tutorial sheet 7*	*Problem solving using tutorial sheet 10*	*Problem solving using tutorial sheet 13*
S-5	SLO-1	*Expectation and Variance*	*MGF , Mean , Variance of Poisson distribution*	*Large sample test- Single Mean*	*Introduction to Queueing Theory and Applications. Kendall, notation*	*Classification of States of a Markov Chain*
	SLO-2	*Problems on Expectation and Variance*	*Applications of Poisson Distribution*	*Difference of Means*	*Introduction to M/M/1 : infinity/ FIFO*	*Irreducible, Non irreducible, a period, Persistent, Non null Persistent*
S-6	SLO-1	*Moment Generating Function*	*Fit a Poisson Distribution*	*Problems on difference of Means*	*Ls, Lq, Ws,Wq*	*Problems on Classification of a Markov Chain*
	SLO-2	*Problems on MGF*	*Introduction , MGF Mean, Variance of Geometric distribution*	*Applications of Difference of Means*	*M/M/1 :Infinity /FIFO problems*	*Problem on Classification of a Markov Chain*
S-7	SLO-1	*Functions of Random variables*	*Applications of Geometric Distribution, problems on Memory less property*	*Introduction to small samples*	*M/M/1 :Infinity /FIFO problems*	*Classification of states of a Markov Chain*
	SLO-2	*Problems on Functions of Random variable*	*Introduction , MGF, Mean, Variance of Uniform Distribution*	*Introduction to small Samples*	*M/M/1 :Infinity /FIFO problems*	*Stationary and steady state*

S-8	SLO-1 SLO-2	*Problem solving using tutorial sheet 2*	*Problem solving using tutorial sheet 5*	*Problem solving using tutorial sheet 8*	*Problem solving using tutorial sheet 11*	*Problem solving using tutorial sheet 14*
S-9	SLO-1	*Tchebycheffs inequality*	*Applications of Uniform Distribution problems*	*Problems on single mean -small samples*	*Single Server Model with Finite System Capacity, Characteristics of the Model (M/M/1) : (K/FIFO)*	*Problems on Classification-State-stationary using Markov Chain*
	SLO-2	*Introduction to theoretical distribution*	*Introduction , MGF, Mean, Variance of Exponential distribution*	*Problems on single mean -small samples*	*Effective arrival rate*	*Problems on Stationary and steady state*
S-10	SLO-1	*Formula and application of Tchebycheffs inequality*	*Applications of Exponential distribution problems*	*Problems on difference of mean-small samples*	*Problems on Model (M/M/1) : (K/FIFO)*	*Problems on Ergodicity using Markov Chain*
	SLO-2	*Applications of chebychevs inequality*	*Introduction to Normal distribution*	*Problems on difference of mean-small samples*	*Problems on Model (M/M/1) : (K/FIFO)*	*Problems on Ergodicity using Markov Chain*
S-11	SLO-1	*Applications of chebychevs inequality using distribution*	*Applications of Normal distribution problems*	*Applications of paired - t test*	*Problems on Model (M/M/1) : (K/FIFO)*	*Problems on Ergodicity*
	SLO-2	*Problems practice using chebychevs inequality*	*Practical applications of Normal distribution*	*Problems of paired - t test.*	*Problems on Model (M/M/1) : (K/FIFO)*	*Problems on Ergodic and Non Ergodic Using Markovchains*
S-12	SLO-1	*Problem solving using tutorial sheet 3*	*Problem solving using tutorial sheet 6*	*Problem solving using tutorial sheet 9*	*Problem solving using tutorial sheet 12*	*Problem solving using tutorial sheet 15*
	SLO-2	*Applications of random variables in engineering*	*Applications of distribution to find the probability using Theoretical distributions*	*Applications of solving any realistic problem situation to determine the probability*	*Applications of Queueing decision models*	*Applications of constructing chain of decisions from the past situations using Monrovians*

Learning Resources	1. *Veerarajan T, Probability , Statistics and Random Processes, Tata Mc.Graw Hill, 1st Reprint 2004* 2. *S.C. Gupta, V.K.Kapoor, Fundamentals of Mathematical Statistics, 9th ed.,, Sultan Chand & Sons, 1999* 3. *Gross. D and Harri.C.M. Fundamentals of Queuing theory, John Wiley and Sons, 1985*	4. *Trivedi K S, Probability and Statistics with reliability, Queueing and Computer Science Applications, prentice Hall of India, New Delhi, 1984* 5. *Allen .A.O. , Probability Statistics and Queueing theory, Academic Press*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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ACADEMIC CURRICULA

Engineering Science Courses

Regulations - 2018

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Kancheepuram, Tamil Nadu, India

Course Code	18CHS201J	Course Name	PHYSICAL AND ANALYTICAL CHEMISTRY	Course Category	S	Engineering Sciences	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Chemical Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Describe the ideal and non-ideal behavior of liquids; learn colligative properties and their applications
CLR-2 :	Elucidate the concepts of chemical equilibrium and the effect of various factors on equilibrium constant
CLR-3 :	Illustrate the difference in behavior of different states of matter essential for separation operations
CLR-4 :	Elucidate the properties and applications of colloids; Understand the kinetics of photochemical reactions
CLR-5 :	Explain the principles of analytical instruments along with their limitations
CLR-6 :	Utilize the physical behavior of atoms and molecules at the microscopic scale

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1 Level of Thinking (Bloom)	2 Expected Proficiency (%)	3 Expected Attainment (%)	PLO 1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	13 PSO - 1	14 PSO - 2	15 PSO – 3
CLO-1 :	Analyze ideal, non-ideal behavior of fluids; Apply colligative properties to find the molecular weight of unknown compounds	2	80	75	H	H	L	L	-	-	-	-	-	-	-	-	H	-	-
CLO-2 :	Describe the significance of Gibbs' free energy and equilibrium constants	2	75	70	H	H	L	L	-	-	-	-	-	-	-	-	M	-	-
CLO-3 :	Apply Gibbs' phase rule and draw the phase diagram of one- and three-component systems	2	75	70	H	H	M	L	-	-	-	-	-	-	-	-	M	-	-
CLO-4 :	Analyze the distinct properties of colloids and photochemical reactions	2	85	80	H	H	-	L	-	-	-	-	-	-	-	-	L	-	-
CLO-5 :	Explain the suitable analytical technique for analyzing various types of compounds	2	80	75	H	-	-	L	L	-	L	-	-	-	-	-	L	-	-
CLO-6 :	Apply the concepts of physical chemistry to various processes in chemical engineering	2	75	70	H	H	M	H	H	M	M	-	-	-	-	M	H	-	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Introduction to solutions, Raoult's law	Introduction to Chemical equilibria	Introduction to Phase equilibria	Introduction to Colloids	Instrumental Methods of Analysis
	SLO-2	Vapour pressures of ideal solutions	Gibbs' free energy and Chemical potential	Component, phase and degrees of freedom	General properties of colloids: Tyndall effect and Brownian movement	Accuracy, precision, common errors (system/manual)
S-2	SLO-1	Vapour pressures of non-ideal solutions	Free energy of a spontaneous reaction	Conditions for equilibrium between phases	Electrical properties of colloids: electrical double layer, Zeta potential	Calibration curves
	SLO-2	Deviations from ideality of Type I, Type II and Type III solutions	Law of mass action	Derivation of Gibbs' phase rule	Electrokinetic properties of colloids: electrophoresis and electro-osmosis	Classification of instrumental methods - spectroscopy, electrochemical and chromatography
S-3	SLO-1	Completely miscible binary solutions: Vapor pressure-Composition and Boiling point-Composition curves of Type I solutions	Law of chemical equilibrium	Representation of one component systems using phase diagrams	Gels and emulsions	Electro-magnetic (EM) spectrum, Interaction of EM radiation with matter
	SLO-2	Vapor pressure-Composition and Boiling point-Composition curves of Type II solutions	Thermodynamic derivation of the law of chemical equilibrium	One component system - water system	Applications of colloids	Generalities of optical methods (light source/ monochromator / sample introduction / detector / signal generator)
S 4-5	SLO-1 SLO-2	Lab 1: Determine critical solution temperature (CST) of phenol-water system	Lab 4: Estimate aspirin drug in tablets using pH meter	Lab 7: Repeat class	Lab 10: Determine the rate constant of acid catalyzed hydrolysis of an ester	Lab 13: Determine fatty acid methyl ester using gas chromatography
S-6	SLO-1	Vapor pressure-Composition and Boiling point-Composition curves of Type III solutions	Problems on Gibbs' free energy	One component system - CO_2 system	Introduction to Photochemistry	Principle, Instrumentation, Working, Applications, and Limitations of analytical techniques
	SLO-2	Fractional distillation of binary liquid systems; The Lever rule	Problems on Gibbs' free energy	One component system - Sulphur system	Laws of photochemistry	UV –Vis spectroscopy
S-7	SLO-1	Distillation of immiscible liquids	Significance of equilibrium constant	Three component systems -Triangular phase diagram	Quantum yield	Infra-red spectroscopy
	SLO-2	Steam ditillation	Equilibrium constants: K_p, K_c,and, K_x	Three component system: acetic acid-chloroform-water system	Photochemical reactions	Atomic absorption spectroscopy

S-8	SLO-1	*Partially miscible liquids*	*Relationship between K_p, K_c, and, K_x*	*Three component system: two salts and water system*	*Photochemical rate law*	*Chromatographic techniques: General principle*
	SLO-2	*Critical solution temperature; Phenol-water system*	*Temperature dependence of Equilibrium constant - Van't Hoff Equation*	*The Nernst distribution law and distribution co-efficient*	*Determination of quantum yields*	*Column chromatography*
S 9-10	SLO-1 SLO-2	*Lab 2: Determine molecular weight by Rast method*	*Lab 5: Estimate sulphate by nephelometry*	*Lab 8: Determine partition co-efficient of benzoic acid between benzene and water*	*Lab 11: Determine the amount of manganese in the given sample of ore*	*Lab 14: Repeat class*
S-11	SLO-1	*Solutions of gases in liquids : Factors influencing solubility of a gas, Henry's law*	*Pressure dependence of equilibrium constants*	*Conditions for the validity of the distribution law*	*Problems on Beer Lambert's law*	*Paper chromatography*
	SLO-2	*Colligative Properties*	*Problems on equilibrium constants*	*Association of the solute in one of the solvents*	*Problems on quantum yield*	*Thin layer chromatography*
S-12	SLO-1	*Relative lowering of vapour pressure, Osmosis and osmotic pressure*	*Problems on equilibrium constants*	*Dissociation of the solute in one of the solvents*	*Kinetics of hydrogen-chlorine reaction: Mechanism*	*Gas chromatography*
	SLO-2	*Elevation in boiling point, Depression in freezing point*	*Le Chatelier's Principle*	*Applications of Nernst distribution law*	*Kinetics of hydrogen-chlorine reaction: Derivation*	*High Performance Liquid Chromatography*
S-13	SLO-1	*Determination of molecular weight from colligative properties*	*Effect of change in concentration, temperature, and pressure*	*Problems on Nernst distribution law*	*Kinetics of hydrogen-bromine reaction: Mechanism*	*Open-ended problems on choice and usage of analytical instruments*
	SLO-2	*Effect of association/dissociation on colligative properties*	*Le Chatelier's principle and physical equilibria*	*Problems on Nernst distribution law*	*Kinetics of hydrogen-bromine reaction: Derivation*	*Open-ended problems on choice and usage of analytical instruments*
S 14-15	SLO-1 SLO-2	*Lab 3: Determine strength of the given acid mixture by conductometric titration*	*Lab 6: Phase diagram of three component system*	*Lab 9: Estimate amount of iron present in a sample using UV-Vis spectrophotometer*	*Lab 12: Determine the amount of reducing sugar by DNS method*	*Lab 15: Practical Model Examination*

Learning Resources	*1. B. R. Puri, L. R. Sharma, Madan S. Pathania, Principles of Physical Chemistry, 47[th] ed., Vishal Publishing Co., 2015* *2. Arun Bahl, B. S. Bahl, G. D. Tuli, Essentials of Physical Chemistry, S. Chand & Company Ltd., 2009.*	*3. Douglas A. Skoog, F. James Holler, Timothy A. Nieman. Principles of Instrumental Analysis, Thomson Learning Inc., 1998*

Learning Assessment

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		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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Experts from Industry	Experts from Higher Technical Institutions	Internal Experts	
1. Mr. A. Subramaniam, PESCO Beam Environmental Solutions Pvt. Ltd.	*1. Dr. Lima Rose Miranda, Anna University email: limamiranda2007@gmail.com*	*1. Dr. M.P. Rajesh, SRMIST*	*3. Dr. S. Prabhakar, SRMIST*
2. Mr. S. T. Kalaimani, CPCL, Chennai	*2. Dr. T. R. Sundararaman, Rajalakshmi Engineering College,*	*2. Dr. K. Deepa, SRMIST*	

Course Code	18CHS251T	Course Name	BASIC CHEMICAL ENGINEERING	Course Category	S	Engineering Sciences	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Chemical Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Describe the basic principles of process calculation
CLR-2 :	Explain the concepts of Stoichiometry equations and material balances.
CLR-3 :	Illustrate the basics of Engineering thermodynamics and first law of thermodynamics
CLR-4 :	Interpret the Second law of thermodynamics and concept of entropy and its applications in chemical process
CLR-5 :	Write the rate equation and reactor design for processes
CLR-6 :	Formulate the material and energy balance for processes and carry out thermodynamic and kinetic analysis.

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO – 3
CLO-1 :	Do unit conversions and stoichiometric calculations	1	90	85	H	H	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Perform material balance for different process	2	80	75	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-3 :	Calculate the heat and work requirement for processes	2	80	80	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-4 :	Analyze the feasibility of processes	2	75	70	H	H	-	H	-	-	-	-	-	-	-	-	H	-	-
CLO-5 :	Write the basic rate equation and basic design of ideal gas	2	80	75	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-6 :	Do the material and energy balance and calculate the thermodynamics parameters and kinetic parameters.	2	80	75	H	H	-	H	-	-	-	-	-	-	-	-	H	M	-

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Units and dimensions	Fundamentals of stoichiometry	Chemical Engineering Thermodynamics	Ideal Gas Processes	Basic Terminology in reaction kinetics – Reaction rate
	SLO-2	Unit conversions	limiting reactant, excess reactant, conversion, selectivity, yield	System, surrounding, boundary, Work, Energy, Heat, Internal energy	Equation for process calculations (for an ideal gas in any mechanically reversible closed system processes)	Factors affecting reaction rate, Rate equation
S-2	SLO-1	Problems solving on unit conversions	Problems solving on limiting and excess reactant	Intensive and Extensive properties	Problems solving on ideal gas	Concentration –Dependent term of a Rate Equation
	SLO-2	Problems solving on unit conversion	Problems solving on conversion and selectivity	State and path functions	Problems solving on ideal gas	Rate constant, order and molecularity of reaction
S-3	SLO-1	mole, mole fraction (or percent) and mass fraction (or percent)	Introduction to material balance	First Law of Thermodynamics- Mathematical statement	Statement of Second Law of Thermodynamics	Classification of Reactions
	SLO-2	Problems solving on mole fraction and mass fraction	Steady state and unsteady state material balance	Limitations of First Law of Thermodynamics	Heat engine	Classification of Reactions
S-4	SLO-1	concentrations	material balance - Drying	Reversible process, Equilibrium	Concept of Entropy	Problems – To Calculate Activation Energy
	SLO-2	molarity, molality, normality and ppm	Problems solving on drying	Types of Equilibrium	Mathematical statement of entropy	Problems – To Calculate Activation Energy
S-5	SLO-1	Density calculation	Problems solving on drying	Energy balance for closed system	Problems solving on entropy	Effect of Temperature dependency on reaction rate-Arrhenius equation
	SLO-2	Problems solving on density calculation	Problems solving on drying with recycle	Energy balance for closed system	Problems solving on	Effect of Temperature dependency on reaction rate-Arrhenius equation
S-6	SLO-1	concentrations	material balance - extraction	Reversible process, Equilibrium	Concept of Entropy	Problems – To Calculate Activation Energy
	SLO-2	molarity, molality, normality and ppm	Problems solving on drying with recycle	Types of Equilibrium	Mathematical statement of entropy	Problems – To Calculate Activation Energy
S-7	SLO-1	Problems solving on molarity, molality and normality	Problems solving on extraction	Derivation for constant volume processes	Entropy change of an ideal gas undergoing a mechanical reversible process in a closed system	Reactor design -basics
	SLO-2	Problems solving on molality	Problems solving on extraction	Derivation for constant pressure processes	Entropy change of an ideal gas undergoing a mechanical reversible process in a closed system	Classification of ideal reactors for single reactions

S-8	SLO-1	*Problems solving on Normality*	*material balance - Crystallization*	*Enthalpy*	*Problems solving on entropy change of an ideal gas*	*Ideal Batch reactor*
	SLO-2	*Problems solving on ppm*	*Problems solving on crystallization*	*Heat capacity: Derivation for heat capacity at constant volume and constant pressure processes*	*Problems solving on entropy change of an ideal gas in a closed system*	*Design of Ideal Batch Reactor*
S-9	SLO-1	*predicting P-V-T properties of gases using ideal gas law*	*Problems solving on crystallization with evaporator*	*Energy Balance for Steady state flow processes*	*Problems solving on entropy change of system*	*Space-Time and Space -velocity*
	SLO-2	*Problems solving on P-V-T properties of gases*	*Problems solving on crystallization with recycle stream*	*Energy Balance for Steady state flow processes*	*Third Law of Thermodynamics*	*Steady state mixed flow and plug flow reactor*

Learning Resources	*1. David M. Himmelblau, Basic Principles and Calculations in Chemical Engineering, 6th ed., Prentice-Hall of India,1998* *2. Bhatt B.I.,Vora S.M., Stoichiometry, 3rd ed., Tata McGraw-Hill Publishing Company, 1996*	*3. Smith, J.M., Van Ness, H.C., Abbott, M.M., Introduction to Chemical Engineering Thermodynamics, 6th ed.,, McGraw Hill International Edition, 2001* *4. Octave Levenspiel, Chemical Reaction Engineering, 3rded.,John Wiley & Sons India,2011*

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		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1 Mr. A. Subramaniam, PESCO Beam Environmental Solutions Pvt. Ltd.	*1. Dr. Lima Rose Miranda, Anna University email: limamiranda2007@gmail.com*	*1. Mr. K. Selvam, SRMIST*
2. Mr. S. T. Kalaimani, CPCL, Chennai	*2. Dr. T. R. Sundararaman, Rajalakshmi Engineering College,*	*2. Ms. S. Kiruthika, SRMIST*

Course Code	18CHS252T	Course Name	CHEMICAL ENGINEERING PRINCIPLES	Course Category	S	*Engineering Sciences*	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Chemical Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Describe the various modes of heat transfer and evaluate the rate of steady state heat transfer*
CLR-2 :	*Explain and analyze the basic concepts of natural and forced convection as applied to various flows and geometry*
CLR-3 :	*Illustrateprinciples of mass transfer, Diffusion phenomena of mass transfer operations, mass transfer coefficients and calculate mass transfer rates*
CLR-4 :	*Elucidate the principles of drying, different types of driers and calculate drying time for different drying periods*
CLR-5 :	*Clarify the concept of distillation and various types of distillation and extraction*
CLR-6 :	*Introduce the basic principles of heat and mass transfer processes, and its applications*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1	2	3	Program Learning Outcomes (PLO) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	*Calculate the rate of heat transfer, and analyze steady state heat conduction.*	2	80	75	H	H	-	-	-	-	-	-	-	-	-	-	M	M	-
CLO-2 :	*Apply the basic concepts and calculate the heat transfer coefficient*	2	80	75	H	H	-	-	-	-	-	-	-	-	-	-	M	M	-
CLO-3 :	*Use mass transfer principles to solve simple diffusion problems*	2	80	70	H	H	-	-	-	-	-	-	-	-	-	-	M	M	-
CLO-4 :	*Calculate drying time for different types of dryer*	2	80	70	H	H	H	-	-	-	-	-	-	-	-	-	M	M	-
CLO-5 :	*Differentiate the various types of distillation and the basics of extraction*	2	80	75	H	H	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-6 :	*Explain the basic principles of heat and mass transfer processes, and its applications*	2	80	75	H	H	M	-	-	-	-	-	-	-	-	-	M	M	-

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Introduction to various modes of heat transfer*	*Concept of heat transfer by convection. Natural and forced convection*	*Introduction to Mass Transfer operations*	*Introduction, Importance of drying in processes*	*Introduction to Distillation, principle*
	SLO-2	*Concept of rate of heat transfer, heat flux.*	*Newton's law of cooling*	*Diffusion, Types, Ficks I law of Diffusion.*	*principles of drying, wet Basis, dry basis*	*Raoult's law*
S-2	SLO-1	*Concept of resistance to heat transfer*	*Application of dimensional analysis for natural convection*	*Steady – state molecular diffusion in fluids at rest and in laminar flow: molecular diffusion in gases.*	*Free moisture, equilibrium moisture, bound and unbound moisture*	*relative volatility*
	SLO-2	*Fourier's law of heat conduction*	*Significance of dimensionless numbers used in natural convection*	*Molecular diffusion in gases: steady state diffusion of A through non-diffusing B*	*Mechanism of drying*	*Methods of distillation: With reflux and without reflux condition*
S-3	SLO-1	*Thermal conductivity*	*Application of dimensional analysis for forced convection*	*Problems solving using molecular diffusion*	*Constant and falling rate period*	*Types of distillation*
	SLO-2	*Steady state heat conduction through a plane wall*	*Significance of dimensionless numbers used in forced convection*	*Gas phase equimolar counter diffusion. Diffusion in Multicomponent gas mixtures*	*Rate of drying curve, critical moisture content*	*Mechanism of batch distillation*
S-4	SLO-1	*Tutorial*	*Empirical correlations for natural convection*	*Problems solving using equimolar counter diffusion*	*Calculation of drying time under constant drying conditions: constant rate period*	*Rayleigh's equation*
	SLO-2	*Steady state heat conduction through a hollow cylinder*	*Problems solving using empirical correlations*	*Problems solving on diffusion in multicomponent gas mixtures*	*Calculation of drying time under constant drying conditions: falling rate period. Total drying time*	*Mechanism of flash distillation*
S-5	SLO-1	*Problems solving on conduction*	*Problems solving using empirical correlations*	*Molecular diffusion in liquids: steady state diffusion of A through non-diffusing B*	*Problems solving using constant rate of drying condition*	*Operating line equation for flash distillation*
	SLO-2	*Problems solving on conduction*	*Empirical correlations for forced convection*	*Problems solving using molecular diffusion*	*Problems solving using falling rate of drying condition*	*Mechanism of steam distillation*
S-6	SLO-1	*Steady state heat conduction through a composite plane wall*	*Problems solving using empirical correlations*	*Problems solving using molecular diffusion*	*Problems solving using total drying rate of drying condition*	*Mechanism of vacuum distillation*
	SLO-2	*Problems solving on composite plane wall*	*Problems solving using empirical*	*Liquid phase equimolal counter diffusion*	*Classification of dryers, solids handling in*	*Mechanism of extractive distillation*

			correlations		*dryers*	
S-7	SLO-1	*Problems solving on hollow cylinder*	*Individual and overall heat transfer coefficient concept*	*Problems solving on equimolar counter diffusion*	*equipments for batch and continuous drying processes*	*Mechanism of azeotropic distillation*
	SLO-2	*Problems solving on concentric hollow cylinder*	*Fouling coefficients*	*Problems solving on equimolar counter diffusion*	*Working principle of tray drier*	*Comparison between extractive and azeotropic distillation*
S-8	SLO-1	*Steady state heat conduction through coaxial cylinders*	*Problems solving on individual heat transfer coefficient*	*Effect of temperature and pressure on diffusivity*	*Working principle of rotary drier*	*Mechanism of Continuous distillation*
	SLO-2	*Problems solving on coaxial cylinder*	*Problems solving on individual heat transfer coefficient*	*Problems solving on effect of temperature and pressure on diffusion*	*Working principle of spray drier*	*General principles of extraction*
S-9	SLO-1	*Problems solving on coaxial cylinder*	*Problems solving on overall heat transfer coefficient*	*Introduction to Mass transfer coefficients*	*Working principle of fluidized bed drier*	*Choice of a solvent*
	SLO-2	*Problems solving on coaxial cylinder*	*Problems solving on overall heat transfer coefficient*	*Types of mass transfer coefficients*	*Concept of freeze drying*	*Working principle of mixer-settler*

Learning Resources	1. *Warren L. McCabe, Julian C. Smith, Peter Harriott, Unit Operations of Chemical Engineering, 7th ed., McGraw Hill Education, 2014* 2. *Christie John Geankoplis, Transport Processes and Separation Process Principles (Includes Unit Operations), 4th ed., Pearson India, 2015*	*3.Binay K Dutta, Heat Transfer: Principles and Applications, PHI Publishers, Delhi,2010* *4.Robert E. Treybal, Mass-Transfer Operations, 3rd ed., McGraw Hill Education, 2012* *5.Binay K. Dutta, Principles of Mass transfer and Separation Processes, Prentice- Hall of India, 2007*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1 Mr. A. Subramaniam, PESCO Beam Environmental Solutions Pvt. Ltd.	*1. Dr. Lima Rose Miranda, Anna University email: limamiranda2007@gmail.com*	*1. Ms. E. Kavitha, SRMIST*
2. Mr. S. T. Kalaimani, CPCL, Chennai	*2. Dr. T. R. Sundararaman, Rajalakshmi Engineering College,*	*2. Ms. E. Poonguzhali, SRMIST*

Course Code	18CHS204T	Course Name	ENGINEERING THERMODYNAMICS	Course Category	S	*Engineering Sciences*	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Chemical Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Describe the basic concepts and laws of thermodynamics, as applied to various systems and processes*
CLR-2 :	*Illustrate the PVT behavior and various equation of state.*
CLR-3 :	*Explain the second law of thermodynamics and the concept of entropy*
CLR-4 :	*Demonstrate the thermodynamic properties and relations, and thermodynamic diagrams*
CLR-5 :	*Elucidate the applications of thermodynamics concepts.*
CLR-6 :	*Elucidate the concept of Energy balance and its applications*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO – 3
CLO-1 :	*Comprehend the basic concepts and laws of thermodynamics as applied for different processes.*	1	90	85	H	-	L	H	H	H	M	-	-	-	-	H	-	-	-
CLO-2 :	*Understand the volumetric behavior and calculate the properties using equation of state.*	1	90	85	H	M	M	M	H	H	M	-	H	-	-	H	-	-	-
CLO-3 :	*Comprehend the second law of thermodynamics and the concept of entropy*	1	90	85	H	M	M	M	H	H	H	H	L	L	H	M	M	L	M
CLO-4 :	*Derive the thermodynamic properties and relations and interpret the thermodynamic diagrams*	2	90	85	H	L	L	L	L	M	H	L	L	L	L	M	M	L	M
CLO-5 :	*Apply the thermodynamic principles to various flow processes and refrigeration.*	2	90	85	H	L	M	L	M	L	L	L	L	L	L	M	M	L	M
CLO-6 :	*Apply the conservation of energy in various chemical engineering processes.*	2	90	85	H	L	L	L	L	M	H	L	L	L	L	M	M	L	M

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Basic concepts of Engineering Thermodynamics.*	*PVT behavior of pure substances: PT diagram*	*Introduction to second law of thermodynamics*	*Fundamental Property relations for a homogeneous fluid of constant composition in a closed system*	*Duct flow of compressible fluids.*
	SLO-2	*Work, heat and energy. Internal energy*	*PV diagram*	*Statements of second law of thermodynamics*	*Fundamental Property relations for a homogeneous fluid of constant composition in a closed system*	*Pipe flow*
S-2	SLO-1	*Thermodynamic properties and its classification.*	*Ideal gas, equations for process calculations (mechanically reversible process in closed system)*	*Heat Engine, Heat pump*	*Maxwell's relations and property estimation.*	*Nozzles*
	SLO-2	*Process and its characterization*	*Isothermal process, isobaric process, isochoric process*	*Carnot's theorem*	*Maxwell's relations and property estimation.*	*Throttling process*
S-3	SLO-1	*Equilibrium*	*Adiabatic process, and polytropic heat capacity*	*Carnot's cycle*	*Enthalpy and entropy as functions of T and P*	*Turbines*
	SLO-2	*Reversible process*	*Problems solving on PVT behavior*	*Ideal-gas temperature scale*	*Enthalpy and entropy as functions of T and P*	*Compression processes: Compressors*
S-4	SLO-1	*First law of thermodynamics*	*Problems solving on PVT behavior*	*Carnot's equation*	*Internal energy and entropy as functions of T and V.*	*Pumps*
	SLO-2	*Energy balance for closed systems*	*Introduction to cubic equations of state:*	*Concept of entropy*	*Internal energy and entropy as functions of T and V.*	*Introduction to ejectors*
S-5	SLO-1	*Problem solving on closed systems*	*Vander Waals equation*	*Entropy changes of an ideal gas in a closed system*	*Two-phase systems: temperature dependence of the vapor pressure of liquids*	*Power cycles*
	SLO-2	*Problem solving on closed systems*	*Redlich/Kwong equation*	*Entropy changes of an ideal gas in a closed system*	*Two-phase systems: temperature dependence of the vapor pressure of liquids*	*Rankine cycle.*

S-6	SLO-1	*Constant volume processes and Constant pressure processes.*	*Problems solving on equation of state*	*Problems solving on Carnot's equation*	*Problems solving on fundamental properties*	*Otto engine*
	SLO-2	*Enthalpy, heat capacity*	*Problems solving on equation of state*	*Problems solving on entropy*	*Problems solving on fundamental properties*	*Diesel engine*
S-7	SLO-1	*Problems solving on enthalpy*	*Virial equations of state,*	*Problems solving on entropy*	*Thermodynamic diagrams.*	*Principles of refrigeration*
	SLO-2	*Problems solving on heat capacity*	*Application of the virial equations*	*Mathematical statement of the second law*	*Joule Thomson expansion*	*Heat Pump*
S-8	SLO-1	*Energy balance for steady-state flow processes*	*Problems solving using Virial equation*	*Entropy balance for open systems*	*Joule Thomson expansion - applications.*	*Carnot refrigerator*
	SLO-2	*Energy balance for steady-state flow processes*	*Problems solving using Virial equation*	*Statement of the third law of thermodynamics.*	*Liquefaction processes*	*Vapor-compression cycle*
S-9	SLO-1	*Problems solving for open system*	*Theorem of corresponding states, acentric factor*	*Problems solving using third law of Thermodynamics*	*Linde liquefaction process*	*Absorption refrigeration*
	SLO-2	*Problems solving for open system*	*Problems solving using acentric factor*	*Problems solving using third law of Thermodynamics*	*Claude liquefaction process*	*Absorption refrigeration*

Learning Resources	*1. Smith, J.M., Van Ness, H.C., Abbott, M.M., Introduction to Chemical Engineering Thermodynamics, 7th ed., McGraw Hill*	*2. Rao .Y.V.C, Chemical Engineering Thermodynamics, University Press (I) Ltd.,1997*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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2. Mr. S. T. Kalaimani, CPCL, Chennai	*2. Dr. T. R. Sundararaman, Rajalakshmi Engineering College,*	*2. Dr. S. Sam David, SRMIST*

Course Code	18CSS201J	Course Name	ANALOG AND DIGITAL ELECTRONICS	Course Category	S	Engineering Sciences	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Science and Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Identify the applications of analog electronics
CLR-2 :	Identify the applications of digital logic families
CLR-3 :	Design the combinational and sequential logic circuits
CLR-4 :	Implement the combinational and sequential logic circuits
CLR-5 :	Analyze the design of counters and registers
CLR-6 :	Utilize the concepts in real time scenarios

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO – 3
CLO-1 :	Identify the analog and digital components in circuit design	1	80	70	H	H	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Analyze the combinational and sequential logic circuits	2	85	75	H	H	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	Apply gates and flip-flops in circuit design	2	75	70	H	-	H	H	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	Use simulation package and realize	2	85	80	H	H	H	H	H	-	-	-	-	-	-	H	-	-	-
CLO-5 :	Apply HDL code and synthesize	2	85	75	H	-	H	H	H	-	-	-	-	-	-	-	-	-	-
CLO-6 :	Build the circuits in bread board and demonstrate and FGPA	3	80	70	-	-	H	H	-	H	-	-	H	-	H	-	-	-	-

		Introduction to Analog electronics	Logic Families	Combinational Logic Circuits	Sequential Logic circuits	Registers & Counters
Duration (hour)		15	15	15	15	15
S-1	SLO-1	Characteristics of BJT (CB, CE and CC configurations) and DC biasing	Transistor as a Switch	Quine-McCluskey minimization technique	Sequential circuits, Latch and Flip-Flops	Registers and Types of Registers- Serial In - Serial Out, Serial In - Parallel out
	SLO-2	BJT Uses	Characteristics of Digital ICs	Combinational Circuits	RS Flip-Flops,	Parallel In - Serial Out, Parallel In - Parallel Out
S-2	SLO-1	Characteristics and uses of JFET (CS, Common Drain and Common Gate)	DL, RTL	Multiplexer	Gated Flip-Flops	Universal Shift Register
	SLO-2	Differences between BJT and JFET	DTL,TTL	Demultiplexer	Edge-triggered RS FLIP-FLOP	Applications of Shift Registers
S-3	SLO-1	Transistor Amplifier: CE amplifier	ECL	Decoder	Edge-triggered D FLIP-FLOPs	Synchronous Counters
	SLO-2	Transistor Amplifier: CC ,CB amplifier	IIL	Encoder	Edge-triggered T FLIP-FLOPs	Asynchronous Counters
S 4-5	SLO-1 SLO-2	Lab 1: Design and Implement Half and Full Wave Rectifiers using simulation	Lab 4: Design and implement transistor as a switch	Lab 7: Design and implement code converters using logic gates simulation	Lab 10: HDL implementation of Flip-Flop	Lab 13: Implement SISO, SIPO, PISO and PIPO shift registers using Flip- flops
S-6	SLO-1	Power Amplifiers: Different classes of Amplifiers and its operation-Class A	Characteristics and uses of MOSFET (CS, Common drain and Common gate)	Binary adder	Edge-triggered JK FLIPFLOPs	Changing the Counter Modulus
	SLO-2	Class B, AB and C	MOSFET Logic	Binary adder as subtractor	JK Master-slave FLIP-FLOP	Decade Counters
S-7	SLO-1	Operational Amplifiers: Ideal v/s practical Op-amp	PMOS,NMOS	Carry look ahead adder	Analysis of Synchronous Sequential Circuit, State Equation, State table	Presettable counters
	SLO-2	Performance Parameters	CMOS Logic	Decimal adder	State Diagram	Counter Design as a Synthesis problem
S-8	SLO-1	Applications: Peak detector, Comparator, Inverting, Non-Inverting Amplifiers	Propagation delay	Magnitude Comparator	Synthesis of sequential circuit using Flip-Flops	Seven segment Display and A Digital Clock.
	SLO-2	Problem solving session	Problem solving session	Problem solving session	Problem solving session	Problem solving session

S 9-10	SLO-1 SLO-2	*Lab 2: Design and implement Schmitt trigger using Op-Amp (simulation)*	*Lab 5: Design CMOS Inverter, measure propagation delay for rising & falling edge*	*Lab 8: Design and implement using simulation the combinational circuits*	*Lab 11: Design and implement using simulation; Synchronous sequential circuits*	*Lab 14: HDL for Registers and Counters*
S-11	SLO-1	*Effect of positive and Negative Feedback Amplifiers,*	*Tristate Logic*	*Read Only Memory*	*Asynchronous sequential circuit*	*D/A Conversion*
	SLO-2	*Analysis of Practical Feedback Amplifiers*	*Tristate Logic Applications*	*Arithmetic Logic Unit*	*Transition Table*	*Types of D/A Converters*
S-12	SLO-1	*Oscillator Operation*	*FPGA Basics*	*Programmable Logic Arrays*	*State table*	*Problem*
	SLO-2	*Crystal Oscillator*	*Introduction to HDL and logic simulation*	*HDL Gate and Data Flow modeling*	*Flow table*	*A/D Conversion*
S-13	SLO-1	*Overview of UJT, Relaxation Oscillator,555 Timer*	*HDL System primitives, user defined primitives, Stimulus to the design*	*HDL Behavioral modeling*	*Analysis of asynchronous sequential circuits*	*Types of A/D conversion*
	SLO-2	*Problem solving session*	*Problem solving session*	*Problem solving session*	*Problem solving session*	*Problem solving session*
S 14-15	SLO-1 SLO-2	*Lab 3: Design and implement using simulator a rectangular waveform generator (Op-Amp relaxation oscillator)*	*Lab 6: HDL Program to realize delay and stimulus in simple circuit*	*Lab 9: HDL program for combinational circuits*	*Lab 12: HDL program for Sequential circuits*	*Lab 15: Design and Implement an A/D Converter.*

Learning Resources	*1. Robert L. Boylestad& Louis Nashelsky, Electronic Devices & Circuit Theory, 11th ed., Pearson, 2013* *2. Anil K Maini, Varsha Agarwal: Electronic Devices and Circuits, Wiley, 2012* ***3.** Paul Tuinenga, SPICE: A Guide to Circuit Simulation and Analysis Using PSpice, 3rd ed., Prentice-Hall, 1995,*	*4. Douglas A, G.K. Kharate, Digital Electronics, Oxford university Press,2012* *5. M. Morris R. Mano, Michael D. Ciletti, Digital Design: With an Introduction to the Verilog HDL, VHDL, and SystemVerilog, 6th ed., Pearson, 2018* *6. A.P. Malvino, Electronic Principles,7th Edition, Tata Mcgraw Hill Publications, 2013*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts	
1. Dr. Devi Jayaraman , Virtusa, devij@virtusa.com	*1. Dr. J. Dhalia Sweetlin, Anna University, jdsweetlin@mitindia.edu*	*1. Dr. Annapurani Panaiyappan.K, SRMIST*	
2. Dr. Viswanadhan, Teken BIM Technologies, viswanathan_alladi@yahoo.com	*2. Dr. B. Latha, Sairam Engineering College, hod.cse@sairam. edu.in*	*2. Dr. D. Anitha, SRMIST*	*3. Ms. Kayalvizhi J, SRMIST*

Course Code	18CSS202J	Course Name	COMPUTER COMMUNICATIONS	Course Category	S	Engineering Sciences	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Science and Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Understand the basic services and concepts related to Internetwork
CLR-2 :	Understand the layered network architecture
CLR-3 :	Acquire knowledge in IP addressing
CLR-4 :	Exploring the services and techniques in physical layer
CLR-5 :	Understand the functions of Data Link layer
CLR-6 :	Implement and analyze the different Routing Protocols

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO – 3
CLO-1 :	Apply the knowledge of communication	2	80	70	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Identify and design the network topologies	3	85	75	H	-	H	-	-	-	-	-	-	-	-	-	M	-	-
CLO-3 :	Design the network using addressing schemes	3	75	70	H	H	-	-	-	-	-	-	-	-	-	-	M	-	M
CLO-4 :	Identify and correct the errors in transmission	1	85	80	H	H	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-5 :	Identify the guided and unguided transmission media	1	85	75	H	-	-	H	-	-	-	-	-	-	-	-	-	-	-
CLO-6 :	Design and implement the various Routing Protocols	3	80	70	H	H	H	H	H	-	-	-	-	-	-	-	M	-	M

Duration (hour)		12	12	12	12	12
S-1	SLO-1	Evolution of Computer Networks, Network categories	IPv4 Addressing, Address space	Line coding: Unipolar scheme	Framing, Flow Control Mechanisms	Forward Techniques, Forwarding Process
	SLO-2	Data Transmission Modes, Network topologies	Dotted Decimal Notation. Classful Addressing	Polar schemes, Bipolar schemes	Sender side Stop and Wait Protocol, Receiver side Stop and Wait Protocol	Routing Table
S-2	SLO-1	Circuit Switching and Packet Switching	Subnet Mask	Amplitude shift keying, Frequency shift keying	Goback N ARQ, Selective Reject ARQ	Intradomain Routing and Interdomain Routing
	SLO-2	Protocols and standards	Subnetting	Phase shift keying, Pulse code Modulation, Delta Modulation	CRC, Checksum	Static Routing and Dynamic Routing
S 3-4	SLO-1 SLO-2	Lab 1: IP Addressing	Lab 4: Router Configuration (Creating Passwords, Configuring Interfaces)	Lab 7: RIP v1	Lab 10: EIGRP Authentication and Timers	Lab 13: Examining Network Address Translation (NAT)
S-5	SLO-1	Layers in the OSI model, Functions of Physical layer, data link layer	Special Addresses	Multiplexing: FDM	Types of Errors	Distance Vector Routing, Problem Solving
	SLO-2	Functions of Network layer, Transport layer	Special Addresses	Multiplexing: FDM	Types of Errors	Link state Routing
S-6	SLO-1	Functions of Session, Presentation layer and Application layer	Classless Addressing	TDM	Forward Error correction	Problem solving
	SLO-2	TCP/IP protocol suite , Link layer protocols	Problem Solving	WDM	CSMA, CSMA/CD	Path vector Routing
S 7-8	SLO-1 SLO-2	Lab 2: Subnetting (VLSM)	Lab 5: Basic Switch Configuration: Vlan	Lab 8: RIP v2	Lab 11: Single-Area OSPF Link Costs and Interface	Lab 14: BGP Configuration
S-9	SLO-1	Network layer protocols	Private Address, NAT, Supernetting	Guided Media: Twisted Pair, Coaxial Cable Fiber optic cable	Hamming Distance	RIP v1,RIP v2
	SLO-2	Transport layer protocols	Hub, Repeaters, Switch	Unguided media: Radio waves	Correction Vs Detection	OSPF
S-10	SLO-1	Serial and Parallel Transmissions	Bridge	Microwaves	HDLC	EIGRP

	SLO-2	*Addressing*	*Structure of Router*	*Infrared*	*PPP*	*BGP*
S 11-12	SLO-1 SLO-2	*Lab 3: LAN Configuration using straight through and cross over cables*	*Lab 6: Static and Default Routing*	*Lab 9: EIGRP Configuration, Bandwidth, and Adjacencies*	*Lab 12: Multi-Area OSPF with Stub Areas and Authentication*	*Lab 15: Configuring Static and Default Routes*

Learning Resources	1. *Behrouz A. Forouzan, "Data Communications and Networking" 5th ed., 2010* 2. *Bhushan Trivedi," Data Communication and Networks" 2016*	3. *William Stallings, Data and Computer Communications,9th ed., 2010* 4. *Todd Lammle, CCNA Study Guide, 7th ed. 2011*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts	
1. Dr. Viswanadhan, Teken BIM Technologies, viswanathan_alladi@yahoo.com	*1. Dr. J. Dhalia Sweetlin, Anna University, jdsweetlin@mitindia.edu*	*1. Mrs. T. Manoranjtham , SRMIST*	
2. Dr. Devi Jayaraman , Virtusa, devij@virtusa.com	*2. Dr. B. Latha, Sairam Engineering College, hod.cse@sairam. edu.in*	*2. Mr. J. Godwin Ponsam, SRMIST*	*Dr. J.S. Femilda Josephin, SRMIST*

Course Code	18ECS201T	Course Name	CONTROL SYSTEMS	Course Category	S	*Engineering Sciences*	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*18ECC104T*	Progressive Courses	*Nil*
Course Offering Department	*Electronics and Communication Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Learn about mathematical modeling techniques of mechanical and electrical systems*
CLR-2 :	*Impart knowledge about the transient and steady state error and analysis*
CLR-3 :	*Identify and analyze stability of a system in time domain using root locus technique*
CLR-4 :	*Know about different frequency domain analytical techniques*
CLR-5 :	*Acquire the knowledge of a controller for specific applications*
CLR-6 :	*Impart knowledge on controller tuning methods*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning: 1 Level of Thinking (Bloom)	2 Expected Proficiency (%)	3 Expected Attainment (%)	PLO 1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	13 PSO–1: Professional Achievement	14 PSO – 2: Project Management Techniques	15 PSO – 3: Analyze & Research
CLO-1 :	*Determine Transfer function of a system by mathematical modeling, block diagram reduction and signal flow graphs*	*1,2*	*80*	*80*	*H*	*H*	*H*	*H*	-	-	-	-	-	-	-	*H*	*H*	-	*H*
CLO-2 :	*Identify the standard test inputs, time domain specifications and calculate steady state error*	*1,2*	*85*	*80*	*H*	*H*	*H*	*H*	*H*	-	-	-	-	-	-	*H*	*H*	-	*H*
CLO-3 :	*Plot a root locus curve and analyze the system stability using Routh array*	*2,3*	*90*	*85*	*H*	*H*	*H*	*H*	*H*	-	-	-	-	-	-	*H*	*H*	-	*H*
CLO-4 :	*Analyze the frequency domain specifications from bode and polar plots*	*2,3*	*90*	*85*	*H*	*H*	*H*	*H*	*H*	-	-	-	-	-	-	*H*	*H*	-	*H*
CLO-5 :	*Design a closed loop control system for specific application*	*1,2,3*	*80*	*80*	*H*	*H*	*H*	*H*	*H*	-	-	-	-	-	-	*H*	*H*	*H*	*H*
CLO-6 :	*Identification of controller parameters and tuning*	*1,2,3*	*85*	*85*															

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Open and closed loop control system*	*Standard test signals and their expression*	*Poles and zeros of a system*	*Frequency domain analysis*	*Controllers-Significance and Need*
	SLO-2	*Feedback and Feed forward control systems*	*Type number and order of a system*	*Pole zero plot and concept of s plane*	*Frequency domain specifications*	*Stability of closed loop systems*
S-2	SLO-1	*Transfer function of a system and basis of Laplace transforms*	*Transfer function of First order system for Step and ramp signal*	*Proper, Strictly Proper and Improper systems*	*Frequency domain plots, minimum and non minimum phase systems*	*SISO and MIMO control systems*
	SLO-2	*Need for mathematical modeling*	*Transfer function of First order system Impulse and parabolic signal*	*Characteristic equation*	*Correlation between time and frequency domain*	*Types of controllers-ON-OFF,P,I,D*
S-3	SLO-1	*Representation of mechanical translational systems using differential equation and determination of transfer function*	*General transfer function of second order system*	*Concept of stability from pole zero location*	*Bode plot approach and stability analysis*	*Composite Controller-PI,PD and PID*
	SLO-2		*Identification of damping factor and classification based on it*	*Need for Stability analysis and available techniques*	*Rules for sketching bode plot*	*Controller parameters and tuning methods*
S-4	SLO-1	*Representation of mechanical rotational systems and determination of transfer function*	*Step response of critically damped second order system*	*Necessary and sufficient Condition for stability*	*Bode plot of typical systems*	*Design Specification, controller configurations- ON-OFF controller*
	SLO-2		*Step response of under damped second order system*	*Significance of Routh Hurwitz Technique*		
S-5	SLO-1	*Conversions of Mechanical system to Electrical system*	*Step response of over damped second order system*	*Computation of Routh array*	*Bode plot of typical systems*	*Design Specification, controller configurations-PID controller*
	SLO-2	*f-V and f-I electrical analogies*	*Step response of undamped second order system*	*Routh array of stable systems*		

S-6	SLO-1	*Block diagram reduction rules and methodology*	*Time domain specifications and their significance*	*Routh array of Unstable systems*	*Polar plot and significance*	*Design of speed control system for DC motor*
	SLO-2		*Numerical solution*	*Routh array of Unstable systems*	*Nyquist stability criterion*	
S-7	SLO-1	*Evaluation of transfer function using block diagram reduction*	*Transient and steady state error analysis*	*Root locus technique*	*Sketching of polar plot on polar graphs*	*Design of control system for Twin Rotor Multi input Multi output System(TRMS) with one degree of freedom*
	SLO-2		*Static and dynamic Error coefficients*	*Rules for sketching root locus*		
S-8	SLO-1	*Signal flow graphs and evaluation of transfer function*	*Static error constants and evaluation of steady state error*	*Root locus plot of typical systems*	*Polar plot of typical systems*	*Case study 1*
	SLO-2					
S-9	SLO-1	*Block diagram to signal flow conversion*	*Dynamic error constants and evaluation of steady state error*	*Root locus plot of typical systems*	*Polar plot of typical systems*	*Case study 2*
	SLO-2					

Learning Resources	1. Nagrath.J and Gopal.M,, "Control System Engineering", 5th Edition, New Age, 2007 2. Benjamin C Kuo, "Automatic Control System", 9th edition, John Wiley & Sons, 2010	3. Gopal.M, "Control System Principles and Design", 2nd Edition, TMH, 2002 4. Sivanandam and Deepa, "Control system Engineering using MATLAB", 2nd edition, Vikas publishers, 2007

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
Level 2	Apply Analyze	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
Level 3	Evaluate Create	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Mr. Anuj Kumar, Bombardier* Transportation, Ahmedabad, *kumaranuj.anii@gmail.com*	1. *Dr. Meenakshi, Professor* of ECE, CEG, Anna University, *meena68@annauniv.edu*	*Dr. T. Deepa, SRMIST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	*Mrs. R. Bakhya Lakshmi, SRMIST*

Course Code	18MES201T	Course Name	ENGINEERING MECHANICS	Course Category	S	Engineering Sciences	L	T	P	C
							3	1	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechanical Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Construct mathematical models, formulate and solve static equilibrium problems in engineering and its applications
CLR-2 :	Utilize theory of dry friction in Mechanical Engineering applications
CLR-3 :	Utilize the concept of centroid and moment of inertia in engineering problems and its applications
CLR-4 :	Solve problems on kinematics and kinetics of particles
CLR-5 :	Solve problems on kinematics and kinetics of rigid bodies
CLR-6 :	Apply static and dynamic equilibrium of particles and rigid bodies

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO – 3
CLO-1 :	Solve statically determinate equilibrium problems in the field of Engineering	2	80	75	H	H	M	M	M	L	L	L	L	L	L	L	L	L	L
CLO-2 :	Solve problems related to dry friction and analyze machines that are functioning based on the theory of friction	2	85	75	H	H	M	M	M	L	L	L	L	L	L	L	L	L	L
CLO-3 :	Determine centroid and moment of inertia for composite objects	2	85	75	H	H	M	M	M	L	L	L	L	L	L	L	L	L	L
CLO-4 :	Analyze kinematics of particles with rectilinear, curvilinear motions, solve dynamic equilibrium problems in particles	2	80	75	H	H	M	M	M	L	L	L	L	L	L	L	L	L	L
CLO-5 :	Analyze kinematics of rigid bodies with translation, rotation, general plane motion, solve dynamic equilibrium in rigid bodies	2	80	75	H	H	M	M	M	L	L	L	L	L	L	L	L	L	L
CLO-6 :	Solve static and dynamic equilibrium of particle and rigid body problems	2	75	70	H	H	M	M	M	L	L	L	L	L	L	L	L	L	L

Duration (hour)		12	12	12	12	12
S-1	SLO-1	Introduction to Mechanics, classification of mechanics	Friction and its types, Laws of Friction, coefficient of friction	Centre of Gravity and Centroids of lines, areas	Rectilinear motion, with non-uniform velocity and acceleration motion	Kinematics of rigid bodies: Translation and rotation of rigid bodies,
	SLO-2	Fundamental concepts and principles of engineering mechanics	Angle of Friction, Angle of repose, limiting friction	Centre of Gravity and Centroids of volumes	Uniform velocity and uniform acceleration motion	Fixed axis rotation - determination of angular displacement, velocity and acceleration
S-2	SLO-1	Concurrent forces in a plane, Coplanar forces	Equilibrium of a block resting on a rough inclined plane	Determination of centroid of line by integration	Curvilinear motion, Normal, tangential, radial	General plane motion
	SLO-2	Vector approach on addition, subtraction of forces	Range of force required to maintain equilibrium of block on rough inclined plane	Determination of area by integration	transverse components of acceleration	Relative motion method
S-3	SLO-1	Resolution of forces	Example problems on dry friction	Centroid of composite lines	Projectile motion, terminology	Velocity analysis of rigid bodies using relative velocity method
	SLO-2	Resultant of several concurrent forces in plane (vector approach)	Applications of friction in wedges	Centroid of composite areas	Derivation of equation of trajectory of a projectile	Velocity analysis of rigid bodies using relative velocity method
S-4	SLO-1 SLO-2	Tutorial on resultant of several concurrent forces	Tutorial on dry and wedge friction	Tutorial on centroid of composite line and area	Tutorial on Projectile motion	Tutorials on velocity analysis of general plane motion using relative velocity method
S-5	SLO-1	Equilibrium of Particle, Free body diagram, Forces in planes, Lami's theorem	Application of friction in Ladder	Determination of centroid of volume by integration	Relative motion	Acceleration analysis of rigid bodies using relative acceleration method
	SLO-2	Problems on equilibrium of particle in planes	Example problems	Determination of centroid of volume by integration	constrained motion	Acceleration analysis of rigid bodies using relative acceleration method
S-6	SLO-1	Forces in space: resultant of concurrent forces in space	Application of friction in flat and V-belts, Ratio of belt tensions	Determination of centroid of composite volume	Newton's second law of motion, D'Alembert's principle	Instantaneous center of rotation in plane motion
	SLO-2	Problems on equilibrium of particle in space	Application of friction in V-belts, Ratio of belt tensions	Theorems of Pappus & Guldinus	Problems using Newton's second law	examples

S-7	SLO-1	*Statics of rigid body, Principle of transmissibility*	*Application of friction in screw jack*	*Determination of moment of inertia of area by integration*	*Principle of work and energy*	*Velocity analysis of rigid bodies using Instantaneous center method*
	SLO-2	*Moment of a force, Varignon's Theorem and its applications*	*Terminology in screws, self-locking of screw jack*	*Determination of moment of inertia of area by integration*	*conservative forces, law of conservation of energy*	*Velocity analysis of rigid bodies using Instantaneous center method*
S-8	SLO-1 SLO-2	*Tutorials on Moment of force and couple system*	*Tutorial on Screw and belt friction*	*Tutorial on area moment of Inertia of composite section*	*Tutorial on principle of work energy*	*Tutorial on Velocity analysis of rigid bodies using Instantaneous center of rotation*
S-9	SLO-1	*Reduction of system of forces into single force and couple system*	*Effort, Mechanical advantage of a screw jack*	*Radius of gyration*	*Principle of impulse and momentum*	*kinetics of rigid bodies, Angular momentum*
	SLO-2	*Reduction of system of forces into single force and couple system*	*efficiency of a screw jack*	*Parallel and perpendicular axis theorems*	*problems on Impulsive motion*	*Newton's second law*
S-10	SLO-1	*Resultant of non-concurrent forces in plane*	*Problems on simple screw jack*	*Derivation of Mass moment of inertia of plate, prism*	*Problems on impulse*	*Problems using Newton's second law*
	SLO-2	*Types of supports and reactions*	*Problems on simple screw jack*	*Derivation of Mass moment of inertia of cylinder*	*Problems on momentum principle*	*Problems using Newton's second law*
S-11	SLO-1	*Equilibrium of rigid bodies in two dimensions*	*Problems on differential screw jack*	*Derivation of Mass moment of inertia of cone*	*Impact of elastic bodies, direct central*	*Kinetics of rigid bodies using work energy principle*
	SLO-2	*Equilibrium of rigid bodies in two dimensions*	*Problems on differential screw jack*	*Derivation of Mass moment of inertia of sphere*	*oblique central impact of elastic bodies*	*Kinetics of rigid bodies using work energy principle*
S-12	SLO-1 SLO-2	*Tutorial on Equilibrium of a two-force body*	*Tutorial on simple and differential screw jack*	*Tutorial on determination of mass moment of inertia of composite bodies*	*Tutorial on oblique central impact of elastic bodies*	*Tutorial on rigid bodies using work- energy principle*

Learning Resources	1. *Ferdinand.P. Beer. E, Russell Johnston Jr., David Mazurek, Philip J Cornwell, Vector Mechanics for Engineers: Statics and Dynamics, McGraw - Hill, 10th ed., 2013* 2. *Meriam J.L and Kraige L.G., Engineering Mechanics, Volume I - statics, Volume II - dynamics, John Wiley & Sons, 7th ed., 2012*	3. *Russel C Hibler, Engineering Mechanics: Statics, Dynamics, Pearson,14th ed., 2015* 4. *Shames.I.H, Krishna MohanaRao.G, Engineering Mechanics (Statics and Dynamics), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 2006* 5. *Timoshenko, Young, Engineering Mechanics, Tata Mc-Graw Hill, 5th ed., 2013*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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2. Dr. A. Velayutham, DRDO, Avadi, velayudham.a@cvrde.drdo.in	*2.Dr. K. Jayabal, IIITDM, Kancheepuram, jayabal@iiitdm.ac.in*	*2. Dr. S. H. Venkatasubramanian, SRMIST*

Course Code	18MHS201T	Course Name	THERMODYNAMICS AND HEAT TRANSFER	Course Category	S	Engineering Sciences	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechatronics Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Utilize the thermodynamic processes with the help of P-V and T-S diagram
CLR-2 :	Utilize second law of thermodynamics and the performance of Heat pump, engine and refrigeration system
CLR-3 :	Utilize the properties of air and the working principle of different air conditioning and refrigeration system
CLR-4 :	Solve the basic calculations involving conduction and convection in Mechatronics system
CLR-5 :	Identify applications of heat transfer in mechatronics systems, study heat requirements of gas turbines and IC engines.
CLR-6 :	Utilize fundamentals of thermodynamics and its application in Mechatronics system

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	13 PSO - 1	14 PSO - 2	15 PSO - 3
CLO-1 :	Identify and describe the energy exchange processes in engineering systems.	2	75	70	H	H	M	M	L	L	L	L	L	L	L	H	M	M	M
CLO-2 :	Understand the second law of thermodynamics and its application to a wide range of systems	2	75	70	H	H	M	M	L	L	L	L	L	L	L	H	M	M	M
CLO-3 :	Extrapolate the psychrometric properties and performance of refrigeration and air conditioning systems	2	75	70	H	H	M	M	L	L	L	L	L	L	L	H	M	M	M
CLO-4 :	Extrapolate the different modes of heat transfer like conduction, convection and radiation.	2	75	70	H	H	M	H	M	M	L	L	L	L	L	H	M	M	M
CLO-5 :	Analyze the heat transfer in refrigeration and air-conditioning systems, internal combustion engine and heat exchangers.	3	75	70	H	H	M	H	M	M	M	L	L	L	L	H	M	M	M
CLO-6 :	Understand the basic laws of thermodynamics and its applications in different engineering systems	3	75	70	H	H	H	M	L	L	L	L	L	L	L	H	M	M	M

Duration (hour)		12	12	12	12	12
S-1	SLO-1	Introduction to thermodynamics	Second law of thermodynamics	Introduction to psychrometric properties	Introduction to heat transfer	Introduction to IC engine and engine components
	SLO-2	Statistical and classical approach.	Kelvin Planck statement, Clausius statement	Dry air, moist air, dry bulb temperature.	Modes of heat transfer: Conduction, convection and radiation	Working principle of two and four stroke of SI and CI engine
S-2	SLO-1	Thermodynamic system, properties, processes and cycles.	Reversible and irreversible processes	Wet bulb temperature, dew point temperature, specific humidity	Fourier law of conduction	Modes of Heat transfer in IC engine
	SLO-2	Thermodynamic equilibrium: Mechanical, chemical and thermal equilibrium.	Second law aspects of heat engine	Calculations of vapor mixtures	General heat conduction equation in Cartesian co-ordinates.	Heat transfer and Engine energy balance
S-3	SLO-1	Quasi-static process, Work and heat transfer	Performance of heat engine	Introduction to Psychrometric chart	Heat stored in the element, heat Conduction with internal heat generation	Problems on heat transfer in IC engine
	SLO-2	Problems on Work and heat transfer	Second law aspects of refrigerator	Psychrometric processes.	Plane wall and cylinder with uniform heat generation	Principle of Heat flux measurement in IC engine
S-4	SLO-1	zeroth law of thermodynamics	CoP of refrigerator	Sensible heating process	Heat Conduction through plane wall	Introduction to turbine, Classifications of turbines
	SLO-2	First law of thermodynamics.	Second law aspects of heat pump	Sensible cooling process	Heat Conduction through composite wall	Merits, demerits and its applications of gas turbine
S-5	SLO-1	First law of thermodynamics applied to closed systems	CoP of heat pump	Humidification and dehumidification	Heat Conduction through hollow Cylinder	Evaluation of Thermodynamics model in pneumatic cylinder
	SLO-2	Isobaric process	Problems on combination of heat engine, heat pump and refrigerator	Cooling and dehumidification	Heat Conduction through composite cylinder	Analysis of heat transfer between the air and the cylinder wall
S-6	SLO-1	Isochoric process	Clausius inequality	Adiabatic mixing	Heat Conduction through hollow Sphere	Conduction heat transfer in Electronics equipment heat sink
	SLO-2	Isothermal process	concept of entropy	Solving problems by using psychrometric chart	Heat Conduction through composite Sphere	Convection heat transfer in electronics equipment heat sink

S-7	SLO-1	*Isentropic process*	*Entropy changes in different thermodynamics processes*	*Solving problems on sensible heating process*	*Introduction about convection*	*Introduction to heat exchanger and its types*
	SLO-2	*Polytropic process*	*Entropy changes in isobaric process*	*Solving problems on sensible cooling process*	*Characteristics parameters in free convection*	*Heat transfer analysis in heat exchangers*
S-8	SLO-1	*First law of thermodynamics applied to open systems*	*Entropy changes in Isochoric process*	*Solving problems on adiabatic mixing Elements of refrigeration systems.*	*Empirical correlations for free convection with horizontal plate*	*Analysis of heat transfer in refrigeration*
	SLO-2	*Steady flow energy equation for boiler, turbine and heat exchanger*	*Entropy changes in Isothermal process*	*Coefficient of performance*	*Empirical correlations for free convection with horizontal Cylinder*	*Analysis of heat transfer in Air conditioning system*
S-9	SLO-1	*Steady flow energy equation for turbine.*	*Problems on Entropy changes in different thermodynamics processes*	*Air-conditioning systems*	*Forced convection with laminar flow over a flat plate*	*Heat transfer problems on refrigeration system*
	SLO-2	*Limitations of first law of thermodynamics*	*Problems on Entropy changes in combined processes*	*Open and closed system.*	*Forced convection with Turbulent flow over a flat plate*	*Heat transfer problems on Air conditioning system*
S-10	SLO-1	*Introduction to thermodynamics*	*Second law of thermodynamics*	*Introduction to psychrometric properties*	*Introduction to heat transfer*	*Introduction to IC engine and engine components.*
	SLO-2	*Statistical and classical approach.*	*Kelvin Planck statement, Clausius statement*	*Dry air, moist air, dry bulb temperature.*	*Modes of heat transfer: Conduction, convection and radiation.*	*Working principle of two and four stroke of SI and CI engine*
S-11	SLO-1	*Thermodynamic system, properties, processes and cycles.*	*Reversible and irreversible processes*	*Wet bulb temperature, dew point temperature, specific humidity.*	*Fourier law of conduction*	*Modes of Heat transfer in IC engine*
	SLO-2	*Thermodynamic equilibrium: Mechanical, chemical and thermal equilibrium.*	*Second law aspects of heat engine*	*Calculations of vapor mixtures*	*General heat conduction equation in Cartesian co-ordinates.*	*Heat transfer and Engine energy balance*
S-12	SLO-1	*Quasi-static process, Work and heat transfer*	*Performance of heat engine*	*Introduction to Psychrometric chart*	*Heat stored in the element, heat Conduction with internal heat generation*	*Problems on heat transfer in IC engine*
	SLO-2	*Problems on Work and heat transfer*	*Second law aspects of refrigerator*	*Psychrometric processes*	*Plane wall and cylinder with uniform heat generation*	*Principle of Heat flux measurement in IC engine*

Learning Resources	1. *Rajput. R. K. Engineering Thermodynamics, 4th ed., Laxmi Publications (P) Ltd., 2015* 2. *Kumar. D. S, Engineering Thermodynamics, 2nd ed., S.K. Kataria and Sons, 2013* 3. *Holman.J.P, Heat Transfer (In SI Units), 10th edition, McGraw Hill Education, 2016*	4. *Yunus a Cengel Michael a Boles, Thermodynamics, 7th ed., Tata McGraw-Hill, 20115* 5. *Nag.P.K., Engineering Thermodynamics, 5th ed., Tata McGraw-Hill, 2013* 6. *Mechanics Laboratory Manual.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1.Mr. S. Senthi Kumar, Grundfos pumps India(p) Ltd, senthel.s@gmail.com	*1. Dr.C.Jegadheesan, Associate Professor, Kongu Engineering College, cjegadheesan.auto@kongu.ac.in*	*1. Mr.M. Thirugnanam, SRMIST*
2. *Mr.G,Vijayaram, TAFE, vijayaram@tafe.com*	*2. Dr.M.Baskaran, Associate Professor, KSR College of Technology, baskaranm@ksrct.ac.in*	*2. Dr.S. Senthil Raja, SRMIST*

Course Code	18PYS201T	Course Name	MATERIALS SCIENCE	Course Category	S	Engineering Sciences	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Physics	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Understand the structure of crystalline materials.
CLR-2 :	Gain knowledge on the basics of material structures, properties and strength of materials
CLR-3 :	Gain knowledge on ceramics, polymers, copolymers and non-crystalline materials
CLR-4 :	Acquire knowledge on polymer nanocomposites, biomaterials, catalytic materials and corrosion and degradation of materials
CLR-5 :	Introduce the working principle of various characterization techniques
CLR-6 :	Understand the structure of crystalline materials

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1 Level of Thinking (Bloom)	2 Expected Proficiency (%)	3 Expected Attainment (%)	Program Learning Outcomes (PLO) 1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	13 PSO - 1	14 PSO - 2	15 PSO – 3
CLO-1 :	Acquire the knowledge on structure of crystalline materials	2	80	85	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Acquire the ability to identify engineering problems using plastic deformation, fatigue, fracture and creep of materials	2	75	80	H	H	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	Understand the basic ideas about ceramics, polymers and non-crystalline solids	2	85	80	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	Appreciate the concepts of reinforced matrix interface, corrosion parameters and uses of various nanocomposites.	2	80	75	H	H	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-5 :	Apply the knowledge for structural and spectroscopic characterization of materials	2	75	85	H	-	-	H	-	-	-	-	-	-	-	-	-	-	-
CLO-6 :	Acquire the knowledge on structure of crystalline materials	2	80	85	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Introduction to materials-crystalline and amorphous	Imperfections in solids: point defects	Semi-crystalline materials: introduction and classification	Introduction to composites	Introduction to experimental techniques
	SLO-2	Single crystalline and polycrystalline materials	Equilibrium concentration of vacancies	Structure and configuration of ceramics	Classification of composites	X-Ray Diffraction (Single Crystal method)
S-2	SLO-1	Concept of basis and lattice	Interstitial impurities in solids	Advanced ceramics-functional properties	Polymer nanocomposites materials	Scanning Ion Conductance Microscopy-principle
	SLO-2	Lattice translational vectors	Substitutional impurities in solids	Mechanical behavior of ceramics-flexural strength	Polymer-matrix composites	Scanning Ion Conductance Microscopy-construction and working
S-3	SLO-1	Primitive cell and Bravais lattice	Line defects: edge dislocations	Fabrication and processing of advanced ceramics	Fiber-reinforced composites	Molecular and spectroscopic analysis-introduction
	SLO-2	Seven types of Bravais lattices	Screw dislocations	Applications of advanced ceramic materials	Metal-matrix composites	FTIR spectroscopy
S-4	SLO-1	Symmetry operations in crystals	Surface and volume imperfections	Glass ceramics-introduction	Ceramic-matrix composites	Concept of Raman spectroscopy
	SLO-2	Rotational and translational symmetry	Interfacial defects, stacking faults	Glass forming and glass tempering	Carbon–carbon composites	Raman spectroscopy- instrumentation
S-5	SLO-1	Indexing of crystal planes	Elastic properties-Hooke's law	Polymers-classification	Degradation of polymers	XPS spectroscopy-concept
	SLO-2	Miller indices -directions and planes	Yield strength	Thermoplastic and thermosetting polymers	Recycling of polymers	XPS spectroscopy- instrumentation
S-6	SLO-1	Various planes in cubic structure	Tensile strength	Mechanical behavior of polymers-macroscopic deformation	Corrosion of metals, forms of corrosion	Introduction to Nuclear Magnetic Resonance (NMR)
	SLO-2	Directions in cubic structure	Ductile and brittle materials	Polymer synthesis-addition and condensation polymerization	Corrosion prevention	Nuclear Magnetic Resonance (NMR)-instrumentation
S-7	SLO-1	Packing of atoms inside solids- packing fraction calculation	Stress strain behavior of metals	Concept of copolymers	Biomaterials-introduction	Introduction to Thermal analysis
	SLO-2	Ionic solids-NaCl crystal structure	Stress strain behavior of ceramics and polymers	Applications of polymers	Classification of biomaterials	Thermo Gravimetric Analyzer-instrumentation

S-8	SLO-1	*Hexagonal close packed (HCP) structure*	*Tensile test, plastic deformation*	*Types of liquid crystals*	*Surface properties of biomaterials*	*Differential Thermal Analyses (DTA)*
	SLO-2	*Estimation of packing fraction in HCP*	*Concept of necking*	*Construction and working of LCD*	*Mechanical properties of biomaterials*	*Differential Scanning Calorimetry (DSC)*
S-9	SLO-1	*Diamond structure-APF*	*Fatigue*	*Non-crystalline materials-metallic glass*	*Catalytic biomaterials –silica, enzymatic hydrogels*	*Dynamic light scattering*
	SLO-2	*Cubic Zinc-Sulfide structure*	*Creep behavior*	*Glass transition-melting and glass transition temperature*	*Applications of biomaterials*	*Particle Size Analysis*

Learning Resources	1. *V. Raghavan, Materials Science and Engineering: A First Course, 5th ed., Prentice Hall India, 2004.* 2. *William D. Callister, Materials Science and Engineering, An Introduction, John Wiley & Sons, 2007*	3. *Kingery, W. D., Bowen H. K., Uhlmann, D. R., Introduction to Ceramics, 2nd ed., John Wiley & Sons, 1976.* 4. *Upadhyaya and A. Upadhyaya, Material Science and Engineering, Anshan Publications, 2007*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Narayanasvamy Vijayan, National Physical Laboratory, nvijayan@nplindia.org	*1. Prof. V. Subramaniam, IITM Chennai, manianvs@iitm.ac.in*	*1. Dr. C. Preferencial Kala, SRMIST*
2. Dr. M. Krishna Surendra, Saint-Gobain Research, Krishna.muvvala@saintgobain.com	*2. Prof. D. Arivuoli, Anna University, arivuoli@annauniv.edu*	*2. Sandeep Kumar Lakhera, SRMIST*

Course Code	18NTS101T	Course Name	NANOSCIENCE AND NANOTECHNOLOGY	Course Category	S	Engineering Sciences	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Nanotechnology	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Acquire knowledge on basics of nanoscience, classes of nanomaterials and their size and dimensionality dependence
CLR-2 :	Obtain knowledge on physical properties of nanostructured materials and their size and dimensionality dependence
CLR-3 :	Understand the physics and chemistry-based experimental approaches to synthesize various types of nanomaterials
CLR-4 :	Gain knowledge on the basic principles of characterization techniques at nanoscale
CLR-5 :	Appreciate the potential applications of the nanotechnology
CLR-6 :	Know the safety and technological issues associated with nanoscience and nanotechnology

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1 Level of Thinking (Bloom)	2 Expected Proficiency (%)	3 Expected Attainment (%)	Program Learning Outcomes (PLO) 1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	13 PSO - 1	14 PSO - 2	15 PSO – 3
CLO-1 :	Analyze fundamentals of nanotechnology, different classes of nanomaterials and their sizes and dimensions	2	80	75	H	M	H	H	M	H	H	H	M	H	M	H	H	H	H
CLO-2 :	Describe various physical properties of nanomaterials	2	80	70	H	H	H	M	M	H	H	M	H	H	M	H	H	H	H
CLO-3 :	Apply chemical and physical methods to synthesize and fabricate nanomaterials	2	75	70	H	H	H	H	H	H	H	H	H	H	H	H	H	M	H
CLO-4 :	Distinguish various characterization techniques involved in nanotechnology	2	80	75	H	M	H	H	H	M	H	H	H	H	H	H	M	H	H
CLO-5 :	Identify the potentialities of nanotechnology	2	80	70	M	M	M	H	M	H	H	H	M	H	M	H	H	H	H
CLO-6 :	Perform preliminary level research in nanoscience/nanotechnology	2	80	75	H	M	H	H	H	M	H	H	H	H	M	H	H	H	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Matter at different scales, Moore's Law	Mechanical properties of nanomaterials	Chemical methods: Metal nanocrystals by reduction	Introduction to electron microscopy	Role of nanotechnology in solar energy conversion
	SLO-2	Nanosystems – classification based on time and length scale	Size dependence of material properties	Synthesis of metal nanoparticles by chemical reduction methods and properties	SEM operating principles	Catalytic application of nanoparticles
S-2	SLO-1	Size dependent phenomena: Quantum dots, wells and wires	Nanodispersions, nanocrystalline solids	Hydrothermal and solvothermal synthesis	Field emission scanning electron microscope (FESEM)	Nanotechnology in molecular electronics and nanoelectronics
	SLO-2	Principle behind emission of different colors from different size quantum dots	Amorphous materials: Nanocrystalline materials embedded in amorphous matrix	Photochemical synthesis	Environmental scanning electron microscope (E- SEM)	Printed electronics
S-3	SLO-1	Surface to volume ratio	Thermal properties of nanomaterials	Sonochemical routes	High resolution -transmission electron microscope (HRTEM)	Polymers with a special nano-architecture
	SLO-2	Fraction of surface atoms and surface energy	Violation of second law of thermodynamics for small systems and short timescale	Ball milling, Grinding	Scanning Tunneling Microscopy (STM)	Applications of nanomaterials based liquid crystalline systems
S-4	SLO-1	Surface stress and surface defects	Thermal transport-size dependence	Electrodeposition techniques	SPM image processing and image analysis	Nanotechnology in food storage
	SLO-2	Quantum confinement – exciton confinement in quantum dots	Melting point- size dependence	Fabrication of nanotubes, nanowires and nanorods	Dynamic AFM imaging of biological samples	Nanotechnology in improving environment
S-5	SLO-1	Carbon-based nano materials	Electronic properties of nanomaterials	Spray Pyrolysis	Nanomechanical characterization	Concept of data storage
	SLO-2	Fullerenes and buckyballs	Electronic States: Dependence of size and dimensionality	Flame pyrolysis	Nanoindentation	Nanomaterials for data storage
S-6	SLO-1	Carbon nanotubes	The electron density of states D(E)	Physical Vapor Deposition: Thermal evaporation	Raman scattering	Chemical sensors
	SLO-2	Graphene	Luttinger liquid behavior of electrons in 1D metals	DC/RF magnetron sputtering	Surface enhanced -Raman scattering	Biosensors

S-7	SLO-1	*Metal based nano materials*	*Magnetic properties of nanomaterials: Particle size and magnetic behavior*	*Molecular beam epitaxy (MBE)*	*UV-Vis - absorption spectra of nanoparticles of different sizes*	*Nanomedicine*
	SLO-2	*Nanogold and nanosilver*	*Superparamagnetism: Langevin function, surface effects, magnetoresistance*	*Chemical vapor deposition(CVD)*	*Semiconductor nanoparticles*	*Nanobiotechnology*
S-8	SLO-1	*Metal-oxide based nano materials*	*Optical properties: instances of light absorption in nanomaterials*	*Metal organic chemical vapor deposition (MOCVD)*	*Metal nanoparticle: Surface plasmons*	*Nanotoxicology*
	SLO-2	*Nanocomposites and nanopolymers*	*Red- and blue shift*	*Layer-by-layer growth of highly controlled high-quality ultrathin films deposition*	*Surface plasmon resonance*	*Challenges in nanotoxicology*
S-9	SLO-1	*Nanoglasses and nanoceramics*	*Phenomenon of light absorption, light emission- quantum yield*	*Nanofabrication: Concept of lithography*	*Magnetic measurements*	*Nanotechnology in cosmetics*
	SLO-2	*Biological nanomaterials*	*Photoluminescence and electroluminescence of nanomaterials*	*Photo and electron beam lithography techniques*	*Vibrating sample magnetometer (VSM)*	*Nanotechnology in aviation industry*

Learning Resources	1. *T. Pradeep, A Textbook of Nanoscience and Nanotechnology, Tata McGraw Hill Education Pvt. Ltd., 2012* 2. *Hari Singh Nalwa, Nanostructured Materials and Nanotechnology, Academic Press, 2008* 3. *Edward L. Wolf, Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience. 2nd ed., Wiley-VCH, 2004* 4. *Hans-Eckhardt Schaefer, Nanoscience: The Science of the Small in Physics, Engineering, Chemistry, Biology, and Medicine, Springer-Verlag Berlin Heidelberg, 1st Edition, 2010.*	5. *M. F. Ashby, P.J. Ferreira, D. L. Schodek, Nanomaterials, Nanotechnologies and Design: An Introduction for Engineers and Architects, BH Publishers of Elsevier, 2009* 6. *A. P. Guimaraes, Principles of Nanomagnetism, Spinger, 1stedition, 2009* 7. *B. Zhang, Physical Fundamentals of Nanomaterials, Elsevier, 1st Edition, 2018.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Sunil Varughese, CSIR-NIIST, s.varughese@niist.res.in	*1. Prof. M. Ghanashyam Krishna, HCU Hyderabad, mgksp@uohyd.ernet.in*	*1. Dr. Kiran Mangalmpalli, SRMIST*
2. Dr. M. Krishna Surendra, Saint-Gobain Research, Chennai, krishna.muvvala@saint-gobain.com	*2. Prof. S. Balakumar, University of Madras, balakumar@unom.ac.in*	*2. Dr. Debabrata Sarkar, SRMIST*

ACADEMIC CURRICULA

Mandatory Courses

Regulations - 2018

SRM
INSTITUTE OF SCIENCE & TECHNOLOGY
(Deemed to be University u/s 3 of UGC Act, 1956)

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Kancheepuram, Tamil Nadu, India

Course Code	18PDM201L	Course Name	COMPETENCIES IN SOCIAL SKILLS	Course Category	M	Mandatory	L	T	P	C
							0	0	2	0

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Career Development Centre*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*enable students understand subtle meanings of words used in academic texts*
CLR-2 :	*determine the grammatical, syntactical, and logical accuracy of sentences*
CLR-3 :	*comprehend an argument's line of reasoning*
CLR-4 :	*understand the structure, organization, tone, and main idea behind the passage*
CLR-5 :	*recognize the logical coherence of ideas in a text*
CLR-6 :	*give the right knowledge, skill and aptitude to face any competitive examination*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO – 3
CLO-1 :	*build vocabulary through methodical approaches and nurture passion for enriching vocabulary*	3	80	75	L	H	-	M	-	-	-	-	M	H	-	H	-	-	-
CLO-2 :	*detect and correct any grammatical, syntactical, and logical fallacies*	2	80	75	L	H	-	M	-	-	-	-	M	H	-	H	-	-	-
CLO-3 :	*hone critical thinking skills by analyzing arguments with explicit and implicit premises to validate the author's point of view*	3	80	75	L	H	-	M	-	-	-	-	M	H	-	H	-	-	-
CLO-4 :	*analyze and evaluate texts critically in multifarious ways*	3	80	75	L	H	-	M	-	-	-	-	M	H	-	H	-	-	-
CLO-5 :	*identification of relationships between sentences based on their function, usage and characteristics*	2	80	75	L	H	-	M	-	-	-	-	M	H	-	H	-	-	-
CLO-6 :	*ace competitive examinations*	2	80	75	L	H	-	M	-	-	-	-	M	H	-	H	-	-	-

Duration (hour)		6	6	6	6	6
S-1	SLO-1	*Synonyms in Isolation and Context*	*Spotting Errors – Level I*	*Critical Reasoning – Weakening*	*Reading Comprehension – Main Idea*	*Para Jumble-Type I*
	SLO-2	*Practice*	*Practice*	*Practice*	*Practice*	*Practice*
S-2	SLO-1	*Antonyms in Isolation and Context*	*Spotting Errors – Level II*	*Critical Reasoning – Inference*	*Reading Comprehension – Tone*	*Para Jumble-Type II*
	SLO-2	*Practice*	*Practice*	*Practice*	*Practice*	*Practice*
S-3	SLO-1	*Common Confusables*	*Spotting Errors – Level II*	*Critical Reasoning – Conclusion*	*Reading Comprehension – Inference*	*Para Jumble-Type III*
	SLO-2	*Practice*	*Practice*	*Practice*	*Practice*	*Practice*
S-4	SLO-1	*Cloze Passage*	*Sentence Correction-Type I & II*	*Critical Reasoning - Explain the paradox*	*Reading Comprehension – Summary*	*Para Completion*
	SLO-2	*Practice*	*Practice*	*Practice*	*Practice*	*Practice*
S-5	SLO-1	*Word Analogy*	*Sentence Correction-Type III & IV*	*Critical Reasoning – Miscellaneous*	*Reading Comprehension – Conclusion*	*Para Completion*
	SLO-2	*Practice*	*Practice*	*Practice*	*Practice*	*Practice*
S-6	SLO-1	*Sentence Completion*	*Sentence Correction-Type V& VI*	*Critical Reasoning – Miscellaneous*	*Reading Comprehension – Miscellaneous*	*Para Summary*
	SLO-2	*Practice*	*Practice*	*Practice*	*Practice*	*Practice*

Learning Resources	1. *Charles Harrington Elstor, Verbal Advantage: Ten Easy Steps to a Powerful Vocabulary, Random House Reference, 2002* 2. *Merriam Webster's Vocabulary Builder, Merriam Webster Mass Market, 2010* 3. *Norman Lewis, How to Read Better and Faster, Goyal, 4th Edition* 4. *Franklin GRE Word List, 3861 GRE Words, Franklin Vocab System, 2014* 5. *Wiley's GMAT Reading Comprehension Grail, Wiley, 2016*	6. *Manhattan Prep GRE : Reading Comprehension and Essays, 5th Edition* 7. *Martin Hewings, Advanced Grammar in Use. Cambridge University Press, 2013* 8. *Manhattan GMAT – Critical Reasoning, GMAT Strategy Guide, 12th Edition* 9. *Joern Meissner, Manhattan Review, GRE Analytical Writing Guide, Manhattan Review Inc, 2011* 10. *GRE Analytical Writing, Solutions to the Real Essay Topics (Test Prep. Series), Vibrant Publishers, 2011*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (100% weightage)								Final Examination	
		CLA – 1 (20%)		CLA – 2 (30%)		CLA – 3 (30%)		CLA – 4 (20%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	-	*40%*	-	*30%*	-	*30%*	-	*30%*	-	-
Level 2	Apply Analyze	-	*40%*	-	*40%*	-	*40%*	-	*40%*	-	-
Level 3	Evaluate Create	-	*20%*	-	*30%*	-	*30%*	-	*30%*	-	-
	Total	100 %		100 %		100 %		100 %		-	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts	
1. Mr. Vijay Nayar, Director, Education Matters, vijayn@edumat.com	*1. Dr. Dinesh Khattar, Delhi University, dinesh.khattar31@gmail.com*	*1. Dr. M. Snehalatha, SRMIST*	*3. Dr. P. Madhusoodhanan, SRMIST*
2. Mr. Ajay Zenner, Career Launcher, ajay.z@careerlauncher.com	*2. Mr. Nishith Sinha, due North India Academics LLP, nsinha.alexander@gmail.com*	*2. Mr Jayapragash J., SRMIST*	*4. Mr. Clement A, SRMIST*

Course Code	18PDM202L	Course Name	CRITICAL AND CREATIVE THINKING SKILLS	Course Category	M	Mandatory	L	T	P	C
							0	0	2	0

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Career Development Centre*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*identify problems*
CLR-2 :	*recognize the logical coherence of ideas*
CLR-3 :	*understand the structure and principles of writing*
CLR-4 :	*interpret the structure, organization, tone, and main idea of the content*
CLR-5 :	*hone comprehension skills*
CLR-6 :	*give the right knowledge, skill and aptitude to face any competitive examination*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1	Learning 2	Learning 3	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12	PLO 13	PLO 14	PLO 15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	*solve problems*	3	80	75	L	H	-	M	-	-	-	-	M	L	-	H	-	-	-
CLO-2 :	*grasp the approaches and strategies to find solutions*	2	80	75	L	H	-	M	-	-	-	-	M	L	-	H	-	-	-
CLO-3 :	*organize and articulate ideas clearly*	2	80	75	L	H	-	M	-	-	-	-	M	L	-	H	-	-	-
CLO-4 :	*analyze and evaluate contents critically in multifarious ways*	2	80	75	L	H	-	M	-	-	-	-	M	L	-	H	-	-	-
CLO-5 :	*understand, comprehend and provide logical conclusions*	2	80	75	L	H	-	M	-	-	-	-	M	H	-	H	-	-	-
CLO-6 :	*gain appropriate skills to succeed in preliminary selection process for recruitment*	3	80	75	L	H	-	M	-	-	-	-	M	H	-	H	-	-	-

Duration (hour)		6	6	6	6	6
S-1	SLO-1	*Ages*	*Permutations-Types*	*Probability-Intro*	*Logical Reasoning – Blood relations, Directions*	*Information Ordering - Analogy*
	SLO-2	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Series completion*	*Math operations*
S-2	SLO-1	*Case Study*	*Statement Completion*	*Principles of Writing*	*Reading Comprehension – Bold Faced*	*Para Completion*
	SLO-2	*Discussion*	*Practice*	*Practice*	*Practice*	*Practice*
S-3	SLO-1	*Quadratic Equations*	*Combination-Concepts*	*Probability theory -Applications*	*Logical Reasoning- Cubes*	*Analytical Reasoning-Intro*
	SLO-2	*In-equations*	*Solving Problems*	*Solving Problems*	*Logical Reasoning-syllogism*	*Analytical Reasoning - Level I*
S-4	SLO-1	*Case Study*	*Statement Completion*	*Principles of Writing*	*Reading Comprehension – Bold Faced*	*Para Completion*
	SLO-2	*Discussion*	*Practice*	*Practice*	*Practice*	*Practice*
S-5	SLO-1	*Permutations-Concepts*	*Combination- Miscellaneous*	*Logical Reasoning – Coding and Decoding*	*Information Ordering - Arrangements*	*Analytical Reasoning-Level II*
	SLO-2	*Solving Problems*	*Solving Problems*	*Practice*	*Practice*	*Analytical Reasoning - Level III*
S-6	SLO-1	*Case Study*	*Statement Completion*	*Principles of Writing*	*Reading Comprehension – Miscellaneous*	*Para Completion*
	SLO-2	*Discussion*	*Practice*	*Practice*	*Practice*	*Practice*

Learning Resources	1. *Dinesh Khattar-The Pearson Guide to Quantitative Aptitude for competitive examinations* 2. *Hari Mohan Prasad, Verbal Ability for Competitive Examinations, Tata McGraw Hill Publications* 3. *Edgar Thrope, Test of Reasoning for Competitive Examinations, Tata McGraw Hill, 4th Edition, 2012* 4. *Norman Lewis, Word Power Made Easy, W.R. Goyal Publications, 2011*	5. *Ellet William, The Case Study Handbook: How to read, discuss, and write persuasively about cases* 6. *Manhattan GMAT – Critical Reasoning, GMAT Strategy Guide, 12th Edition* 7. *Wiley's GMAT Reading Comprehension Grail, Wiley, 2016* 8. *Manhattan Prep GRE : Reading Comprehension and Essays, 5th Edition*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (100% weightage)								Final Examination	
		CLA – 1 (20%)		CLA – 2 (30%)		CLA – 3 (30%)		CLA – 4 (20%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	-	*40%*	-	*30%*	-	*30%*	-	*30%*	-	-
Level 2	Apply Analyze	-	*40%*	-	*40%*	-	*40%*	-	*40%*	-	-
Level 3	Evaluate Create	-	*20%*	-	*30%*	-	*30%*	-	*30%*	-	-
	Total	100 %		100 %		100 %		100 %		-	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

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Course Code	18PDM203L	Course Name	ENTREPRENEURIAL SKILL DEVELOPMENT	Course Category	M	*Mandatory*	L	T	P	C
							0	0	2	0

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Career Development Centre*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*gain knowledge about Entrepreneurship*
CLR-2 :	*study mindsets of Entrepreneur*
CLR-3 :	*assimilate skills and behavioral aspects of entrepreneurship*
CLR-4 :	*generate creative and innovative ideas*
CLR-5 :	*acquire knowledge about the entrepreneurial processes*
CLR-6 :	*develop entrepreneurial skills*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	**Learning** 1 Level of Thinking (Bloom)	2 Expected Proficiency (%)	3 Expected Attainment (%)	**Program Learning Outcomes (PLO)** 1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	13 PSO - 1	14 PSO - 2	15 PSO – 3
CLO-1 :	*Understand the concept of Entrepreneurship and Entrepreneur*	2	80	75	L	H	-	M	-	-	-	-	M	L	-	H	-	-	-
CLO-2 :	*Comprehend the mindset of Entrepreneurs*	2	80	75	L	H	-	M	-	-	-	-	M	L	-	H	-	-	-
CLO-3 :	*Understand the skills and behavioral aspects required in Entrepreneurs*	3	80	75	L	H	-	M	-	-	-	-	M	L	-	H	-	-	-
CLO-4 :	*Analyze the role of Creativity and Innovation in their Entrepreneurial journey*	3	80	75	L	H	-	M	-	-	-	-	M	L	-	H	-	-	-
CLO-5 :	*Create and present their Business Model*	3	80	75	L	H	-	M	-	-	-	-	M	H	-	H	-	-	-
CLO-6 :	*Acquire entrepreneurial skills*	1	80	75	L	H	-	M	-	-	-	-	M	H	-	H	-	-	-

Duration (hour)		6	6	6	6	6
S-1	SLO-1	*Introduction*	*Motivation*	*Self Analysis*	*Negotiating skill*	*Business Model Canvas*
	SLO-2	*Benefits of entrepreneurship*	*External and internal*	*SWOT*	*People Management*	*Business Model Canvas*
S-2	SLO-1	*Origin of Entrepreneurship*	*Theories of Entrepreneurship*	*Communication*	*Creativity*	*Business Opportunity Identification*
	SLO-2	*Evolution of Entrepreneurship*	*Theories of Entrepreneurship*	*Networking*	*Idea Generation*	*Business Opportunity Identification*
S-3	SLO-1	*Social and Economic factors Influencing Entrepreneurship*	*Success Stories – Case Study Analysis*	*Interpersonal skills*	*Problem Solving*	*Business Model canvas presentation*
	SLO-2	*Environment and Psychological factors Influencing Entrepreneurship*	*Success Stories – Case Study Solution*	*Collaborative skills*	*Problem solving*	*Business Model canvas presentation*
S-4	SLO-1	*Myths about entrepreneurship*	*Success Stories – Case Study Analysis*	*Team management skills*	*Decision Making*	*Business Model canvas presentation*
	SLO-2	*Myths about entrepreneurship*	*Success Stories – Case Study Solution*	*Team management skills*	*Six Thinking hats*	*Business Model canvas presentation*
S-5	SLO-1	*Entrepreneurship Failures*	*Risk-taking Behavior*	*Leadership*	*Inventions*	*Business model presentation*
	SLO-2	*Entrepreneurship Failures*	*Resilience*	*Shared leadership*	*Inventions*	*Business model presentation*
S-6	SLO-1	*Entrepreneurship in India – A Preview*	*Global Markets for Entrepreneurs*	*Time Management*	*Innovations*	*Business model presentation*
	SLO-2	*Indian Entrepreneurships*	*Understanding the cross cultural behaviors and differences*	*Prioritisation*	*Innovations*	*Business model presentation*

Learning Resources	1. *Elon Musk – Ashley Vance- Virgin Books-2015* 2. *Think and Grow Rich – Napolean Hill - The Ralston Society – 1937* 3. *The Lean Startup – Eric Ries - Crown Publishing Group (USA) – 2011* 4. *The $100 Startup – Chris Gullibeau - Crown Business- 2012* 5. *Creativity, Innovation, and Entrepreneurship: The Only Way to Renew Your Organization - H. James Harrington - Productivity Press- December 2018*	6. *www.wfnen.org; National Entrepreneurship Network – Wadhwani Foundation* 7. *https://www.forbes.com/sites/.../2017/.../top-entrepreneur-stories-to-inspire-you-in-2017/* 8. *https://bizztor.com/in/successful-indian-entrepreneurs-stories* 9. *https://www.entrepreneur.com/article/299214* 10. *https://www.fundera.com/blog/young-entrepreneurs* 11. *The Entrepreneurs: Success and Sacrifice - by Kip Marlow cbseacademic.nic.in/web material/Curriculum19/Main.../20_Entrepreneurship.pdf*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (100% weightage)								Final Examination	
		CLA – 1 (20%)		CLA – 2 (30%)		CLA – 3 (30%)		CLA – 4 (20%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	-	40%	-	30%	-	30%	-	30%	-	-
Level 2	Apply Analyze	-	40%	-	40%	-	40%	-	40%	-	-
Level 3	Evaluate Create	-	20%	-	30%	-	30%	-	30%	-	-
	Total	100 %		100 %		100 %		100 %		-	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts	
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2. Mr. Ajay Zenner, Career Launcher, ajay.z@careerlauncher.com	*2. Dr. A.K. Sheik Manzoor, Anna University, sheikmanzoor@annauniv.edu*	*2. Mr. Ananth Kumar, SRMIST*	*4. Mrs. Deepa Narayanan. SRMIST*

Course Code	18PDM204L	Course Name	BUSINESS BASICS FOR ENTREPRENEURS	Course Category	M	Mandatory	L	T	P	C
							0	0	2	0

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Career Development Centre*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Provides a base of Managerial application skills that enable students to understand practical managerial concepts*
CLR-2 :	*Comprehend business models*
CLR-3 :	*Understand different accounting concepts*
CLR-4 :	*Understand the taxation and tax laws*
CLR-5 :	*Understand the process of design thinking*
CLR-6 :	*Acquire knowledge on business skills*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)
CLO-1 :	*Explain the nature and purpose of marketing; understand the fundamentals of each of the most important marketing tasks*	1	80	75
CLO-2 :	*Use the Business Models in their startups*	1	80	75
CLO-3 :	*Identify and appreciate the strong linkages between finance and globalization*	2	80	75
CLO-4 :	*Implement tax process*	2	80	75
CLO-5 :	*Acquire Design Thinking concepts to implement in the startup*	1	80	75
CLO-6 :	*Implement the essential business basics*	3	80	75

Program Learning Outcomes (PLO)

	1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	13 PSO - 1	14 PSO - 2	15 PSO – 3
CLO-1	L	H	-	M	-	-	-	-	M	L	-	H	-	-	-
CLO-2	L	H	-	M	-	-	-	-	M	L	-	H	-	-	-
CLO-3	L	H	-	M	-	-	-	-	M	L	-	H	-	-	-
CLO-4	L	H	-	M	-	-	-	-	M	L	-	H	-	-	-
CLO-5	L	H	-	M	-	-	-	-	M	H	-	H	-	-	-
CLO-6	L	H	-	M	-	-	-	-	M	H	-	H	-	-	-

		Marketing Management	Business Models	Financial Management	Costing and Taxation	Design Thinking
Duration (hour)		6	6	6	6	6
S-1	SLO-1	*Introduction to Marketing Management*	*Business Models for startups*	*Introduction to Finance Management*	*Pricing Strategies*	*Design Thinking*
	SLO-2	*Understand the market*	*Introduction to SAAS*	*Effective and efficient management of money*	*Pricing for market penetration*	*Developing design concepts*
S-2	SLO-1	*6 P's of Marketing*	*Business model*	*Accounting Process*	*Types of Pricing*	*Five stages of design concepts*
	SLO-2	*5 P's of Marketing*	*Introduction to PAAS*	*Four steps in business transactions*	*Pricing strategies*	*Super charging with design thinking*
S-3	SLO-1	*Introduction to Consumer Behavior*	*Revenue Models*	*Basic Accounting Procedures*	*Introduction to MIS*	*Creating concepts*
	SLO-2	*Create value proposition*	*Application of revenue models*	*Basic book keeping for financial transactions*	*Data Analysis*	*Creating concepts*
S-4	SLO-1	*Types of Marketing*	*Outsourcing Models*	*Financial Statements*	*Taxation*	*Hackathon / Challenge Labs*
	SLO-2	*Business marketing concepts*	*Partnership Models*	*Profit and Loss account, Balance sheet Statement of cash flow*	*Taxation*	*Hackathon / Challenge Labs*
S-5	SLO-1	*Market Segmentation*	*Profitability*	*Working Capital Management*	*Tax laws*	*Hackathon / Challenge Labs*
	SLO-2	*Market Positioning*	*Business Metrics*	*Utilizing current assets and current liabilities for efficient operation*	*Tax laws*	*Hackathon / Challenge Labs*
S-6	SLO-1	*Branding*	*Business Model Analysis*	*Financial Ratios*	*Case studies and Problem Solving*	*Hackathon / Challenge Labs*
	SLO-2	*Creating USP*	*Practical Implementation*	*Profitability, Liquidity, Operating, Leverage*	*Case studies and Problem Solving*	*Hackathon / Challenge Labs*

Learning Resources	1. *Elon Musk – Ashley Vance- Virgin Books-2015* 2. *Think and Grow Rich – Napolean Hill - The Ralston Society – 1937* 3. *The Lean Startup – Eric Ries - Crown Publishing Group (USA) – 2011* 4. *The $100 Startup – Chris Gullibeau - Crown Business- 2012* 5. *Creativity, Innovation, and Entrepreneurship: The Only Way to Renew Your Organization - H. James Harrington - Productivity Press- December 2018*	6. *www.wfnen.org; National Entrepreneurship Network – Wadhwani Foundation* 7. *https://www.forbes.com/sites/.../2017/.../top-entrepreneur-stories-to-inspire-you-in-2017/* 8. *https://bizztor.com/in/successful-indian-entrepreneurs-stories* 9. *https://www.entrepreneur.com/article/299214* 10. *https://www.fundera.com/blog/young-entrepreneurs* 11. *The Entrepreneurs: Success and Sacrifice - by Kip Marlow* *cbseacademic.nic.in/web material/Curriculum19/Main.../20_Entrepreneurship.pdf*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (100% weightage)								Final Examination	
		CLA – 1 (20%)		CLA – 2 (30%)		CLA – 3 (30%)		CLA – 4 (20%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	-	*40%*	-	*30%*	-	*30%*	-	*30%*	-	-
Level 2	Apply Analyze	-	*40%*	-	*40%*	-	*40%*	-	*40%*	-	-
Level 3	Evaluate Create	-	*20%*	-	*30%*	-	*30%*	-	*30%*	-	-
	Total	100 %		100 %		100 %		100 %		-	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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Course Code	18CYM101T	Course Name	ENVIRONMENTAL SCIENCE	Course Category	M	Mandatory	L	T	P	C
							1	0	0	0

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	*Chemistry*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Acquire knowledge on various causes, effects and control measures of environmental air and water pollution*
CLR-2 :	*Analyze causes, effects and control measures of soil, thermal and radiation pollution*
CLR-3 :	*Utilize processes involved in waste water treatment and study the cause of a local polluted site*
CLR-4 :	*Analyze impacts, disposal methods and treatments involved in solid waste management*
CLR-5 :	*Identify impacts, disposal methods, treatments involved in biomedical waste management*
CLR-6 :	*Analyze the environmental issues and identify appropriate solutions*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1	Learning 2	Learning 3	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12	PLO 13	PLO 14	PLO 15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	*Analyze the sources, effects and control measures of environmental air pollution*	1	80	70	H	H	H	H	-	-	H	-	-	-	-	-	-	-	-
CLO-2 :	*Acquire knowledge on the treatment of soil, thermal and radiation management*	1	75	65	H	H	H	H	-	-	H	-	-	-	-	-	-	-	-
CLO-3 :	*Acquire knowledge on various process involved in the treatment of wastewater*	1	80	70	H	H	H	H	-	-	H	-	H	-	-	-	-	-	-
CLO-4 :	*Identify sources, disposal and treatment methods of solid waste management*	1	80	75	H	H	H	H	-	-	H	-	H	-	-	-	-	-	-
CLO-5 :	*Identify sources, disposal and treatment methods of biomedical waste management*	1	75	65	H	H	H	H	-	-	H	-	H	-	-	-	-	-	-
CLO-6 :	*Utilize the concepts learnt in protecting the environment towards sustainable development*	1	80	70	H	H	H	H	-	-	H	-	H	-	-	-	-	-	-

Duration (hour)		3	3	3	3	3
S-1	SLO-1	*Environmental segments Structure of atmosphere*	*Determination of BOD, COD*	*Waste water treatment- Introduction*	*Solid waste management: Types*	*Biomedical Waste Management Definition and Effects*
	SLO-2	*Composition of atmosphere*	*Determination of TDS and trace metals*	*Primary treatment*	*Effects Process of waste management*	*Categories of biomedical waste*
S-2	SLO-1	*Air Pollution Sources*	*Sources, effects and control measures of Soil pollution*	*Secondary treatment*	*Disposal methods, Open dumping Engineered land filling*	*Process of biomedical waste management*
	SLO-2	*Effects – acid rain, ozone layer depletion and greenhouse effect*	*Sources, effects and control measures of Thermal pollution*	*Tertiary treatment*	*Composting Incineration*	*Treatment and disposal methods*
S-3	SLO-1	*Control measures of air pollution*	*Sources and effects of: Radiation pollution*	*Activity: Visit to a local polluted site-Urban/Rural/Industrial/Agricultural*	*Activity: Monitoring solid waste management in local areas*	*Activity: Visit a hospital to understand the biomedical waste management*
	SLO-2	*Sources, Effects and control measures of Water pollution*	*Control measures of Radiation pollution*	*Activity: Visit to a local polluted site-Urban/Rural/Industrial/Agricultural*	*Activity: Monitoring solid waste management in local areas*	*Activity: Visit a hospital to understand the biomedical waste management*

Learning Resources	Books	More books
Learning Resources	1. *Erach Bharucha, Textbook of Environmental Studies for Undergraduate Courses, 2nd ed., UGC* 2. *Kamaraj. P, Arthanareeswari. M, Environmental Science–Challenges and Changes, 6th ed., Sudhandhira Publications, 2013*	*3. R. Jeyalakshmi, Principles of Environmental Science, 2nd ed., Devi publications, 2008* *4. Helen P Kavitha, Principles of Environmental Science, 1st ed., Shine Publications and Distributors, 2013*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (100% weightage)								Final Examination	
		CLA – 1 (20%)		CLA – 2 (30%)		CLA – 3 (30%)		CLA – 4 (20%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40%*	-	*30%*	-	*30%*	-	*30%*	-	-	-
Level 2	Apply Analyze	*40%*	-	*40%*	-	*40%*	-	*40%*	-	-	-
Level 3	Evaluate Create	*20%*	-	*30%*	-	*30%*	-	*30%*	-	-	-
	Total	100 %		100 %		100 %		100 %		-	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Sudarshan Mahapatra, Encube Ethicals Pvt. Ltd, sudarshan.m@encubeethicals.com	*1. Prof. G. Sekar, IIT Madras, gsekar@iitm.ac.in*	*1. Prof. M. Arthanareeswari, SRMIST*
2. Dr. Shanmukhaprasad Gopi, Dr. Reddy' s Laboratories, shanmukhaprasadg@drreddys.com	*2. Prof. Vivek Polshettiwar, TIFR Mumbai, vivekpol@tifr.res.in*	*2. Dr. K. K. R. Datta, SRMIST*

ACADEMIC CURRICULA

Open Elective Courses

Regulations - 2018

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Kancheepuram, Tamil Nadu, India

Course Code	18ASO101T	Course Name	ELEMENTS OF AERONAUTICS	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Aerospace Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Understand the art of flying*
CLR-2 :	*Understand variation of pressure, temperature, density in the layers of atmosphere and their effect on the flying objects*
CLR-3 :	*Identify the types of construction of aircrafts and the working of Engines*
CLR-4 :	*Know functions of various components of flying objects and the operating mechanisms*
CLR-5 :	*Know the working of various types of rockets and satellites*
CLR-6 :	*Get a bird's eye view of Aerospace Engineering*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1 Level of Thinking (Bloom)	Learning 2 Expected Proficiency (%)	Learning 3 Expected Attainment (%)	PLO 1 Engineering Knowledge	PLO 2 Problem Analysis	PLO 3 Design & Development	PLO 4 Analysis, Design, Research	PLO 5 Modern Tool Usage	PLO 6 Society & Culture	PLO 7 Environment & Sustainability	PLO 8 Ethics	PLO 9 Individual & Team Work	PLO 10 Communication	PLO 11 Project Mgt. & Finance	PLO 12 Life Long Learning	PLO 13 PSO - 1	PLO 14 PSO - 2	PLO 15 PSO – 3
CLO-1 :	*Describe the evolution of aircrafts and their types*	2	85	75	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	*Describe about the atmosphere and variation in properties, aircraft flight and different speed regimes*	2	85	75	H	H	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	*Explain the basics of aircraft structures, power plants*	2	85	75	H	-	H	H	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	*Explain the basics of aircraft controls and instruments*	2	85	75	H	H	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-5 :	*Describe the basic Space Technology concepts*	2	85	75	H	-	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-6 :	*Identify the various components and systems in aircraft and describe its working mechanism*	2	85	75	H	H	H	H	-	-	-	-	-	-	-	-	-	-	-

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*History of Aviation*	*International Standard Atmosphere*	*Introduction to aircraft construction*	*Aircraft controls*	*Basic principle of rocket propulsion*
	SLO-2	*Imitation of birds, Ornithopters*	*Hydrostatic equation*	*History of Aircraft Construction*	*Functions of aileron, elevator and rudder.*	*Applications of Rockets*
S-2	SLO-1	*Lighter than air vehicles*	*Temperature, pressure and altitude relationships*	*Truss and Monocoque construction*	*Secondary flight controls*	*Types of Rockets*
	SLO-2	*Hot air balloons*	*Gradient and isothermal region*	*Semi-monocoque construction.*	*High lift devices*	*Solid propulsion rockets*
S-3	SLO-1	*George Cayley's contribution*	*Bernoulli's equation for incompressible flow*	*Typical wing Structures*	*Types of control systems*	*Liquid propulsion rockets Working*
	SLO-2	*Otto Lilienthal Contribution*	*Application*	*Fuselage Structures*	*History of Control system evolution*	*Liquid propulsion rockets Advantages and Disadvantages*
S-4	SLO-1	*Wright Brothers contribution*	*Forces acting on aircraft*	*Materials used in Aircraft*	*Mechanical control systems*	*Hybrid and cryogenic rockets*
	SLO-2	*History*	*Moments acting on aircraft*	*Explanation with examples*	*Powered control systems*	*Hybrid and cryogenic rockets Advantages and Disadvantages*
S-5	SLO-1	*Effects of 1st world war*	*How does an aircraft wing generate lift?*	*Types of power plants*	*Fly by wire control systems*	*History of ISRO*
	SLO-2	*Effect of 2nd world war*	*Preliminary explanation*	*Fundamental Classification*	*Basic Operation*	*Establishment of ISRO*
S-6	SLO-1	*Classification of airplanes*	*Basic characteristics of airfoils*	*An insight into air breathing engines*	*Basic instruments for flying*	*Launch vehicles designed and developed by ISRO*
	SLO-2	*Detailed classification*	*NACA nomenclature*	*Piston Engines*	*Pitot static instruments*	*Examples explanation*
S-7	SLO-1	*Components of a simple conventional aircraft*	*Introduction to high speed flight*	*Gas turbine engines*	*Altimeter*	*Principle of Satellite Operation*

	SLO-2	*Functions of each component of a simple conventional aircraft*	*propagation of sound, Mach number*	*Types of Gas turbine engines*	*ASI, VSI*	*Types of Satellites*
S-8	SLO-1	*Introduction to Unmanned aerial vehicles*	*Subsonic and transonic flows*	*Relative merits of piston-prop, turboprop, and jet engines*	*Gyroscopic instruments*	*Satellite applications*
	SLO-2	*Applications of UAV*	*Supersonic and hypersonic flows*	*Comparison based on performance characteristics*	*Turn and slip indicator Artificial horizon.*	*Space Debris*
S-9	SLO-1	*Aviation for society*	*Supersonic flows*	*Relative merits of jet engine*	*Turn and slip indicator*	*Case study-I on successful launches*
	SLO-2	*Aviation for socio economic development*	*Hypersonic flows*	*Comparison based on performance characteristics*	*Artificial horizon*	*Case study-2 on launch failures*

Learning Resources	1. *Charles Harrington Kermode,A.C., Flight Without Formulae, 5th ed., Pearson Education,1970* 2. *Anderson, J.D., Introduction to Flight, 8th ed., Tata McGraw Hill,1996* 3. *Clancy L.J.., Aerodynamics, 2nd ed., Sterling book house 1975*	4. *Shevell R.S., Fundamentals of flights, 2nd ed., Pearson education 2004* 5. *Kermode.A.C., Mechanics of Flight, 12th ed. Pearson Education 1972* 6. *McKinley, J.L., R.D. Bent, Aircraft Power Plants, McGraw Hill 1993*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. S. Raja, National Aerospace Laboratories, Bangalore, raja@nal.res.in	*1. Dr. K. M. Parammasivam, Madras Institute of Technology, Chennai, mparams@mitindia.edu*	*1. Mr.Abdur Rasheed, SRMIST*
2. Dr. A. Sakthivel, CEMILAC, Bangalore, asakthironika@gmail.com	*2. Dr.A.P.Haran, Park College of Engineering & Technology, email: ap_haran@rediffmail.com*	*2. Mr. S. Chandra Sekhar, SRMIST*

Course Code	18ASO102T	Course Name	CREATIVITY, INNOVATION AND NEW PRODUCT DEVELOPMENT	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Aerospace Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Improve creativity and problem solving methods
CLR-2 :	Improve the knowledge in finding innovative approach to issues
CLR-3 :	Equip students the skills of project selection
CLR-4 :	Understand patent laws and international practices
CLR-5 :	Have expose to design, testing of an engineering product
CLR-6 :	Set the quality standards in developing a prototype of any engineering product

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO – 3
CLO-1 :	Understand the importance of thinking ability in the field of engineering	2	85	80	H	H	-	-	-	H	H	H	-	H	-	H	-	-	-
CLO-2 :	Update the skills to solve engineering problems	2	85	80	H	H	-	-	-	H	H	H	-	-	-	H	-	-	-
CLO-3 :	Undertake better projects which will be helpful for nation development	2	85	80	H	-	-	H	-	H	H	H	H	-	-	H	-	-	-
CLO-4 :	Perform better research	2	85	80	H	H	-	-	-	H	H	H	-	-	H	H	-	-	-
CLO-5 :	Study and analyze the case studies in the technical way	2	85	80	H	-	H	-	-	H	H	H	H	-	-	H	-	-	-
CLO-6 :	Support for the design of quality products and services	2	85	80	H	H	H	H	-	H	H	H	-	-	H	H	-	-	-

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Introduction	Collection of ideas	Introduction to project evaluation	Evaluation of IPR	Design of product prototype
	SLO-2	The process of technological innovation	Categories of ideas	Preliminary methods	4 traditional forms	Factors of design
S-2	SLO-1	Factors contributing to successful technological innovation	Different routes for collecting ideas	Screening methods	Definition of IPR	Requirement of design
	SLO-2	Examples for the factors	Examples	Examples	Development of 7 types of IPR	Design process
S-3	SLO-1	Technological milestones	Taking different views, Combining the unusual	Product life cycle	Need for IPR in India	Functional design
	SLO-2	Technological evolution	Examples	Different organizations	Patentable innovation	Functional margins
S-4	SLO-1	The need for creativity for individual and nation	Adapt, adopt & improve	Product Evaluation profile	Obligations	Test and Qualification
	SLO-2	The need for innovation for individual and nation	Breaking the rules.	Stability factors	Enforcement measures	Types of tests and their significance
S-5	SLO-1	Creativity -Obstacles	Challenge the assumptions	Growth factors	Patent search and its advantages	Test plan
	SLO-2	Problem solving-Obstacles	Asking searching questions	Marketability factors	IP Council	Issues in concluding a test
S-6	SLO-1	Creativity -keys and questions	Increasing the yield	Research factors	International Treaties	Quality standards
	SLO-2	Problem solving-keys and questions	Implementation methods	Development factors	Conventions	Product Strategy

S-7	SLO-1	*Brain Storming*	*Purpose and types, Indian National Technology Missions*	*Position factors*	*WIPO*	*Six-sigma Practice Procedure*
	SLO-2	*Examples*	*Detailed explanation*	*Production factors*	*TRIPS*	*Implementation*
S-8	SLO-1	*Different techniques for creative intelligence*	*Project selection criteria*	*Value Engineering*	*WTO*	*Marketing- methods*
	SLO-2	*Detailed explanation with examples*	*Analysis methods*	*Need for value engineering*	*PCT*	*Marketing- research*
S-9	SLO-1	*Case Study-1on technology innovation*	*Case Study-2 on project selection*	*Case Study-3 on project evaluation*	*Case Study-4 on IPR*	*Case Study -5 on product development*
	SLO-2	*Example*	*Example*	*Example*	*Example*	*Example*

Learning Resources	1. *Keleen A.L., New Product Planning and Development, International Correspondence Schools Division, Scraton, Pennsyvania, 1969* 2. *Paul Sloane, The Leader's Guide to Lateral Thinking Skills, 2nd ed., Kogan Page India, New Delhi, 2008* 3. *Department of Space: IPR Manual, Bangalore, 2007* 4. *Osho, Creativity – Unleashing the Forces Within, St Martin's Griffin, New York, March, 2007*	5. *Abdul Kalam.A.P.J., Arun Tiwari, "Wings of Fire", Universities Press, Hyderabad,1999* 6. *Edward de Bono, How to have a beautiful mind, Vermilon, London, 2004* 7. *Khandwalla, R.N., Fourth Eye (Excellence through creativity), Wheeler Publishing, Allahabad, 1992.* 8. *Rajiv.V.Dharaskar, Innovation-Growth Engine for Nation. Nice Buzzword but often Misunderstood, www.dharaskar.com* 9. *Annamalai.N., www.creativitysphere*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
Level 2	Apply Analyze	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
Level 3	Evaluate Create	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. S. Raja, National Aerospace Laboratories, Bangalore, raja@nal.res.in	*1. Dr. K. M. Parammasivam, Madras Institute of Technology, Chennai, mparams@mitindia.edu*	*1. Mr.Abdur Rasheed, SRMIST*
2. Dr. A. Sakthivel, CEMILAC, Bangalore, asakthironika@gmail.com	*2. Dr.A.P.Haran, Park College of Engineering & Technology, email: ap_haran@rediffmail.com*	*2. Mr. S. Chandra Sekhar, SRMIST*

Course Code	18ASO103T	Course Name	AVIATION AND AIRLINE MAINTENANCE MANAGEMENT	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Aerospace Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Create insights to the concepts of Air transportation and Airline management
CLR-2 :	Familiarize the concept of Airline forecasting and fleet planning
CLR-3 :	Identify the significance of airline scheduling and equipment maintenance
CLR-4 :	Create insights to the concepts of Aircraft reliability and aging aircraft maintenance
CLR-5 :	Familiarize the aviation supporting organization and state regulatory
CLR-6 :	Familiarize with aviation maintenance and management

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO – 3
CLO-1 :	Identify and understand the organization details in air-transportation	2	85	75	H	-	L	L	M	M	M	H	M	M	L	L	M	M	H
CLO-2 :	Identify the forecasting methods in airline	2	85	75	H	-	L	L	M	L	L	L	M	M	L	L	M	M	H
CLO-3 :	Understand the scheduling process and maintenance of aircraft	2	85	75	M	-	-	-	L	M	M	M	M	M	L	L	H	M	M
CLO-4 :	Understand the aging aircraft maintenance	2	85	75	H	-	L	M	M	M	L	M	M	M	M	M	M	M	H
CLO-5 :	Understand the aviation supporting organizations and state regulatory	2	85	75	H	-	L	L	H	M	M	M	M	M	H	M	M	M	M
CLO-6 :	Understand the concept of aviation maintenance and management	2	85	75	H	-	L	L	M	M	M	M	M	M	L	L	M	M	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Air Transportation	Airline Economics	Introduction to airline scheduling	Aircraft reliability	Aviation supporting organisations
	SLO-2	Development of Air Transportation	Airline Forecasting	Mission of Airline scheduling	Parameters to monitor	World trade organisation
S-2	SLO-1	Comparison of Air Transportation with other Modes of Transport	Fleet Planning	Equipment maintenance	Maintenance schedule	World tourism organisation
	SLO-2	International Aviation Association	Aircraft Selection Process	Maintenance system of a jet aircraft	Maintenance program	State regulatory
S-3	SLO-1	ICAO	Operating Cost	Flight operations and crew scheduling	Schedule determination	Responsibilities and functions of CAA
	SLO-2	IATA	Passenger Capacity	Objective of ground service	Condition monitoring maintenance	Responsibilities and functions of FAA
S-4	SLO-1	Aviation Classification	Load Factor	Ground operations and facility limitations	ETOPS and EROPS	DGCA
	SLO-2	Factors Affecting General Aviation Industry	Passenger Fare and Tariffs	Schedule planning and coordination	Aircraft depressurization	functions of DGCA
S-5	SLO-1	Aircraft Uses	Influence of Geographical, Economic and Political Factors	Traffic flow	Aging Aircraft	Turbine engine monitoring
	SLO-2	airport classification	On Routes And Route Selection	Schedule salability	Maintenance in aging aircraft	Turbine engine vibration monitoring
S-6	SLO-1	Airline Management	Fleet Commonality	Schedule Adjustment	Operating cost associated with maintenance	Onboard maintenance system
	SLO-2	Levels of Management	Factors Affecting Fleet Choice	Chain reaction effect	Helicopter maintenance	Life usage monitoring
S-7	SLO-1	Functions of management	Valuation and Depreciation	Load factor leverage	Maintenance schedule	Technology in aircraft maintenance

	SLO-2	*Management by Objective*	*Budgeting*	*Equipment's and types of schedule*	*Current Capabilities of NDT*	*Airline financing*
S-8	SLO-1	*Principle of organization planning*	*Cost planning*	*Preparing flight plans*	*Applications of NDT in maintenance*	*Sources of fund*
	SLO-2	*Organizational Chart*	*Aircrew Analysis*	*Aircraft scheduling in line with aircraft maintenance practice*	*Equipment and tools for maintenance*	*Globalization*
S-9	SLO-1	*Line management*	*Route Analysis*	*Hub and spoke scheduling*	*Spare maintenance*	*Globalization of airlines*
	SLO-2	*Staff Management*	*Aircraft evaluation*	*Advantages and Disadvantages*	*Future aircraft maintenance*	*Future Challenges*

Learning Resources	1. *John G Wensveen, Air Transportation – A Management Prespective, Ashgate Publications, 8th ed., 2015* 2. *Friend C.H., Aircraft Maintenance Management, Longman aviation technology. 2nd ed., 1992*	3. *Indian Aircraft Manual, DGCA, sterling book House, Mumbai, reprint 2014* 4. *PS Senguttuvan, Fundamentals of air transport management, excel books, reprint 2010*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Wg .Cdr K. Manoharan (Retd), Blue Dart Aviation Ltd., manoharank@bluedart.com	*1. Mr. D. Balaji, Professor, KPRIET, Coimbatore, dbalajideva@gmail.com*	*1. K.lynthezhuthon, SRMIST*
2. Dr. Raja S, CSIR-NAL, Bangalore, raja@nal.res.in	*2. Dr. K. M. Parammasivam, Madras Institute of Technology, Chennai, mparams@mitindia.edu*	*2. Mr .G. Mahendra Perumal, SRMIST*

Course Code	18ASO104T	Course Name	AIRCRAFT GENERAL ENGINEERING AND MAINTENANCE PRACTICES	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Aerospace Engineering*	Data Book / Codes/Standards	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Identify ground handling tools and equipments to perform ground handling operation of aircraft*
CLR-2 :	*Maintain the aircraft ground servicing units*
CLR-3 :	*Upkeep the safety aspects and improve the human relations in working environment.*
CLR-4 :	*Work in the planning process environment of maintenance industry.*
CLR-5 :	*Maintain the tools, accessories, components ,minor & major assemblies*
CLR-6 :	*Utilize the knowledge acquired to work as an efficient maintenance engineer.*

Course Learning Outcomes (CLO): *At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO – 3
CLO-1 : *Understand the operation of various ground handling equipments & procedures*	2	85	75	H	-	L	L	M	M	M	M	M	M	L	L	M	M	H
CLO-2 : *Acquire knowledge on utility of aircraft ground servicing units and their maintenance*	2	85	75	H	-	L	L	M	L	L	L	M	M	L	L	M	M	H
CLO-3 : *Know the safety aspects of usage of fluids & the human performance factors*	2	85	75	M	-	-	-	L	M	M	M	M	M	L	L	H	M	M
CLO-4 : *Acquire knowledge on different maintenance operational procedures*	2	85	75	H	L	L	M	M	M	L	M	M	M	M	M	M	M	H
CLO-5 : *Acquire knowledge on various maintenance practices.*	2	85	75	H	L	L	L	H	M	M	M	M	M	H	M	M	M	M
CLO-6 : *Acquire comprehensive knowledge about ground handling & operational procedure of aircraft & its servicing units.*	2	85	75	H	L	L	L	M	M	M	M	M	M	L	L	M	M	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Introduction to Aircraft Ground Handling Procédures.*	*Introduction to Maintenance and handling of ground equipment*	*Safety aspects when working with electricity*	*Introduction to Maintenance Procedure*	*Hand Tools*
	SLO-2	*Aircraft Taxing Procedure*	*Maintenance and handling of Compressor*	*Safety aspects when working with oil, gases, oxygen and chemicals*	*Maintenance Planning*	*Care of Tools*
S-2	SLO-1	*Aircraft Towing Operations*	*Maintenance of Portable Hydraulic Test Stand.*	*Remedial action during an incident*	*Modification Procedure*	*Calibration of tools and equipment*
	SLO-2	*Safety Precautions during Towing Operations*	*Handling of Portable Hydraulic Test Stand*	*Remedial action during an accident.*	*Stores Procedure*	*Calibration standards*
S-3	SLO-1	*Aircraft Jacking Procedure*	*Maintenance of Electric power supply equipment*	*Human Factors*	*Certification Procedure*	*Control Cables*
	SLO-2	*Safety Precautions during Jacking Procedure*	*Handling of Electric power supply equipment*	*Human Error, Murphy's Law*	*Release Procedure*	*Pipes and Unions*
S-4	SLO-1	*Chocking & Mooring Operations*	*Maintenance of Charging Trolley*	*Human performance and limitations – Vision& Hearing*	*Interface with aircraft operation*	*Transmissions*
	SLO-2	*Safety Precautions during Chocking & Mooring Operations*	*Handling of Charging Trolley*	*Information Processing*	*Maintenance, Inspection*	*Bearing & Hoses*
S-5	SLO-1	*Aircraft Storage Methods*	*Maintenance of Air-conditioning and Heating Unit*	*Attention & Perception*	*Quality control*	*Springs*
	SLO-2	*Storage of Rotables*	*Handling of Air-conditioning and Heating Unit*	*Memory & Physical Access*	*Quality assurance*	*NDT Techniques*
S-6	SLO-1	*Refueling Procedures*	*Maintenance of Ground Support Air Starter Unit*	*Claustrophobia*	*Publications*	*Engineering drawing diagrams*
	SLO-2	*Defueling Procedures*	*Handling of Ground Support Air Starter Unit*	*Factors affecting human performance – Workload*	*Bulletins*	*Standards*
S-7	SLO-1	*Aircraft Deicing Procedures*	*Maintenance of Oil Pressure Unit*	*Stress*	*Airworthiness Directives*	*Fits and Clearance*

	SLO-2	*Aircraft Anti-icing Procedures*	*Handling of Oil Pressure Unit*	*Time Pressure & Deadlines*	*Structural Repair Manual*	*Welding & Swaging*
S-8	SLO-1	*Effect of environmental condition on aircraft handling and operation*	*Maintenance of Fire extinguishers*	*Medication*	*Overhaul Manual*	*Brazing & Soldering*
	SLO-2	*Aircraft cleaning and Maintaining*	*Handling of Fire extinguishers*	*Noise & Fumes*	*Log Books*	*Bondings*
S-9	SLO-1	*Ground signaling, Marshaling of aircraft in day time*	*Maintenance of Jacks, Cranes, Ladders, Platforms, Trestles & Chocks*	*Climate & Temperature*	*Introduction to ATA*	*Corrosion and its removal*
	SLO-2	*Ground signaling, Marshaling of aircraft in night time.*	*Handling of Jacks, Cranes, Ladders, Platforms, Trestles & Chocks*	*Working Environment*	*ATA Specifications*	*Trouble shooting techniques.*

Learning Resources	1. *Airframe and Power plant Mechanics, General Hand Book, Federal Aviation Administration, AC65 – 9A* 2. *Airframe and Power plant Mechanics, Airframe Hand Book, Federal Aviation Administration, AC65 – 15A* 3. *Civil Aviation Inspection(CAP 459) Part – II* 4. *Acceptable Methods, Techniques & Practices (FAA) – EA-AC43.13-1A & 2A*	5. *Michael J.Kroes, William A.Watkins ad Frank Delp, Aircraft Maintenance and Repair, 7th ed., Tata McGraw Hill, New Delhi, 2013* 6. *CAP 715 – An Introduction to Aircraft Maintenance Engineering Human Factors for JAR 66, Civil Aviation Authority, UK*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Wg .Cdr K. Manoharan (Retd), Blue Dart Aviation Ltd., manoharank@bluedart.com	*1. Dr.A.P.Haran, Park College of Engineering & Technology, email: ap_haran@rediffmail.com*	*1. Dr. S. Sivakumar, SRMIST*
2. Dr. Raja S, CSIR-NAL, Bangalore, raja@nal.res.in	*2. Dr. K. M. Parammasivam, Madras Institute of Technology, Chennai, mparams@mitindia.edu*	*2. Mr .G. Mahendra Perumal, SRMIST*

Course Code	18ASO105T	Course Name	FLOW VISUALIZATION TECHNIQUES	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Aerospace Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Identify the type of flow visualization used in air flow*
CLR-2 :	*Identify the type of flow visualization used in water flow*
CLR-3 :	*Identify the type of flow visualization for compressible flow*
CLR-4 :	*Assess the need of image-based measurement like Particle Image Velocimetry*
CLR-5 :	*Understand the operation of various other flow visualization techniques*
CLR-6 :	*Utilize the knowledge acquired about various flow visualization for improving the aerodynamics*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO – 3
CLO-1 :	*Understand Flow Visualization requirements and applications*	2	80	70	H	-	H	L	-	-	M	-	-	-	-	-	-	M	L
CLO-2 :	*Acquire knowledge on Flow Visualization using air and water*	2	80	70	H	-	H	L	-	-	-	-	-	-	-	-	H	M	M
CLO-3 :	*Learn the working principles of compressible flow visualization techniques*	2	80	70	H	-	H	L	-	-	-	-	-	-	-	-	-	M	M
CLO-4 :	*Appreciate the usefulness of Particle Image Velocimetry, setup, working and its applications*	2	80	70	H	-	H	L	H	-	-	-	-	-	-	-	H	H	H
CLO-5 :	*Gain knowledge on various other visualization techniques*	2	80	70	H	-	H	L	M	-	-	-	-	-	-	-	M	M	M
CLO-6 :	*Acquire comprehensive understanding of various flow visualization techniques and their applications*	2	80	70	H	-	M	L	-	-	M	-	-	-	-	-	M	M	M

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Introduction to Flow Visualization*	*Safety requirements*	*Skin Friction Visualization*	*Holographic Interferometer*	*Tracer Methods*
	SLO-2	*Need for Flow Visualization*	*Safety procedures*	*Requirements for Skin Friction*	*Applications of Holographic Interferometer*	*Hydrogen Bubble Method*
S-2	SLO-1	*Applications of Flow Visualization*	*Chemical Safety*	*Interferometer*	*Particle Image Velocimetry (PIV)*	*Dye Injection*
	SLO-2	*Types of Flow Visualization*	*Human Safety*	*Fringe Imaging*	*PIV and its Types*	*Types of dye*
S-3	SLO-1	*Flow Visualization in Water*	*Surface Visualization*	*Compressible Flow Visualization*	*PIV Setup*	*Spark Tracer Technique*
	SLO-2	*Laminar Flow Visualization*	*Need for Surface Visualization*	*Gladstone Dale Relation*	*PIV Procedure*	*Spark Tracer Setup*
S-4	SLO-1	*Hele-Shaw Apparatus*	*Surface Visualization versus Surface Measurements*	*Requirements for Optics*	*Pulse Signals*	*Molecular Tagging Velocimetry (MTV)*
	SLO-2	*Dye Injection Method*	*Advantages of Surface Visualization*	*Optics and Setup procedures*	*Synchronizer*	*Setup for MTV*
S-5	SLO-1	*Flow Visualization in Air*	*Wall Shear Stress*	*Shadowgraph*	*Imaging for PIV*	*Thermometry*
	SLO-2	*Usage of Tufts*	*Need for Wall Shear Stress Study*	*Shadowgraph procedure*	*Image Correlation*	*Devices for Thermometry*
S-6	SLO-1	*Smoke Generators*	*Surface Pressure Visualization*	*Schlieren*	*Video Recording*	*Low density flow visualization*
	SLO-2	*Smoke Injection Methods*	*Pressure Sensitive Paints (PSP)*	*Schlieren procedure*	*Video Imaging*	*Challenges for low density flow study*

S-7	SLO-1	*Light Sources*	*Application of PSP on Surfaces*	*Mach Zehnder Interferometer*	*Postprocessing PIV data*	*Electron Beam Flow visualization*
	SLO-2	*Light Diffuser*	*Time resolved PSP*	*Mach Zehnder Interferometer Setup*	*Post processing PIV software*	*Glow Discharge visualization*
S-8	SLO-1	*Laser Sources*	*Surface Flow Visualization*	*Fresnel Equation*	*Error Sources in PIV*	*Surface Temperature Visualization*
	SLO-2	*Laser Sheet for smoke visualization*	*Shear Sensitivity*	*Applications of Mach Zehnder Interferometer*	*Applications of PIV*	*Temperature Sensitive Paints (TSP)*
S-9	SLO-1	*Photographic Equipment*	*Liquid Crystal Coating*	*Holography*	*3D PIV*	*3D Imaging*
	SLO-2	*Photographic Techniques*	*Choice of Liquid Crystals*	*Holography setup*	*Setup for 3D PIV*	*3D Image processing*

Learning Resources	1. *Alexander J Smits, TT Lim, Flow Visualization: Techniques and Examples, 2nd ed., Imperial College Press, 2012* 2. *Rathakrishnan E, Instrumentation, Measurements, and Experiments in Fluids, 1st ed., CRC Press, 2007* 3. *Settles G S, Schlieren and Shadowgraph Techniques: Visualizing Phenomena in Transparent Media, 1st ed., Springer, 2001*	4. *Merzkirch W (Ed Gersten K), Techniques of flow visualization, AGARDograph No. 302, 1984* 5. *Journal of Visualization, Springer* 6. *Journal of Visualization and Image processing, Begell House*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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2. Dr. Raja S, CSIR-NAL, email: raja@nal.res.in	*2. Dr. Parammasivam K M, MIT, Chennai, email: mparams@mitindia.edu*	*2. Dr. Kannan B T, SRMIST*

Course Code	18ASO106T	Course Name	AIRPORT ENGINEERING	Course Category	O	*Open Elective*	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Aerospace Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Familiarize about airports and surveys*
CLR-2 :	*Understand about airport planning and forecasting*
CLR-3 :	*Understand and design runway and taxiways*
CLR-4 :	*Understand about air traffic control tower and terminal areas*
CLR-5 :	*Understand about helipads and STOL ports*
CLR-6 :	*Utilize the knowledge acquired to work as an airport engineer*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO – 3
CLO-1 :	*Identify airports and surveys involved*	2	85	75	H	-	L	L	M	M	M	M	M	M	L	L	M	M	H
CLO-2 :	*Identify airport planning and forecasting*	2	85	75	H	-	L	L	M	L	L	L	M	M	L	L	M	M	H
CLO-3 :	*Understand and design runway and taxiways*	2	85	75	M	-	-	-	L	M	M	M	M	M	L	L	H	M	M
CLO-4 :	*Understand about air traffic control tower and terminal areas*	2	85	75	H	L	L	M	M	M	L	M	M	M	M	M	M	M	H
CLO-5 :	*Understand about helipads and STOL ports*	2	85	75	H	L	L	L	H	M	M	M	M	M	H	M	M	M	M
CLO-6 :	*Acquire comprehensive knowledge about airport and the utilities.*	2	85	75	H	L	L	L	M	M	M	M	M	M	L	L	M	M	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*International airport authority of India*	*Airport Planning*	*Runway design*	*Planning and design of terminal area*	*Heliport*
	SLO-2	*Civil aviation department*	*Improvement of existing Airport*	*Runway orientation*	*Terminal building*	*Advantages of helicopter*
S-2	SLO-1	*Airport Authority of India*	*Airport site selection*	*Change in direction of runway*	*Passenger Flow*	*Characteristics of helicopter*
	SLO-2	*Open sky policy*	*Factors influence location*	*Basic runway length*	*Sequence of activity*	*Planning of heliport*
S-3	SLO-1	*Airport terminology*	*Airport size*	*Corrections to basic runway length*	*Size of apron*	*Site Selection*
	SLO-2	*Aircraft Classification*	*Factors affecting size of airport*	*Runway patterns*	*Hangars*	*Obstruction clearance requirements*
S-4	SLO-1	*Components parts of Aeroplane*	*Aviation Forecasting*	*Comparison of runway patterns*	*Typical airport layout*	*Elevated heliport*
	SLO-2	*Aircraft Characteristics*	*Important aspects*	*Taxiway design*	*Air Traffic Control*	*Marking and lighting of heliport*
S-5	SLO-1	*Jet Aircraft Characteristics*	*Airport obstructions*	*Layout of taxiways*	*Significance of ATC*	*Heliport in airport*
	SLO-2	*Civil and military aircrafts*	*Imaginary surface*	*Geometric standards for taxiway*	*Flight Rules*	*STOL ports*
S-6	SLO-1	*Classification of aerodrome*	*Objects with actual height*	*Exit taxiways*	*ATC Network*	*Characteristics of STOL Aircraft*
	SLO-2	*Classification of airports*	*Clear Zone*	*Location of exit taxiway*	*ATC Aids*	*Advantages of STOL Aircraft*

S-7	SLO-1	*Flying Activities*	*Turning zone*	*Design of exit taxiways*	*Classification*	*Planning of STOL Port*
	SLO-2	*Scheduled and non-scheduled flights*	*Zoning Laws*	*Loading aprons*	*Automation in ATC Aids*	*Aspects of the planning*
S-8	SLO-1	*Airport Survey*	*Environmental considerations*	*Holding Aprons*	*GPS ATC*	*Obstruction clearance requirements*
	SLO-2	*Objectives and types of survey*	*Factors influenced by airport activity*	*Fillets*	*Free Flight ATC*	*Runway and taxiway of STOL port*
S-9	SLO-1	*Drawings to be Prepared*	*Pollution factor*	*Separation Clearance*	*Free flight types*	*Lighting of STOL Port*
	SLO-2	*Types of plan*	*Social factor*	*Bypass or turnaround taxiway*	*Approaches of free flight*	*Marking of STOL Port*

Learning Resources	1. *Rangwala. Airport Engineering, Charotar Publishing House Pvt., 15th ed., 2015*	2. *Norman J. Ashford, Saleh A. Mumayiz, Paul H. Wright. Airport Engineering: Planning, Design and Development of 21St - Century Airports", 4th ed., CBS Publishers & Distributors. April 2011*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Wg.Cdr K.Manoharan (Retd), Blue Dart Aviation Ltd, email: manoharank@bluedart.com	*1. Mr. D. Balaji, KPRIET, Coimbatore, email: dbalaji.deva@gmail.com*	*1. K. Iynthezhuthon, SRMIST*
2. Dr. Raja S, CSIR-NAL, Bangalore, raja@nal.res.in	*2. Dr. K. M. Parammasivam, Madras Institute of Technology, Chennai, mparams@mitindia.edu*	*2. Mr .G. Mahendra Perumal, SRMIST*

Course Code	18BTO101T	Course Name	HUMAN HEALTH AND DISEASES	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*State the basic structural organization of human health system*
CLR-2 :	*Summarize the etiology of human infectious diseases*
CLR-3 :	*Describe immune system of human body and immune disorders*
CLR-4 :	*Impart information about genetic disease*
CLR-5 :	*Indicate the high risk diseases associated with modern society*
CLR-6 :	*State about disease diagnosis and treatment strategies*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO – 3
CLO-1 :	*Recall basic human biology at the genetic, cellular, and physiological levels*	2	80	70	-	-	-	L	-	M	-	-	-	H	-	H	-	L	H
CLO-2 :	*Interpret how the human body maintains a healthy balance, and how disturbances of this balance underlie diseases*	2	85	75	-	-	-	L	-	M	-	-	-	H	-	H	-	L	H
CLO-3 :	*Discuss about infectious organism and understand defense mechanism of our human body*	2	75	70	-	-	-	L	-	M	-	-	-	H	-	H	-	L	H
CLO-4 :	*Describe disease causing agents*	2	85	80	-	-	-	L	-	M	-	-	-	H	-	H	-	L	H
CLO-5 :	*Familiarize with modern biomedical scientific approaches to treat disease.*	2	85	75	-	-		L	-	M	-	M	-	H	-	H	H	H	H
CLO-6 :	*Demonstrates the importance of taking responsibility for one's own health*	2	80	70	-	-	-	L	-	M	-	H	-	H	-	H	-	H	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Introduction to human heath*	*Concepts of human disease*	*Immune system*	*Mendelian genetics*	*Disease Diagnosis*
	SLO-2	*Anatomy and physiology*	*Disease Disorder and syndrome*	*Physical chemical and cellular barrier*	*Genetics of simple and complex traits*	*Treatment strategy*
S-2	SLO-1	*Respiratory system*	*Pathology of disease*	*Types of Immune cell*	*Hereditary disease*	*Biomedical Instruments*
	SLO-2	*Circulatory system*	*Mechanism of disease*	*Humoral and cell mediated immunity*	*Karyotype preparation and analysis Chromosome abnormality*	*Biosensors*
S-3	SLO-1	*Digestive system*	*Infectious disease*	*Cells Involved in inflammation*	*Thalassemia*	*Drug designing and development*
	SLO-2	*Execratory system*	*Causative agents Bacteria, virus and parasites*	*Inflammatory Process*	*Cystic fibrosis*	*Computer aided drug designing*
S-4	SLO-1	*Reproductive system*	*Bacteria: Introduction Pathogenesis*	*Immune disorders*	*Duchene Muscular dystrophy*	*Drug metabolism*
	SLO-2	*Fertilization and embryogenesis*	*Bacterial toxins*	*Abscesses, ulcer, cellulitis And Allergy*	*Sickle cell anemia*	*ADME property of a drug*
S-5	SLO-1	*Cell structure*	*virulence of bacterial infection*	*Autoimmunity*	*Indian genetic disease database*	*Sources of drug- plants and microbes*
	SLO-2	*Tissue types*	*Antibiotic resistance strains*	*Immunodeficiency*	*Human gene mutation database*	*Route of administration*
S-6	SLO-1	*How body gets energy*	*Virus: An overview of replication cycle of virus*	*High risk disease of modern society*	*Principle class of metabolic disorders*	*Bulk Drugs and processing*
	SLO-2	*ATP Synthesis*	*Effect of virus infection in the host cell*	*Obesity, Hypertension and diabetics*	*Inherited Metabolic disorders*	*Active pharmaceutical ingredient*

S-7	SLO-1	*Cell metabolism*	*Epidemiology*	*Neoplasm*	*Metabolic syndrome*	*Vaccines types, Recommendation by age*
	SLO-2	*Cell cycle*	*Roots of spreading, Emerging and reemerging virus*	*Oncogenes and tumor suppressor genes*	*Risk factors*	*Vaccines – Recent advancement*
S-8	SLO-1	*Checkpoints in cell division*	*Parasitosis, common parasites of human*	*Types of cancer*	*Lysozyme storage disease: Molecular basis*	*Immunotherapy*
	SLO-2	*Cell division -Mitosis and Meiosis*	*Plasmodium – life cycle and disease*	*Stages of cancer*	*List of proteins involved in LSD*	*Immunotherapeutic approaches currently in use*
S-9	SLO-1	*Growth factors- overview*	*Fungal Infections*	*Cancer in future*	*Balanced nutrition and Malnutrition*	*Stem cell therapy*
	SLO-2	*Types and function*	*Endemic mycoses in immunocompromised patients*	*Life style and cancer risk*	*Deficiency disease*	*Gene therapy*

Learning Resources	1. *Goodenough and McGuire, Biology of Humans: Concepts, Applications and issues, 4th ed., Benjamin Cummins/Pearson Publisher, 2011*	2. *Marianne Neighbors, Ruth Tannehil, Human Diseases, 4th ed.,Jones Cengage learning, 2015*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	*1. Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	*1. Dr. Lilly M Saleena, SRMIST*
2. Dr. Karthik Periyasamy, Aurobindo Pharma Limited, Hyderabad, karthikmpk@gmail.com	*2. Prof. R. B. Narayanan, SVCE, Chennai, rbn@svce.ac.in*	*2. Dr.Priya Swaminathan, SRMIST*

Course Code	18BTO102T	Course Name	MODELLING OF BIOMOLECULES	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	State the basic structural organization of human health system
CLR-2 :	Summarize the etiology of human infectious diseases
CLR-3 :	Describe immune system of human body and immune disorders
CLR-4 :	Impart information about genetic disease
CLR-5 :	Indicate the high risk diseases associated with modern society
CLR-6 :	State about disease diagnosis and treatment strategies

		Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	Recall basic human biology at the genetic, cellular, and physiological levels	2	80	70	-	-	-	L	-	M	-	-	-	H	-	H	-	L	H
CLO-2 :	Interpret how the human body maintains a healthy balance, and how disturbances of this balance underlie diseases	2	85	75	-	-	-	L	-	M	-	-	-	H	-	H	-	L	H
CLO-3 :	Discuss about infectious organism and understand defense mechanism of our human body	2	75	70	-	-	-	L	-	M	-	-	-	H	-	H	-	L	H
CLO-4 :	Describe disease causing agents	2	85	80	-	-	-	L	-	M	-	-	-	H	-	H	-	L	H
CLO-5 :	Familiarize with modern biomedical scientific approaches to treat disease.	2	85	75	-	-		L	-	M	-	M	-	H	-	H	H	H	H
CLO-6 :	Demonstrates the importance of taking responsibility for one's own health	2	80	70	-	-	-	L	-	M	-	H	-	H	-	H	-	H	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Introduction to human heath	Concepts of human disease	Immune system	Mendelian genetics	Disease Diagnosis
	SLO-2	Anatomy and physiology	Disease Disorder and syndrome	Physical chemical and cellular barrier	Genetics of simple and complex traits	Treatment strategy
S-2	SLO-1	Respiratory system	Pathology of disease	Types of Immune cell	Hereditary disease	Biomedical Instruments
	SLO-2	Circulatory system	Mechanism of disease	Humoral and cell mediated immunity	Karyotype preparation and analysis Chromosome abnormality	Biosensors
S-3	SLO-1	Digestive system	Infectious disease	Cells Involved in inflammation	Thalassemia	Drug designing and development
	SLO-2	Execratory system	Causative agents Bacteria, virus and parasites	Inflammatory Process	Cystic fibrosis	Computer aided drug designing
S-4	SLO-1	Reproductive system	Bacteria: Introduction Pathogenesis	Immune disorders	Duchene Muscular dystrophy	Drug metabolism
	SLO-2	Fertilization and embryogenesis	Bacterial toxins	Abscesses, ulcer, cellulitis And Allergy	Sickle cell anemia	ADME property of a drug
S-5	SLO-1	Cell structure	virulence of bacterial infection	Autoimmunity	Indian genetic disease database	Sources of drug- plants and microbes
	SLO-2	Tissue types	Antibiotic resistance strains	Immunodeficiency	Human gene mutation database	Route of administration
S-6	SLO-1	How body gets energy	Virus: An overview of replication cycle of virus	High risk disease of modern society	Principle class of metabolic disorders	Bulk Drugs and processing
	SLO-2	ATP Synthesis	Effect of virus infection in the host cell	Obesity, Hypertension and diabetics	Inherited Metabolic disorders	Active pharmaceutical ingredient

S-7	SLO-1	*Cell metabolism*	*Epidemiology*	*Neoplasm*	*Metabolic syndrome*	*Vaccines types, Recommendation by age*
	SLO-2	*Cell cycle*	*Roots of spreading, Emerging and reemerging virus*	*Oncogenes and tumor suppressor genes*	*Risk factors*	*Vaccines – Recent advancement*
S-8	SLO-1	*Checkpoints in cell division*	*Parasitosis, common parasites of human*	*Types of cancer*	*Lysozyme storage disease: Molecular basis*	*Immunotherapy*
	SLO-2	*Cell division -Mitosis and Meiosis*	*Plasmodium – life cycle and disease*	*Stages of cancer*	*List of proteins involved in LSD*	*Immunotherapeutic approaches currently in use*
S-9	SLO-1	*Growth factors- overview*	*Fungal Infections*	*Cancer in future*	*Balanced nutrition and Malnutrition*	*Stem cell therapy*
	SLO-2	*Types and function*	*Endemic mycoses in immunocompromised patients*	*Life style and cancer risk*	*Deficiency disease*	*Gene therapy*

Learning Resources	1. *Goodenough and McGuire, Biology of Humans: Concepts, Applications and issues, 4th ed., Benjamin Cummins/Pearson Publisher, 2011*	2. *Marianne Neighbors, Ruth Tannehil, Human Diseases, 4th ed.,Jones Cengage learning, 2015*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	*1. Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	*1. Dr. Lilly M Saleena, SRMIST*
2. Dr. Karthik Periyasamy, Aurobindo Pharma Limited, Hyderabad, karthikmpk@gmail.com	*2. Prof. R. B. Narayanan, SVCE, Chennai, rbn@svce.ac.in*	*2. Dr.Priya Swaminathan, SRMIST*

Course Code	18BTO103T	Course Name	ACTIVATED CARBON TECHNOLOGY	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*State a basic understanding of activated carbon and its industrial applications.*
CLR-2 :	*Demonstrate the preparation of the material from different sources of waste*
CLR-3 :	*Apply the engineering aspects of the adsorbents*
CLR-4 :	*Prepare the adsorbents for the waste water treatment plants*
CLR-5 :	*Analyze the problems of the industrial effluents that are hazardous to the environment*
CLR-6 :	*Apply a solution to solve the industrial effluent problems*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO – 3
CLO-1 :	*Discuss about the activated carbon from different sources and subsequent knowledge to apply industrially*	1	80	80	H	H	H	H	-	M	L	H	H	H	H	H	H	H	H
CLO-2 :	*Prepare the activated carbon from different sources*	2	85	75	H	H	H	H	-	-	M	H	H	H	H	H	H	H	H
CLO-3 :	*Explain the kinetics on the adsorption of heavy metals, dyes and toxic substances*	2	75	80	M	H	M	H	M	M	-	M	H	H	H	H	H	H	H
CLO-4 :	*Evaluate mechanism of activated carbon that is ultimately responsible for removing the toxic substance from the effluent*	2	85	80	H	H	H	H	-	-	H	L	H	H	H	H	H	H	H
CLO-5 :	*Design an alternative adsorption process and present the solution to adsorption problems.*	3	85	75	H	H	H	H	-	M	H	H	H	L	H	H	H	H	H
CLO-6 :	*Formulate the activated carbon for better environment*	2	80	80	H	H	H	H	L	M	M	M	H	H	H	H	H	H	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Activated Carbon and Its Surface Structure*	*Principle of Adsorption Kinetics*	*Activated adsorption from solutions*	*Principle of AAS and its applications*	*Application of activated adsorption technology in the waste water treatment*
	SLO-2	*Basics of activated carbon*	*Effect of contact time on the adsorption characteristics*	*Types of isotherms for solution phase*	*AAS analysis of dyes adsorption by activated carbon*	*Application of Activated Carbon in Environmental Pollution*
S-2	SLO-1	*Historical Perspective ofActivated Carbon Adsorption and its Integration with Biological Processes*	*Effect of pH on the adsorption characteristics*	*Types of adsorption isotherm sorbent selection*	*Characterizing the pore structure of the carbon by SEM*	*Integration of Activated Carbon Adsorption with Biological Processes in Wastewater and Water Treatment*
	SLO-2	*Activated carbon-crystalline structure, porous structure and chemical structure*	*Effect of agitation and adsorbent dosage on the adsorption characteristics e*	*Regeneration of activated carbon*	*Proximate analysis of activated carbon prepared from various raw materials*	*Industrial waste water treatment using natural material as an adsorbent*
S-3	SLO-1	*Types of materials from different sources*	*Thermodynamic parameters like change in free energy, enthalpy and entropy for the process of removal*	*Batch adsorption kinetics*	*Principles of FTIR analysis for the prepared activated carbon*	*AC on the removal of hazardous organic and inorganic compounds from industrial waste water*
	SLO-2	*Preparation of granulated and powder activated carbon*	*Contact Oxidation Process Followed by Activated Carbon*	*Factors influencing adsorption from binary solution*	*X-ray refractive diffraction (XRD) studies for activated carbon*	*AC on the removal of hazardous gases and vapors from industrial flue gases*
S-4	SLO-1	*Influence of carbon-oxygen surface groups of adsorption properties*	*Models, and types of adsorption*	*Transport processes in adsorption from liquid phase on activated carbon*	*X-ray photoelectron spectroscopy (XPS) studies for activated carbon*	*Application of activated adsorption technology in pharmaceutical industries*
	SLO-2	*Influence of other surface groups of adsorption properties*	*Influencing factors for adsorption properties*	*Capillary transport in adsorption from liquid phase on activated carbon*	*Interpretation of results*	*Application of activated adsorption technology in leather industries*
S-5	SLO-1	*Chemical activation using acids*	*Influencing factors for the Adsorption equilibrium*	*Adsorption behaviour of Low-Bio-degradable Organics on Activated Carbon Surfaces*	*X-ray absorption spectroscopy (XAS) studies for activated carbon*	*Application of activated adsorption technology in food industries*
	SLO-2	*Chemical activation using alkalis*	*Development of adsorption isotherms*	*Adsorption behaviour of Non-Bio-degradable Organics on Activated Carbon Surfaces*	*Interpretation of analysis*	*Application of activated adsorption technology in paint industries*

S-6	SLO-1	*Preparation of carbon from agricultural wastes*	*Linear, Freundlich, Langmuir adsorption isotherms*	*Design for packed columns*	*BET Principle and analysis*	*Adsorption for Textile Wastewater Treatment*
	SLO-2	*Preparation of activated carbon from agricultural waste using chemical agents*	*Temkin and Dubinin–Radushkevich isotherm models*	*Process design factors of fixed-bed adsorption columns*	*Interpretation of BET analysis*	*Improved Control of Pollutants through Integrated Adsorption and Biological Treatment*
S-7	SLO-1	*Preparation of activated carbon from lower cost materials*	*Adsorption Equilibria of the Light Hydrocarbon Gases on the Activated Carbon and Silica Gel*	*Phenol wastewater treatment by a two-step adsorption–oxidation process on activated carbon*	*Analysis and design of GAC and PAC Contactors*	*Application of activated adsorption technology in plating industries*
	SLO-2	*Effect of activating agents*	*Adsorption Equilibria of the heavy Hydrocarbon Gases on the Activated Carbon and Silica Gel*	*Hydrocarbon wastewater treatment process on activated carbon*	*Interpretation of results*	*Application of activated adsorption technology in dye industries*
S-8	SLO-1	*Activated carbon from e-waste such as PCB, Metallic and non-metallic components*	*Simulated Binary Isothermal Adsorption on Activated Carbon in Periodic Countercurrent Column Operation*	*Scale-up laboratory adsorption column*	*Thermal analysis of prepared activated carbon*	*Application of activated adsorption technology in drug industries*
	SLO-2	*Using physical and chemical methods for the preparation of AC from e waste*	*Solving problems*	*Criteria for scale up*	*Interpretation of results*	*Application of activated adsorption technology in brewing industries*
S-9	SLO-1	*pH, solubility and Iodine number of activated carbon*	*A Liquid-Phase Adsorption and rate of diffusion of phenol from aqueous solution into Activated Carbon*	*Adsorption of phenols onto granular activated carbon in a liquid–solid fluidized bed*	*Differential Scanning Calorimetry for the analysis of activated carbon*	*Adsorption of Normal Paraffins and Sulfur Compounds on Activated Carbon*
	SLO-2	*Different types of carbon Nano-materials: CNT, CNF, CNB, their structure*	*Solving problems*	*Desorption of phenols onto granular activated carbon in a liquid–solid fluidized bed*	*Interpretation of results*	*Application of activated adsorption technology in dairy industries*

Learning Resources	1. *Bansal, R.C. and M. Goyal, Activated Carbon Adsorption, Boca Raton, FL: CRC Press, 2013* 2. *Harry Marsh Francisco Rodríguez Reinoso, Activated Carbon, I Edition, Elsevier Science, June 2006* 3. *Douglas M. Ruthven, Principles of Adsorption and Adsorption Processes, Wiley, 1984*	4. *Jean Rouquerol, Francoise Rouquerol, Kenneth S.W.Sing, Adsorption by Powders and Porous Solids: Principles, Methodology and Applications, Academic Press, 1998* 5. *Richard I. Masel, Principles of Adsorption and Reaction on Solid Surfaces, Wiley, 1996*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Prabhakaran M, CK & Industries, ck_prabhu@yahoo.co.in	*1. Dr. Swarna V Kanth, CLRI, Anna University, chord@clri.res.in*	*1. Dr. M. Pandimadevi, SRMIST*
2. Mr.Vinod Kanth, Consultant,svkuvk71@yahoo.com	*2. Dr. R. Aravindan, CLRI, Anna Universwity, aravindhan@clri.res.in*	*2. Dr. B.Samuel Jacob, SRMIST*

Course Code	18BTO104T	Course Name	DEFENCE FORCES IN OUR BODY	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	Data Book / Codes/Standards	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Analyze the various components of the immune system*
CLR-2 :	*Discuss the innate immune cells and their role in fighting against pathogens*
CLR-3 :	*Demonstrate the adoptive immune system and their function*
CLR-4 :	*Illustrate the methods and techniques used in immunology*
CLR-5 :	*Discuss how the human body respond to pathogens*
CLR-6 :	*Apply immunotherapy*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO – 3
CLO-1 :	*Explain about the basic concept of immune system*	1	80	80	H	H	H	H		M	L	H	H	H	H	H	H	H	H
CLO-2 :	*Describe the different type of immune cells and organs*	2	85	75	H	H	H	H			M	H	H	H	H	H	H	H	H
CLO-3 :	*Analyse how the body respond to pathogens*	2	75	80	M	H	M	H	M	M		M	H	H	H	H	H	H	H
CLO-4 :	*Discuss about the immunotechniques used to assess immune functions*	2	85	80	H	H	H	H			H	L	H	H	H	H	H	H	H
CLO-5 :	*Evaluate immunity to infections*	2	85	75	H	H	H	H		M	H	H	H	L	H	H	H	H	H
CLO-6 :	*Describe immunotherapy*	2	80	80	H	H	H	H	L	M	M	M	H	H	H	H	H	H	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Introduction to the immune system*	*Introduction to innate immune system*	*Introduction to adaptive immune system*	*Antigen –antibody interaction*	*What is an infection?*
	SLO-2	*History of modern immunology*	*Components of the innate immune system*	*Components of the adaptive immune system*	*Forces in antigen-antibody interaction*	*Human infectious agents*
S-2	SLO-1	*What is immunity?*	*Anatomical barriers- Chemical and mechanical*	*Types of adaptive response*	*Affinity and avidity*	*Bacterial diseases*
	SLO-2	*Concept of self and non-self*	*Anatomical barriers- Biological*	*Innate versus adaptive immune response*	*Cross-reactivity and specificity*	*Immunity to bacteria*
S-3	SLO-1	*Primary lymphoid organ Blood marrow*	*Humoral components-complements*	*Antibody mediated immune response*	*Antibody as Immunoassays*	*Viral diseases*
	SLO-2	*Primary lymphoid organ Thymus*	*Humoral components-coagulation factors*	*What are antibodies and antigens?*	*Agglutination*	*Immunity to viruses*
S-4	SLO-1	*Hematopoietic stem cell*	*Cytokines*	*Immunoglobulin structure*	*Blood typing*	*Fungi and human diseases*
	SLO-2	*Development of blood cell lineage*	*Properties and functions of cytokines*	*Role of antibodies*	*Immuno electrophoresis*	*Immunity to fungi*
S-5	SLO-1	*Red blood cells and platelets*	*Phagocytosis and macrophages*	*Effect of antigen-antibody binding*	*Principle of ELISA Clinical utility*	*Protozoan and worms*
	SLO-2	*White Blood cells*	*Neutrophil granules and killing*	*Types of antibodies*	*Types of ELISA*	*Immunity to protozoan*
S-6	SLO-1	*The myeloid cells- granulocytic*	*NK cell cytotoxicity*	*Cell mediated immunity- T cells*	*Western Blot and confirmation*	*Vaccination-how does it work?*
	SLO-2	*The myeloid cells- monocytic*	*Dendritic cells and its action*	*Different types of T cells and their functions*	*ELISPOT- detection of virus*	*Different types of vaccination*

S-7	SLO-1	*The lymphoid cells- T and B cells*	*Pathogen recognition*	*T cell receptor*	*Tissue sectioning*	*Immunodeficiency*
	SLO-2	*The lymphoid cells- NK cells*	*Innate immune receptors*	*How does a T cell recognize antigen?*	*Immunohistochemistry*	*Autoimmune diseases*
S-8	SLO-1	*Secondary lymphoid organs-Spleen*	*Inflammation and its process*	*Antigen presenting cells*	*Fluorescence and its utility in immunoassays*	*Introduction to cancer*
	SLO-2	*Secondary lymphoid organs-Lymph nodes*	*Signs of inflammation*	*Interaction of APC with the T cells*	*Flow cytometry*	*Immunity to cancer*
S-9	SLO-1	*The lymph*	*Mechanism of inflammation*	*Clonal selection*	*Isolation of immune cells*	*Strategies of cancer treatment*
	SLO-2	*The lymphatic system*	*Role of inflammation in diseases*	*Primary and secondary immune response*	*Activation of immune cells*	*Immunotherapy*

Learning Resources	1. *A.K. Chakravarty, Immunology and Immunotechnology,Oxford University Press, 2006* 2. *Peter Wood, Understanding Immunology,2nd ed., Pearson Education, 2006*	3. *Sudha Gangal, Shubhangi Sontakke, Textbook of basic and clinical immunology, Universities Press, 2013* 4. *Richard Coico, Geoffrey Sunshine, Immunology: A short course, 6th ed., Wiley-Blackwell, 2009*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	*1. Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	*1. Dr. E.Berla Thangam, SRMIST*
2. Dr. Karthik Periyasamy, Aurobindo Pharma Limited, Hyderabad, karthikmpk@gmail.com	*2. Prof. R. B. Narayanan, SVCE, Chennai, rbn@svce.ac.in*	*2. Dr.Oindrilla.M, SRMIST*

Course Code	18BTO105T	Course Name	ANIMAL MODELS FOR RESEARCH	Course Category	O	*Open Elective*	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Learn the basics of animal experiments*
CLR-2 :	*Apply the concept of living model organism and selection of appropriate model*
CLR-3 :	*Use of various animal models available*
CLR-4 :	*Analyze the different alternatives and ethical issues*
CLR-5 :	*Use pilot experiments to evaluate their working/living environment*
CLR-6 :	*Analyze animal experiment data and correlate with human case reports*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	*Describe about the fundamentals of animal experiments*	1	85	80	L	M	H	H	H	L	M	H		M	H	H	H	H	H
CLO-2 :	*Recognize the similarities between anima models and humans*	2	85	70	M	M	H	H	H	M	M	H		M	H	H	M	L	M
CLO-3 :	*Discuss the knowledge on different animal models available*	2	80	75	M	H	M	H	H	L	L	H		L	H	H	H	M	L
CLO-4 :	*Explain the functions that can be studied in animal models*	2	75	80	M	H	H	H	H		H	H		L	H	H	M	M	M
CLO-5 :	*Analyze the animal alternatives and ethical issues*	3	85	75	H	M	H	H	H		H	H	L	H	H	H	H	L	M
CLO-6 :	*Interpret pilot experiments to study animal model experiment*	3	80	80	H	H	H	H	H	M	M	M	L	H	H	H	H	M	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Introduction to biology of animals*	*Selection of animal models*	*Transgenesis and transgenic animal models*	*Drugs and compound administration*	*Animals in laboratory environment*
	SLO-2	*Structure and organs*	*Mammals, bovine, aquatic, insect*	*Knockout, Knockin, Mutation models*	*Need for animal models to test new compounds prior clinical study*	*Light cycle, temperature and humidity*
S-2	SLO-1	*Classification of animals*	*Mammal biology – life cycle*	*CRISPR cas 9*	*Oral administration*	*Pathogen free environment lab*
	SLO-2	*Vertebrate and Invertebrate*	*Rats, mice, sheep and bovine*	*UAS gal 4 systems*	*Nasal dosage*	*Precautions and protective gear to be followed by researchers*
S-3	SLO-1	*Human evolution*	*Rats – types of rats*	*Animal models for cataracts and retinitis pigmentosa*	*Inhalation*	*Housing and Animal husbandry*
	SLO-2	*Darwinism theory*	*Genetic background among different sub species*	*Animal models for Atherosclerosis and myocardial infarction*	*Inhalation related experiment animal models*	*Animal husbandry training*
S-4	SLO-1	*Human diseases*	*Mice – types of mice*	*Animal models for cardiac and cardiovascular disease*	*Inhalation related experiment animal models and issues that can be replicated*	*3 R`s and Alternative for animal models*
	SLO-2	*Need for animal models*	*Genetic background among different sub species*	*Animal models for metabolic syndrome*	*Invasive administrations – intravenous*	*Tissue culture – cell lines*
S-5	SLO-1	*Experimental animal models*	*Sheep and cow as animal models*	*Animal models for diabetes and obesity*	*Invasive administrations – intravenous and intra-peritoneal*	*Primary tissue culture*
	SLO-2	*Monkey, rat, rabbit - living animals models*	*Disease research on sheep and cow*	*Animal models for liver diseases*	*Invasive administrations – intraocular*	*3D cell culture reconstructing and replacing organs*
S-6	SLO-1	*Chicken, pig tissues – non living animal models*	*Aquatic animals models*	*Animal models for skin disorders and regeneration*	*Invasive administrations – intraocular and intramuscular*	*Limitation and ethical issues in research on humans*
	SLO-2	*Pig heart as cardiovascular model*	*Life cycle of zebra fish and Japanese rice fish and research*	*Animal models for stroke, olfactory and neuromuscular dysfunction*	*Invasive administrations – Subcutaneous*	*Lower order animal models*

S-7	SLO-1	*Classical animal models used – squid*	*Hydra as an aquatic animal model*	*Animal models for schizophrenia*	*Invasive administrations – Subcutaneous*	*Ethical issues in using humans samples*
	SLO-2	*Nervous system in squid and early evidences*	*Life cycle and environmental toxin researches*	*Animal models for Alzheimer`s and Huntington disease*	*Non invasive drug administration*	*Ethical issues in using experiments animals*
S-8	SLO-1	*Classical animal models used – cats*	*Non vertebrate insect models – Drosophila and C. elegans*	*Animal models for Parkinson and multiple sclerosis.*	*Skin adsorption*	*Computer science – simulations and animal models*
	SLO-2	*Visuals tracks in cats and early evidences*	*Life cycle of C. elegans and research*	*Animal models for Mood disorders*	*Selecting appropriate drug administration route*	*Heart diseases and simulation*
S-9	SLO-1	*Classical animal models – primates*	*Life cycle of Drosophila as evolution models*	*Animal disorder for mania*	*Understand route of exposure in toxicity cases*	*Computational models*
	SLO-2	*Behavioral assays in primates.*	*Drosophila genetics*	*Animal disorder for stress coping and resilience.*	*Human-animal equivalent dose calculation and problems*	*Computational models to repalce animal cognition*

Learning Resources	1. *Hau J, Van Hoosier GL Jr, Handbook of Laboratory Animal Science, Volume I: Essential Principles and Practices" 2nd ed., CRC Press: Boca Raton, FL, 2003*	2. *Micheal Conn P, Animal Models for the Study of Human Disease,2nd ed., Academic Press, 2017* 3. *Jerome Y Yager, Animal Models of Neuro-developmental Disorders, Human Press, 2015*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	*1. Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	*1. Dr. S. Sahabudeen, SRMIST*
2. Dr. Karthik Periyasamy, Aurobindo Pharma Limited, Hyderabad, karthikmpk@gmail.com	*2. Prof. R. B. Narayanan, SVCE, Chennai, rbn@svce.ac.in*	*2. Dr.R.A. Nazeer, SRMIST*

Course Code	18BTO106T	Course Name	WASTE TO WEALTH TO WHEELS	Course Category	O	*Open Elective*	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Identify the applications of engineering concepts for sustainable waste management*
CLR-2 :	*Identify the applications of energy conversion technology*
CLR-3 :	*Identify the significance of eco-friendly process*
CLR-4 :	*Create insights to the concepts of zero-waste process*
CLR-5 :	*Analyze the important fuel properties of wastes and biomass*
CLR-6 :	*Utilize the concepts basic engineering calculations (mass and heat balances) for biomass based energy systems*

		Learning			**Program Learning Outcomes (PLO)**														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	*Formulate the methodology for waste segregation based on international policy*	*1*	*80*	*70*	*H*	*H*	*M*	*M*	*M*	*H*	*H*	*H*	*M*	*H*	*M*	*H*	*M*	*H*	*H*
CLO-2 :	*Analyze calorific parameters of wastes and biomass*	*2*	*85*	*75*	*H*	*M*	*M*	*M*	*M*	*H*	*H*	*H*	*M*	*L*	*H*	*H*	*M*	*H*	*H*
CLO-3 :	*Apply thermo-chemical conversion process for waste to energy conversion*	*2*	*75*	*70*	*H*	*H*	*M*	*M*	*M*	*H*	*H*	*H*	*H*	*M*	*H*	*H*	*H*	*M*	*H*
CLO-4 :	*Apply bioprocessing techniques to convert waste to biofuel and value added chemicals*	*2*	*85*	*80*	*H*	*H*	*M*	*M*	*M*	*H*	*H*	*H*	*H*	*M*	*H*	*H*	*H*	*H*	*H*
CLO-5 :	*Identify the applications of mass and energy balance for making commercially viable Waste to wealth process*	*2*	*85*	*75*	*H*	*H*	*M*	*M*	*M*	*H*	*H*	*H*	*M*	*H*	*M*	*H*	*H*	*H*	*H*
CLO-6 :	*Describe the National policy towards biofuel production and Energy security*	*1*	*80*	*70*	*H*	*M*	*M*	*M*	*M*	*H*	*H*	*H*	*M*	*H*	*M*	*H*	*H*	*M*	*H*

Duration (hour)		**9**	**9**	**9**	**9**	**9**
S-1	SLO-1	*Sources of industrial wastes*	*Thermal processing of wastes: Combustion, Co-generation/co-firing*	*Catalytic depolymerization of biomass-derived oxygenated feedstocks*	*Treatment based on aerobic and anaerobic waste bioprocessing*	*Energy content estimation of wastes and products by bomb (solid and liquid)(ASTM)*
	SLO-2	*Sources of agro and MSW wastes*	*Pyrolysis and torrefecation*	*Biosynthetic pathway for lignin synthesis*	*Vermi-composting of solid wastes for bio-fertilizer; Vermi-wash*	*For gaseous fuel (ASTM)*
S-2	SLO-1	*Impact of wastes on biodiversity*	*Hydrolysis and plasma treatment for waste to energy conversion*	*Hydrolysis of cellulose from lignocellulosic wastes over novel solid acids*	*Production of hydrocarbons (bioalkanes) from lignocelluloses*	*Process calculations for energy and mass balance of waste and by product recovery*
	SLO-2	*Effect on food chain/food web*	*Catalytic conversion process*	*Inhibitory compounds of lignin degradation that impedes bioprocessing*	*Quality comparison between conventional and bio-based chemicals*	*Software hands on training for mass and energy balance*
S-3	SLO-1	*Waste segregation methodologies*	*Syngas production*	*Synthesis of polyols by hydrogenation / hydrogenolysis of cellulose and sugar*	*Production of biodiesel (Oil seeds/Algae)*	*Case : non-conventional transportation fuels and their manufacturers obtained by processing of wastes*
	SLO-2	*Hazardous and non-hazardous wastes*	*Flue gas filters and value addition from particulate matter*	*Role of green solvents and ionic liquids in fuel production*	*Whole crop biorefinery approach*	*Municipal leachate processing and value product development*
S-4	SLO-1	*Recalcitrant and non-recalcitrant wastes*	*Waste heat recovery*	*Hybrid energy system using biological routes*	*Oleagenous organisms (Fungi and yeast)*	*Management of post-energy recovery residues (bottom ash, fly ash, digestate)*
	SLO-2	*Xenobiotics and Rationale for bioprocessing*	*Hydrothermal electricity production*	*Clean coal technologies bioleaching and biosorption*	*Enzymatic transesterification Vs. Chemical methods*	*Bioenergy-Biochar energy cycle*
S-5	SLO-1	*Waste characterization*	*Bio refinery demonstration projects on ethanol*	*Unified oils and biodiesel from oil seeds and algae by chemical catalysis*	*Biobutanol, ABE synthesis, bioalkanes*	*R& D scope in WWW Gas to liquids (GTL) technology*
	SLO-2	*Calorific value estimation: Bomb and Junker's calorimeter*	*Case study on India's potential on second generation bioethanol*	*Case study on India's potential on second generation biodiesel from Jatropha*	*Biopolymers and plastics (PHA, PHB and PLA)*	*CO_2 sequestration by biological modes*
S-6	SLO-1	*Point source collection and non-point source wastes collection*	*Distillation technology for bioethanol*	*Fischer–Tropsch process – Gas to liquid fuels*	*Gaseous fuels: Biomethane*	*Landill fill emission control*
	SLO-2	*Role of smart dustbins*	*Adsorption technology for ethanol fractionation*	*Comparison of fuel quality standards from FT and fossil fuel*	*Energy conversion strategies from biogas*	*Land fill and flue gas recovery for its commercial application*

S-7	SLO-1	*Energy crops – Terrestrial*	*Bio refinery demonstration projects on Biodiesel*	*3rd generation biofuel: For transportation*	*Biohydrogen and Gas to liquid fuel technologies*	*Current and Emerging Challenges to Renewable Energy Development*
	SLO-2	*Energy crops – Aquatic*	*Case study of implementation of Biodiesel project by Indian Railways*	*3rd generation biofuel: For value added hydrocarbons*	*ABE biosynthesis (Acetone Butanol and Ethanol)*	*Government policies for energy security*
S-8	SLO-1	*Potential Benefits of Replacing Fossil Fuels with Biofuel, Biomass and Biogas*	*Transesterification and distillation*	*Genetically modified (GM) organisms for improved fuel production*	*Metabolic pathway engineering for ABE biosynthesis*	*Community Participation in Renewable Energy Development*
	SLO-2	*Implication of fossil fuel on National economy, environment and energy security*	*Refining technologies for biodisesel*	*GM bioenergy crops and its implication for developing countries*	*Aircraft liquid biofuel from biomass feedstocks*	*Contract farming strategy for non-edible feedstock production*
S-9	SLO-1	*Political Drivers for Biofuel Development*	*By product processing of biodiesel production*	*Algal based technologies for biofuel and value added chemical preparation*	*Bio-alkanes and alkenes from waste biomass to be used as jet engines fuels*	*Combined industrial waste treatment for energy recovery*
	SLO-2	*Activities of MNRE, Government of India and International Energy Agency*	*Conversion of de-oiled cake into value added products*	*GM algae and its regulatory issues*	*New energy research Projects pertaining to transportation fuels in Global context*	*Urban and rural integration system for sustainable waste utilization for value added product generation*

Learning Resources	1. *David M. Mousdale, Biofuels: Biotechnology, Chemistry, and Sustainable Development, CRC Press, 2008* 2. *Roland A. Jansen, Second Generation Biofuels and Biomass, Wiley, 2013*	3. *A.H.Scragg, Biofuels, Production, Application and Development, CAB International, 2009* 4. *Robert C. Brown, Tristan R.Brown, Biorenewable Resources: Engineering New Products from Agriculture, 2nd ed., Wiley, 2014*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

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2. Dr. Karthik Periyasamy, Aurobindo Pharma Limited, Hyderabad, karthikmpk@gmail.com	*2. Prof. R. B. Narayanan, SVCE, Chennai, rbn@svce.ac.in*	*2. Dr. K.Ramani, SRMIST*

Course Code	18BTO107T	Course Name	FUNDAMENTAL NEUROBIOLOGY	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Recall the brain function from its organization
CLR-2 :	Discuss Molecular signaling in neurons
CLR-3 :	Compare Neural basis of senses
CLR-4 :	Explain different methods for studying neuro-immune functions
CLR-5 :	Analyze genetic variations in brain development
CLR-6 :	Analyze genetic variation and inheritance pertaining to nervous system disorders

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO – 3
CLO-1 :	Describe the fundamental organization of brain and its functions	1	80	80	L	H	H	H	-	M	L	H	H	H	H	H	L	H	H
CLO-2 :	Explain the concepts and experiments in the neurotransmitters	2	85	75	M	H	H	M	-	-	M	H	L	H	H	H	L	H	H
CLO-3 :	Recognize the pattern of brain energy metabolism	2	75	80	M	H	M	H	M	M	-	M	H	H	H	H	L	H	H
CLO-4 :	Discuss the different methods in the neuroendocrine and immune interactions	2	85	80	L	H	H	H	-	-	H	L	L	H	H	H	M	H	H
CLO-5 :	Analyze the role of genes in brain development and functions	3	85	75	L	H	H	M	-	M	H	H	H	L	H	H	H	H	H
CLO-6 :	Explain the concepts of nervous system disorder and the diseases associated with it	2	80	80	M	H	H	H	L	H	M	M	H	H	H	H	H	H	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Basics of Neurobiology	Membrane potential	Brain energy metabolism at the cellular level	Nature of central systems	Disorders of the nervous system
	SLO-2	Understanding brain function	Action potential	Sensory systems	Survey methods	Developmental disorder:
S-2	SLO-1	Orientation of Central nervous system	Resting potential	Receptors to perceptions	Neuroendocrine circuits	Autism, Dyslexia, ADHD
	SLO-2	Peripheral nervous system	Electrochemical basis of nerve function	Chemical and somatic senses	Functions of neuroendocrine system	Mental Disorder
S-3	SLO-1	Levels of Neural organization	Electrical and Thermodynamic Forces in Passive Distribution of Ions	Molecular and neural basis of visual perception	Neuroendocrine tumors	Schizophrenia
	SLO-2	Concept of functional units	Hyperpolarization or Depolarization	Organization of autonomic nervous system and functions	Global epidemiology of neuroendocrine tumors	Degenerative disorders
S-4	SLO-1	Cellular basis of Neurobiology	Chemical basis for neuronal communication	Nature of motor system and its functions	Neuro-immune circuits	Alzheimer's disease
	SLO-2	Clinical issues in neurobiology	Ion pumps and Ion gradients	Reflexes and fixed motor responses	Neuro-immune functions	Parkinson's disease
S-5	SLO-1	Neuron terminology	Ion channels	Locomotion	Neuroendocrine-immune interactions in neurological disorders	Psychiatric disorder
	SLO-2	Cell biology of neurons and glia	Hyperpolarization-Activated Ionic Currents	Food intake and metabolism	Neuroendocrine-immune interactions in autoimmune diseases	Depression and anxiety
S-6	SLO-1	Differentiation of axon and dendrite	Neurotransmitters	Water intake and body fluids	Developmental genetics of the brain.	Vascular disorders
	SLO-2	Structural neuroscience methods: A brief history	Neuropeptides	Sleep, dreaming and wakefulness	Genes for human brain development	Stroke

S-7	SLO-1	*Sensorimotor, autonomic and enteric divisions*	*Receptors of neurotransmitters*	*Reward and motivation*	*Genes in neurological disorders.*	*Other disorders*
	SLO-2	*Synapses and spines*	*Non-classical neurotransmitters*	*Emotion and addiction*	*Epigenetics of the brain.*	*Epilepsy*
S-8	SLO-1	*Inhibitory circuit neurons*	*Synthesis of neurotransmitters and neuropeptides*	*Cognitive development and aging*	*Epigenetics in brain disorders*	*Drug addiction*
	SLO-2	*Inhibitory projection neurons*	*Release and metabolism of neurotransmitters*	*Cognitive impairment*	*Role of Environmental factors in neurodevelopment.*	*Neural Plasticity, Goat Brain Dissection*
S-9	SLO-1	*Excitatory neurons*	*Molecular mechanisms nerve terminal*	*Learning and memory*	*Exposure of lead and methyl mercury in neurodevelopmental disorders.*	*Understanding brain by Artificial Intelligence*
	SLO-2	*Neuroglia and glial sheaths*	*Molecular signaling in neurons*	*Language, communication and consciousness*	*Neurotoxins*	*Neural network for analyzing brains network*

Learning Resources	1. *Larry Squire, Darwin Berg,Floyd E. Bloom,Sascha du Lac,Anirvan Ghosh,Nicholas C. Spitzer, Fundamental Neuroscience, 4th ed., Academic Press, 2012*	2. *Michael Aschner,* Lucio G. Costa,Environmental factors in Neurodevelopmental*and neurodegenerative disorders, Academic Press, 2015*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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2. Dr. Karthik Periyasamy, Aurobindo Pharma Limited, Hyderabad, karthikmpk@gmail.com	*2. Prof. R. B. Narayanan, SVCE, Chennai, rbn@svce.ac.in*	*2. Dr. R. VasanthaRekha, SRMIST*

Course Code	18ECO106J	Course Name	PCB DESIGN AND MANUFACTURING	Course Category	O	Open Elective	L	T	P	C
							2	0	2	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Electronics and Communication*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Explore the terminologies of PCB design and Electronic components*
CLR-2 :	*Design consideration involved in PCB design*
CLR-3 :	*Utilize the PCB design consideration for special application circuits*
CLR-4 :	*Design a PCB layout using CAD tool*
CLR-5 :	*Explore various PCB manufacturing techniques*
CLR-6 :	*Equip the learners to explore and understand PCB design technology, design constraints and manufacturing technique*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO – 3
CLO-1 :	*Identify the various types of PCB and electronics components packaging*	2	80	70	H	-	-	L	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	*Select suitable design and consider appropriate parameters involved in PCB design*	3	80	70	M	-	L	-	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	*Apply the appropriate design rules in designing PCB for special application circuits*	2	80	70	M	-	-	L	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	*Design and develop a PCB layout using CAD tool*	3	80	70	M	-	-	M	H	-	-	-	-	-	-	-	-	-	-
CLO-5 :	*Identify and select the required PCB manufacturing technology*	3	80	70	L	-	-		H	-	-	-	-	-	-	-	-	-	-
CLO-6 :	*Develop PCB layout using PCB design CAD (Computer Aided Design) tool and proficiency in PCB fabrication*	1	80	70	H	-	L	L	H	-	-	-	-	-	-	-	-	-	-

Duration (hour)		12	12	12	12	12
S-1	SLO-1	*Nomenclature of a Printed Circuit Board*	*PCB Design Considerations - Important Design Elements*	*Design Rules for Analog Circuits*	*Schematic Capture* **-** *Introduction schematic capture tool*	*Image Transfer Techniques- Screen Printing, Pattern Transferring Techniques*
	SLO-2	*Classification of Printed Circuit Boards*	*PCB Design Considerations - Important Performance Parameters*	*Design Rules for Analog Circuits*		
S-2	SLO-1	*Manufacturing of basic PCB - Single-and Double-sided Plated Through-holes*	*PCB Design Considerations - Mechanical Design Considerations*	*Design Rules for Digital Circuits*	*Schematic Capture* **-** *Simulation of simple electronic circuit*	*Image Transfer Techniques- Printing Inks, Photo Printing, Laser Direct Imaging (LDI)*
	SLO-2	*Manufacturing of Multi-Layer Boards - Flexible Boards, Challenges in modern PCB Design and Manufacture, Standards*	*PCB Design Considerations - Mechanical Design Considerations*	*Design Rules for Digital Circuits*	*Schematic Capture* **-** *Schematic to layout transfer*	*Copper Clad Laminates - Properties of Laminates, Types of Laminates, Evaluation of Laminates*
S 3-4	SLO-1	*Study of electronic components- Passive electronic components*	*Design and analysis of RL and RC time constants. Schematic in CAD tool*	*Schematic and PCB Layout in CAD tool. Regulated power supply design. - Full wave rectifier circuit design with fixed voltage regulator*	*PCB Layout Design of single digit pulse counter using PCB design tool.*	*Mini Project - PCB Layout Design of electronic turn ON/OFF timer using IC555 using PCB design tool.*
	SLO-2					
S-5	SLO-1	*Types, Symbols, Packaging shapes and terminal details of Electronic Components –Resistors, Thermistors Capacitors, Inductors*	*PCB Design Considerations - Electrical Design Considerations*	*Design Rules for High Frequency Circuits*	*PCB Layout Design - Conception Level Introduction*	*Etching Techniques – wet Etching chemicals*
	SLO-2	*Diodes, Light Emitting Diodes (LED), Photodiode,*	*PCB Design Considerations - Conductor Patterns*	*Design Rules for Fast Pulse Circuits*	*PCB Layout Design - Specifying Parts, Packages and Pin Names, Libraries*	*Etching Techniques - Mechanical Etching*
S-6	SLO-1	*Transistors, Field-effect Transistors, Insulated Gate Bipolar Transistor (IGBT), Thyristor*	*Component Placement Rules*	*Design Rules for Microwave Circuits*	*PCB Layout Design - Checking foot prints of the components, Part list, Net list, Making Net list Files*	*PCB Assembly Process*
	SLO-2	*Integrated Circuits (ICs), Three-terminal Voltage Regulator*	*Fabrication and Assembly Considerations*	*Design Rules for Microwave Circuits*	*PCB Layout Design – Placing Parts, Routing Traces, Modifying Traces*	*Through-hole*

S 7-8	SLO-1	*Study of electronic components- active devices, analog and digital integrated circuits (IC)*	*Design and analysis of RLC circuits. Schematic in CAD tool*	*Schematic and PCB Layout in CAD tool. Regulated power supply design. -Full wave rectifier circuit design with fixed voltage regulator*	*PCB Design of single digit pulse counter: Schematic and PCB layout using PCB design tool.*	*Mini Project - Manufacture the PCB for electronic turn ON/OFF timer using IC555and construct and test the designed circuit.*
	SLO-2					
S-9	SLO-1	*Digital Integrated Circuits, Random Access Memory*	*Environmental Factors*	*Design Rules for High-density Interconnection Structures*	*PCB Layout Design - Mounting Holes*	*PCB Assembly Process*
	SLO-2	*Read Only Memory*	*Cooling Requirements*	*Design Rules for High-density Interconnection Structures*	*Adding Text, PCB Layout*	*Surface Mount, Mixed Technologies*
S-10	SLO-1	*Microcontrollers, Surface Mount Devices*	*Packaging Density*	*Electromagnetic Interference (EMI)*	*PCB Layout Design - DRC,*	*PCB Assembly Process*
	SLO-2	*Transformer, Relays, Connectors*	*Layout Design*	*Electromagnetic Compatibility (EMC)*	*Pattern Transfer, Layout printing*	*Soldering*
S 11-12	SLO-1	*Study of testing and measuring Instruments: Logic analyzer, spectrum analyzer, IC tester (Analog and Digital), LCR meters*	*PCB Layout Design - of RL, RC and RLC circuits*	*Schematic and PCB Layout in CAD tool. Regulated power supply design. Full wave rectifier circuit design with fixed voltage regulator*	*Mini Project - PCB Layout Design of electronic turn ON/OFF timer using IC555 using PCB design tool.*	*Mini Project - Manufacture the PCB for electronic turn ON/OFF timer using IC555and construct and test the designed circuit.*
	SLO-2					

Learning Resources	1. *Raghbir Singh Khandpur, Printed Circuit Boards: Design, Fabrication, and Assembly, McGraw-Hill Electronic Engineering, 2006* 2. *Charles A. Harpe, High Performance Printed Circuit Boards, McGraw Hill Professional, 2000* 3. *Bruce R. Archambeault, James Drewniak, PCB Design for Real-World EMI Control, Volume 696 of The Springer International Series in Engineering and Computer Science, Springer Science & Business Media, 2013* 4. *Kraig Mitzner, Complete PCB Design Using OrCAD Capture and PCB Editor, Newnes / Elsevier, 2009*	5. *Douglas Brooks, Signal Integrity Issues and Printed Circuit Board Design, Prentice Hall PTR, 2003* 6. *Mark I. Montrose, Printed Circuit Board Design Techniques for EMC Compliance: A handbook for designers,2nd ed., Wiley, 2015* 7. *Esim open source tool: http://esim.fossee.in/* 8. *TINA/Orcad User manual*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*1. Dr. P. Eswaran, SRMIST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	*2. Dr. D. Malathi, SRMIST*

Course Code	18ECO108J	Course Name	EMBEDDED SYSTEM DESIGN USING ARDUINO	Course Category	O	*Open Elective*	L	T	P	C
							2	0	2	3

Pre-requisite Courses	*Nil*	**Co-requisite Courses**	*Nil*	**Progressive Courses**	*Nil*
Course Offering Department	*Electronics and Communication*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Get to know about ARDUINO hardware details and environment*
CLR-2 :	*To understand the core elements of ARDUINO programming language*
CLR-3 :	*Create insights to the concepts of serial communication*
CLR-4 :	*To use common input and output devices*
CLR-5 :	*Apply the ARDUINO programming into real time applications*
CLR-6 :	*Apply the ARDUINO programming into real time applications*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	**Learning** 1 Level of Thinking (Bloom)	2 Expected Proficiency (%)	3 Expected Attainment (%)	**Program Learning Outcomes (PLO)** 1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	13 PSO - 1	14 PSO - 2	15 PSO – 3
CLO-1 :	*Analyze the programming skill*	2	80	70	H		-	-	-	-	-	-	-	-	-	-	-	H	H
CLO-2 :	*Apply the real time data's into digital*	2	85	75	H	H	H	H	H	-	-	-	H	-	H	-	-	H	H
CLO-3 :	*Interact with almost many devices*	2	75	70	H	-	H	H	H	-	-	-	H	-	H	-	H	H	-
CLO-4 :	*Learn techniques to handle timer delays and IO devices*	2	85	80	H	H	H	H	H	-	-	-	H	-	H	-	H	H	-
CLO-5 :	*Use and modifying the existing libraries*	2	85	75	H	-	H	H	H	-	-	-	H	-	H	-	H	H	-
CLO-6 :	*Use and modifying the existing libraries*	2	85	80	H	H	H	H	H	-	-	-	H	-	H	-	H	H	H

Duration (hour)		**12**	**12**	**12**	**12**	**12**
S-1	SLO-1	*Introduction to arduino platform*	*Introduction to Arduino C*	*Analog and Serial Communication*	*IO Programming*	*Case Studies*
	SLO-2	*Block diagram*	*Arduino C Data Types*	*Introduction to Analog Communication*	*Introduction to Timer/Counters*	*Wireless Communication Using Zigbee*
S-2	SLO-1	*AT mega 328p architecture*	*Decision Making in C*	*Pulse Width Modulation*	*Introduction to Timer/Counters*	*Bluetooth*
	SLO-2	*AT mega 328p architecture*	*Decision Making in C*	*RS232*	*Timer programming*	*Robotics -Motor and Sensor*
S 3-4	SLO-1	*Lab 1 Getting Started with Adriano*	*Lab 4 -Sensor Interfacing for Temperature Monitoring*	*Lab 7: Actuators – Stepper Motor*	*Lab10: Interrupt Programming*	*Lab 13: Mini Project*
	SLO-2	*CCS and AVR Studio 7 Blinking Led*	*Lab 4 -Sensor Interfacing for Displacement Measurement*	*Lab 7: Actuators – Stepper Motor*	*Lab10: Interrupt Programming*	*Lab 13: Mini Project*
S-5	SLO-1	*Pin function*	*Program Loops in C*	*I2C*	*Timer programming*	*Security-RFID, Infrared*
	SLO-2	*Overview of main features-I/O ports*	*Functions in C*	*I2C*	*Timer programming*	*Security-RFID, Infrared*
S-6	SLO-1	*Features-timers,interrupts*	*Introduction to Pointers*	*I2C*	*Timer programming*	*Bio medical application*
	SLO-2	*Features-timers,interrupts*	*Introduction to Pointers*	*I2C*	*Timer programming*	*Bio medical application*
S 7-8	SLO-1	*Lab 2 GPIO LED*	*Lab 5: PWM BASED SERVO MOTOR INTERFACING*	*Lab 8: DC MOTOR*	*Lab11: Watch Dog Timer*	*Lab14: Model Practical*
	SLO-2	*Switch Based Led Control*	*Lab 5: PWM Based Servo Motor Interfacing*	*Lab 8: DC MOTOR*	*Lab11: Watch Dog Timer*	*Lab14: Model Practical*

S-9	SLO-1	*Features-PWM,SERIAL PORT*	*Using Pointers Effectively*	*SPI Protocol*	*Interrupts*	*Bio medical application*
	SLO-2	*Features-ADC*	*Structures, Unions, and Data Storage*	*SPI Protocol*	*Interrupt programming*	*Bio medical application*
S-10	SLO-1	*Introduction to Arduino IDE*	*Arduino Libraries*	*Interfacing with sensors*	*External interrupt*	*GPS Navigation*
	SLO-2	*Writing ,saving,compiling with IDE.*	*Arduino Libraries*	*Interfacing with sensors*	*External interrupt*	*GPS Navigation*
S 11-12	SLO-1	*Lab 3: DISPLAY INTERFACE-7 SEGMENT*	*Lab 6: SERIAL COMMUNICATION*	*Lab 9: Repeat/Revision of Experiments*	*Lab 12 : I2C*	*Lab:15 University Practical*
	SLO-2	*LCD 16x2 Matrix*	*Lab 6: Serial Communication*	*Lab 9: Repeat/Revision of Experiments*	*Lab 12: I2C*	*Lab:15 University Practical*

Learning Resources	*1. Michael-Margolis,Arduino-Cookbook., Revised edition, O'Reilly,1st edition, 2011* *2. D.Dale.Wheat, Arduino.Internals, TIA publication, 5th edition, 2011*	*3. James M. Fiore, Embedded Controllers Using C and Arduino, ARDUINO open source community, 2018* *4. Jack Purdum ,Beginning C for Arduino , Apress, 2012*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

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1. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*1.Mrs. S. Suhasini,, SRM IST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECO121T	Course Name	BASIC BIOMEDICAL ENGINEERING	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Electronics and Communication*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Analyze the scopes and roles of Biomedical Engineering*
CLR-2 :	*Utilize biomedical instrumentation modules*
CLR-3 :	*Utilize medical imaging principles and its applications*
CLR-4 :	*Analyze the scope of biomechanics and its applications*
CLR-5 :	*Utilize biomaterials and its applications*
CLR-6 :	*Gain the knowledge about Biomedical Engineering*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1 Level of Thinking (Bloom)	2 Expected Proficiency (%)	3 Expected Attainment (%)	PLO 1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	13 PSO - 1	14 PSO - 2	15 PSO – 3
CLO-1 :	*Analyze the areas in which biomedical engineers can work*	2	85	75	-	-	-	-	-	-	-	-	-	-	-	L	-	-	L
CLO-2 :	*Analyze the basic biomedical instrumentation unit*	3	85	75	L	-	-	-	-	-	-	-	-	-	-	-	-	-	L
CLO-3 :	*Analyze basic medical imaging principles*	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	*Apply the concepts of biomechanics on human body*	3	85	75	L	-	-	-	-	-	-	-	-	-	-	-	-	-	L
CLO-5 :	*Identify domains where biomedical engineers can work*	3	85	75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-6 :	*Analyze the applications of Biomedical Engineer*	3	85	75	M	-	-	-	-	-	-	-	-	-	-	L	-	-	L

		Introduction to Biomedical Engineering	Biomedical Instrumentation	Medical Imaging system	Biomechanics	Biomaterials
Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Evolution of the modern health care system*	*Introduction: Bioinstrumentation*	*X-Ray production*	*Introduction: Principal Areas of Biomechanics*	*Biomaterials Introduction*
	SLO-2	*Modern Healthcare system*	*Basic Bioinstrumentation System*	*X-Ray Imaging principle*	*Fundamentals of biomechanics and qualitative analysis*	*Classification of Biomaterials*
S-2	SLO-1	*What is Biomedical Engineering*	*Physiological Systems of the body*	*Application of X-ray imaging*	*Kinematics of Human Body Models*	*Properties of Biomaterials: Mechanical*
	SLO-2	*Roles played by the Biomedical Engineers*	*Sources of Biomedical Signals*	*CT-Imaging principle*	*Kinetics of Human Body Models*	*Properties of Biomaterials: Chemical*
S-3	SLO-1	*Types of Biomedical Engineering*	*Origin of Bioelectric Signals*	*CT-Imaging Applications*	*Modelling of Bio systems*	*Properties of Biomaterials: Biological*
	SLO-2	*Surgical instruments and medical devices*	*Origin of Bioelectric Signals*	*MRI- Introduction*	*Tissue Biomechanics*	*Biomedical alloys and its medical applications- titanium*
S-4	SLO-1	*Biomaterials*	*Various Electrodes used for picking the biomedical signals*	*MRI Imaging principles*	*Modelling in Cellular Biomechanics*	*Biomedical alloys and its applications- Stainless steel, Cobalt-Chromium alloys*
	SLO-2	*Biomechanics*	*Various Electrodes used for picking the biomedical signals*	*MRI Imaging principles*	*Fluid mechanics*	*Introduction to ceramics*
S-5	SLO-1	*Tissue Engineering*	*ECG Introduction*	*MRI Imaging Applications*	*Mechanics of the musculoskeletal system impact*	*Alumina, Zirconia*
	SLO-2	*Neural Engineering*	*ECG system Block diagram and its uses*	*Ultrasound basics*	*Mechanics of Blood Vessels*	*Titanium, Hydroxyapatite*
S-6	SLO-1	*Telehealth*	*EEG Introduction*	*Ultrasound Imaging*	*Cardiac Biomechanics*	*Glass ceramics*
	SLO-2	*Bio signal processing*	*EEG system Block diagram and its uses*	*Ultrasound Application*	*Biomechanics of Chest and Abdomen*	*Introduction to polymers*

S-7	SLO-1	*Medical Imaging*	*EMG Introduction*	*fMRI Imaging*	*Cochlear Mechanics*	*Types of polymers*
	SLO-2	*Computational modelling*	*EMG system Block diagram and its uses*	*fMRI Imaging Application*	*Dynamics of Human Body Models*	*Biodegradable polymers and its applications*
S-8	SLO-1	*BioMEMS*	*Cardiac pacemakers and its uses*	*PET- Imaging*	*Gait analysis*	*Composites and its applications*
	SLO-2	*Mobile POCT*	*Cardiac Defibrillators and its uses*	*PET Imaging Application*	*Biomechanics in physical education*	*Wound-Healing process*
S-9	SLO-1	*Professional Status of Biomedical Engineering*	*Patient Monitoring System Introduction*	*SPECT Imaging*	*Biomechanics in strength and conditioning*	*Biomaterials for artificial valve, Ear*
	SLO-2	*Professional Societies*	*Patient Monitoring System Block diagram and its uses*	*SPECT Imaging Application*	*Biomechanics in sports medicine and rehabilitation*	*Biomaterials for artificial Skin, Eye*

Learning Resources	1. *Anthony Y. K. Chan, Biomedical Device Technology: Principles and Design, Charles C Thomas publisher, 2008* 2. *R.S Khandpur, Handbook of Biomedical Instrumentation, 3rd ed., McGraw Hill, 2014* 3. *Joseph J. Carr, John M.Brown, Introduction to Biomedical Equipment Technology, 4th ed., Pearson, 2002*	4. *John Enderle, Joseph Bronzino, Introduction to Biomedical Engineering, Academic Press, 2011* 5. *Andrew R Webb, Introduction to Biomedical Imaging, Wiley-IEEE Press, 2003* 6. *Sujata V. Bhat, Biomaterials, 2nd ed., Alpha Science International, 2005*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Sathyanarayanan J, Mindray Medical India Pvt Ltd, sathyanarayananjayagopal@mindray.com	*1. Dr. S. Poonguzhali, Anna University, poongs@annauniv.edu*	*1. Ms. Oinam Robita Chanu, SRMIST*
2. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*2. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*2. Dr. D. Kathirvelu, SRMIST*

Course Code	18ECO122T	Course Name	HOSPITAL INFORMATION SYSTEMS	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Utilize the planning and organizational activities of Hospitals
CLR-2 :	Analyze the concepts in clinical and diagnostic services
CLR-3 :	Utilize the policies and procedures about support services and material management
CLR-4 :	Utilize the features in staff and safety management in hospital
CLR-5 :	Analyze the reporting system and recent advancement in hospital administration
CLR-6 :	Apply all the advanced application the field of telemedicine

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1 Level of Thinking (Bloom)	2 Expected Proficiency (%)	3 Expected Attainment (%)	Program Learning Outcomes (PLO) 1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	13 PSO - 1	14 PSO - 2	15 PSO – 3
CLO-1 :	Analyze the role of hospitals and ensure proper healthcare delivery	2	85	75	L	-	-	-	-	M	-	-	-	-	-	-	L	-	-
CLO-2 :	Suggest appropriate technologies and services in clinical and diagnostic field	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	L	-	-
CLO-3 :	Analyze the supportive services and the use of proper material management	3	85	75	M	-	-	-	-	-	M	L	-	-	-	-	M	-	L
CLO-4 :	Identify objectives of staff management and ensure safety management in hospitals	3	85	75	M	-	-	-	-	-	-	L	-	-	-	L	L	-	-
CLO-5 :	Implement the advance technologies and effectively evaluate the healthcare information	3	85	75	L	-	-	-	-	M	-	L	L	-	-	-	L	L	L
CLO-6 :	Implement the various standards in hospital and healthcare services	3	85	75	L	-	-	-	-	M	-	-	-	-	-	-	L	-	-

		Planning and designing of hospitals	Inpatient and Outpatient services	Material management services	Management services in hospitals	Patient record and advancement in healthcare services
Duration (hour)		9	9	9	9	9
S-1	SLO-1	Hospital as a social system	Design and planning of emergency department	Pharmacy services- goals of hospital pharmacy services	Human resource management- Human resource development	Medical record management- Importance of medical record
	SLO-2	Primary health care and hospitals	Health information and counselling	Staff organization and divisions of hospital pharmacy services	Hospital staff skill development	Methods of record keeping
S-2	SLO-1	Hospital planning and design-Guiding principles in planning	Outpatient services –Types and functions of outpatient department	Benefits of formulatory system	Nursing management-Functions of nursing management	Electronic medical record-Benefits and drawbacks
	SLO-2	Regionalization of Hospital service	Physical features of outpatient department	Other services of hospital pharmacy	Nursing management- organizational structure	Record retention and disposal
S-3	SLO-1	Role of health promotion approach in hospitals	Ward/Indoor services-Components of the ward system	Transport services-Types of ambulance	Biomedical waste management- Types and Composition of Biomedical Waste	Office management -skills required by the office staff
	SLO-2	Health promoting hospital system	Design of special units	Communication and physical facilities of ambulance service	Categories of biomedical waste	Functions of office management
S-4	SLO-1	Healthy hospital environment	Operation theatre services-Planning and designing of Operation theatres	Staff transport services	Concept of total quality management	Operations research in hospitals-Phases of operation research
	SLO-2	Components of healthy hospital environment	Types of Operation theatres	Other transport services in hospitals	Types of approaches in quality management	Operations research in hospitals- Tools and techniques of operations research
S-5	SLO-1	Creating manpower services	Policies and procedures of operation theatres	Medicolegal services- Steps for Medicolegal Examination	Quality assessment and management tools	Emerging health insurance – components of health insurance
	SLO-2	Hospital engineering: Key to efficient healthcare services	Assessing operation theatre utilisation	Problems faced by healthcare professionals in medicolegal service	Clinical audit	Emerging health insurance-Types of health insurance
S-6	SLO-1	Designing disabled friendly hospitals-Barriers faced and implications in Persons with disabilities	Clinical laboratory services-Introduction and role of laboratory medicine	Food safety in hospitals-Need of food safety	Quality improvement-Cause and effect method	Advantages and common problems of health insurance schemes
	SLO-2	Need for disabled-friendly health services	Testing procedure in clinical laboratory	Sources of food contamination	Pareto analysis	Role of health and hospital administrators in Health insurance

S-7	SLO-1	*Barrier-Free Environment to Universal Design*	*Radio diagnosis and imaging services-Planning and equipments of radiology department*	*Materials management- Principles of material management*	*Failure mode and effect analysis*	*Telemedicine clinic –functions and classification of telemedicine*
	SLO-2	*Overcoming the barriers*	*Advancement in radiology service*	*Concepts of Inventory control*	*Triggers of quality improvement strategy in a hospital*	*Challenges for telemedicine*
S-8	SLO-1	*Energy conservation- Classification*	*Radiation oncology service-Radiotherapy facilities*	*Modern techniques for inventory control*	*Occupational safety-Roles and responsibilities*	*Growth of mobile phones and potential of mobile health*
	SLO-2	*Types of energy streams in hospitals*	*Nuclear medicine services-Categorization and nuclear medicine department*	*Integrated concept for materials management*	*Prevention of hazards specific to health sector*	*Mobile health and its applications*
S-9	SLO-1	*Need for energy conservation*	*Planning of nuclear medicine department*	*Purchase and procurement system-Essentials for procurement process*	*Hospital security-Physical security*	*Challenges in implementing information and Communication technology in healthcare*
	SLO-2	*Energy conservation opportunities in hospitals*	*Ancillary requirements*	*Purchase system*	*Organizational chart of security wing*	*Information and communication technology applications in healthcare*

Learning Resources	1. *SonuGoel, Anil Kumar Gupta, Amarjeet Singh, Hospital administration A problem- solving approach, 1st ed., Elsevier, 2014*	2. *Sakharkar B M, Principles of hospital administration and planning, 2nd ed., Jaypee Brothers Medical Publishers, 2009* 3. *Kunders G D, Hospitals: Facilities planning and management, 1st ed., Tata Mcgraw Hill, 2008*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	*2. Mr. P. Muthu, SRMIST*

Course Code	18ECO123T	Course Name	BIOMEDICAL IMAGING	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Electronics and Communication*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Utilize the working principle of X-ray imaging*
CLR-2 :	*Analyze the principle behind tomographic imaging and the reconstruction techniques*
CLR-3 :	*Interpret the theory behind nuclear medicine and utilize the working of imaging modalities in nuclear medicine*
CLR-4 :	*Analyze the physics of ultrasound and the different imaging modes using ultrasound*
CLR-5 :	*Utilize the physical principle of nuclear magnetic resonance and magnetic resonance image reconstruction*
CLR-6 :	*Utilize imaging modalities X-ray, computed tomography, nuclear medicine, ultrasound and magnetic resonance imaging*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO – 3
CLO-1 :	*Analyze the physics and principle behind the working of X-ray imaging*	2	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-2 :	*Identify the principle behind working of tomographic imaging and reconstruction procedures.*	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-3 :	*Analyze the working principle of nuclear medicine imaging modalities*	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-4 :	*Identify the physics of ultrasound and the modes of ultrasound imaging*	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-5 :	*Explain the physical principle of magnetic resonance imaging and the instrumental components involved in MR imaging*	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-6 :	*Understand the basic principle and working of medical Imaging systems*	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-

		X-ray	**Computed Tomography**	**Ultrasound**	**Magnetic Resonance Imaging**	**Nuclear medicine**
Duration (hour)		**9**	**9**	**9**	**9**	**9**
S-1	SLO-1	*General principles of Imaging with X-rays*	*Introduction: Tomographic Imaging*	*Characteristics of sound: Propagation, wavelength, frequency and speed*	*Principles of NMR Imaging*	*Radionuclide decay terms and relationship*
	SLO-2	*X-ray Production –X-ray source*	*Comparison between tomographic and planar imaging*	*Pressure, Intensity and dB scale*	*Free Induction decay*	*Nuclear transformation*
S-2	SLO-1	*X-ray tube current, tube output*	*Basic principle: Technique of producing CT images*	*Interaction of ultrasound with matter: Acoustic impedance, reflection, refraction*	*Excitation, Emission*	*Radionuclide production*
	SLO-2	*Beam intensity, X-ray Energy Spectrum*	*Contrast scale*	*Scattering, Attenuation*	*Relaxation times-T1 & T2*	*Radiopharmaceuticals*
S-3	SLO-1	*Coherent and Compton scattering*	*System components: first generation, second generation, third generation,*	*Transducers: Piezoelectric materials, resonance transducers*	*Spin echo technique*	*Radiation detection and measurement: types of detectors, Gas-filled detectors*
	SLO-2	*Photoelectric effect*	*Fourth, fifth and spiral/helical CT*	*Damping block, matching layer, Resolution*	*Spin echo contrast weighting*	*Scintillation detectors*
S-4	SLO-1	*Linear and Mass attenuation coefficient of X-rays in tissue*	*X-ray source, types of detectors*	*Transducer arrays*	*T1 weighted image*	*Semiconductor detectors*
	SLO-2	*Instrumentation for Planar X-ray Imaging: Collimators*	*Gantry and slip ring technology, Collimation and filtration*	*Multi-element linear array scanners*	*T2 weighted image*	*Pulse height spectroscopy*
S-5	SLO-1	*Antiscatter grids Intensifying screens*	*Processing system*	*Multi-linear and phased array*	*Gradient recalled sequence*	*Non-imaging detector applications*
	SLO-2	*X-ray films*	*Iterative reconstruction, back projection reconstruction*	*Generation and detection of ultrasound*	*Proton density weighted images, pulse sequence for fast imaging*	*Counting statistics*
S-6	SLO-1	*Instrumentation for computed and digital radiography*	*Filtered back projection*	*Basic pulse echo apparatus: A-scan*	*Slice selection gradient*	*Nuclear imaging*
	SLO-2	*X-ray Image characteristics: Signal to Noise ratio*	*Helical /Spiral CT: Helical pitch*	*B-Mode*	*Frequency encode gradient*	*Anger scintillation camera*

S-7	SLO-1	*Spatial resolution, Contrast to Noise ratio*	*Basic reconstruction approaches*	*M-mode*	*Phase encode gradient*	*Basic principle :Emission computed tomography*
	SLO-2	*X-ray contrast agents, X-ray angiography*	*Slice sensitivity profile*	*Echocardiograph*	*2D spin echo data acquisition*	*Single photon emission computed tomography*
S-8	SLO-1	*X-ray Fluoroscopy*	*Multislice CT*	*Duplex scanner*	*Basic NMR components: Main magnet, RF transmitter/receiver*	*Positron emission tomography*
	SLO-2	*X-ray mammography*	*Detector configuration*	*Intravascular imaging*	*Body coils, gradient coils*	*Imaging techniques and scanner instrumentation*
S-9	SLO-1	*Dual energy Imaging*	*Measurement of X-ray dosage*	*Artefacts: Refraction, shadowing and enhancement*	*fMRI : Basic principle*	*Dual modality: PET/CT*
	SLO-2	*Abdominal X-ray scans*	*Methods for dose reduction*	*Reverberation*	*BOLD concept, MR spectroscopy*	*Working and applications*

Learning Resources	1. *R.S.Khandpur, Handbook of Biomedical instrumentation, 3rd ed., Tata McGraw Hill, 2014*	2. *Jerrold T. Bushberg, John M. Boone, The essential physics of medical imaging, 3rd ed., Lippincott Williams & Wilkins, 2011*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Sathyanarayanan J, Mindray Medical India Pvt Ltd, sathyanarayananjayagopal@mindray.com	*1. Dr. S. Poonguzhali, Anna University, poongs@annauniv.edu*	*1. Dr. T. Jayanthi, SRMIST*
2. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*2. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*2. Dr. U. Snekhalatha, SRMIST*

Course Code	18ECO124T	Course Name	HUMAN ASSIST DEVICES	Course Category	O	*Open Elective*	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	**Co-requisite Courses**	*Nil*	**Progressive Courses**	*Nil*
Course Offering Department	*Electronics and Communication*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Utilize the latest technology and device used for assisting human disability*
CLR-2 :	*Analyze various devices used for mobility*
CLR-3 :	*Utilize the various assist device used for hearing*
CLR-4 :	*Utilize the various assist device used for vision*
CLR-5 :	*Utilize the various assist device used in orthopaedic*
CLR-6 :	*Analyze the working principles of cardiac assist devices and Artificial kidney*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO – 3
CLO-1 :	*Comprehend the assistive technology (AT) used for mobility*	2	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-2 :	*Analyze the Assist technology used for hearing*	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	-	L	-
CLO-3 :	*Evaluate the Assist technology used for sensory impairment of vision*	3	85	75	-	-	-	-	-	-	-	-	-	-	-	-	-	L	-
CLO-4 :	*Evaluate the assist device used in orthopedic*	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	L	-
CLO-5 :	*Analyze the latest use of assist technology in health care*	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-6 :	*Design the prosthetic heart valves and pacemaker*	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Basic assessment and evaluation for mobility*	*Basic ear anatomy, Mechanism of hearing*	*Anatomy of eye*	*Anatomy of upper & lower extremities -*	*Basic Anatomy and physiology of heart.*
	SLO-2	*Basic assessment and evaluation for mobility*	*Common tests audiograms*	*Categories of visual impairment*	*Classification of amputation types*	*Cardiac assist devices*
S-2	SLO-1	*Manual wheelchairs*	*Air conduction, Bone conduction*	*Intraocular Devices*	*Prosthesis prescription*	*Intra-Aortic Balloon Pump (IABP),*
	SLO-2	*Electric power wheelchairs*	*Masking techniques,*	*Extraocular Devices*	*Hand and arm replacement*	*Prosthetic heart valves*
S-3	SLO-1	*Power assisted wheelchairs*	*SISI*	*Permanent Vision Restoration*	*Different types of models, externally powered limb prosthesis*	*Evaluation of prosthetic valve*
	SLO-2	*Wheel chair standards & tests -*	*Hearing aids principles*	*Non-Permanent Vision Restoration*	*Different types of models, externally powered limb prosthesis*	*Heart pacemaker*
S-4	SLO-1	*Wheel chair transportation*	*Drawbacks in the conventional unit*	*Voice Control Sound Control.*	*Foot orthosis*	*CABG*
	SLO-2	*Control systems, navigation in virtual space by wheelchairs*	*DSP based hearing aids*	*Sensor Technology Adapted for the Vision Impaired*	*Pediatric orthoses*	*Extracorporeal support*
S-5	SLO-1	*Wheel chair seating and pressure ulcers.*	*Cochlear Implants*	*Libraille*	*Wrist-hand orthosis*	*Vascular prosthesis*
	SLO-2	*EOG based voice controlled wheelchair*	*Internal Hearing Aid*	*GRAB*	*feedback in orthotic system*	*Vascular prosthesis*
S-6	SLO-1	*BCI based wheelchair*	*External Hearing Aid*	*mathematical Braille*	*Components of upper limb prosthesis*	*Artificial heart*
	SLO-2	*Fuzzy logic expert system for automatic tuning of myoelectric prostheses*	*Permanent Hearing Restoration*	*Blind mobility aids*	*Components of lower limb prosthesis*	*Intermittent positive pressure breathing (IPPB) type assistance for lungs*

S-7	SLO-1	*Intelligent prosthesis*	*Non-Permanent Hearing Restoration*	*Reading writing & graphics access,*	*Lower extremity- and upper extremity-orthoses*	*Dialysis for kidneys*
	SLO-2	*Intelligent prosthesis*	*Touch Tactile Haptic Technology*	*Orientation & navigation Aids*	*Lower extremity- and upper extremity-orthoses*	*Artificial Kidney*
S-8	SLO-1	*Future trends in assistive technology*	*Sound Coding Translation*	*Wearable Assistive Devices for the Blind*	*functional electrical stimulation*	*Haemodialysis*
	SLO-2	*virtual reality based training system for disabled children*	*Acoustic Transducers Hearing Quality*	*Wearable tactile display for the fingertip.*	*Sensory assist devices*	*Membrane dialysis*
S-9	SLO-1	*Information technology, telecommunications,*	*Electric Electronic Stimulation*	*Cortical implants*	*Sensory assist devices*	*Portable dialysis monitoring and functional parameter*
	SLO-2	*new media in assisting healthcare*	*Hearing Enhancement*	*Retinal implants*	*Slints – materials used*	*Latest use of assistive technology for chronic heart diseases and healthcare*

Learning Resources	1. *Levine S.N. Advances in Bio-medical engineering and Medical physics, 1st ed., Vol. I, II, IV, Interuniversity publications, 1968.* 2. *Marion. A. Hersh, Michael A. Johnson, Assistive Technology for visually impaired and blind, 1st ed., Springer Science & Business Media, 2010* 3. *Kopff W.J, Artificial Organs, 1st ed., John Wiley and Sons, 1976* 4. *Daniel Goldstein, Mehmet Oz, Cardiac assist Devices, Wiley, 2000* 5. *Kenneth J. Turner, Advances in Home Care Technologies: Results of the match Project, 1st ed., Springer, 2011* 6. *Albert M.Cook, Webster J.G, Therapeutic Medical Devices, Prentice Hall Inc.,1982* 7. *Gerr .M. Craddock Assistive Technology-Shaping the future, 1st ed., IOS Press, 2003* 8. *Brownsell, Simon, et al,. A systematic review of lifestyle monitoring technologies, Journal of telemedicine and telecare 17.4 (2011): 185-189* 9. *Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph.D, Bronzino, Clinical Engineering, 1st ed., CRC Press, 2010* 10. *Pascal Verdonck, Advances in Biomedical Engineering, 1st ed., Elsevier, 2009*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	*2. Dr. U. Snekhalatha, SRMIST*

Course Code	18ECO125T	Course Name	QUALITY CONTROL FOR BIOMEDICAL DEVICES	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Electronics and Communication*	Data Book / Codes/Standards	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Utilize Quality, Quality control measures essential for an organization*
CLR-2 :	*Utilize the quality management principles and good management practices*
CLR-3 :	*Utilize the various quality control tools*
CLR-4 :	*Utilize the various quality management tools*
CLR-5 :	*Analyze the various standards applicable to healthcare globally and nationally*
CLR-6 :	*Implement the global standards in healthcare*

		Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	*Analyze the underlying concepts of quality and quality control concepts of an organization*	2	85	75	-	-	-	M	-	-	-	M	M	-	-	L	-	M	L
CLO-2 :	*Evaluate the various quality management principles and good management practices*	3	85	75	L	-	-	-	-	-	-	-	-	-	-	-	-	-	L
CLO-3 :	*Evaluate various tools of quality control*	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	*Analyze the various quality management tools*	3	85	75	L	-	-	-	-	-	-	-	-	-	-	-	-	-	L
CLO-5 :	*Analyze the various standards applicable to healthcare globally and nationally*	3	85	75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-6 :	*Analyze the outcomes of implementing global standards*	3	85	75	M	-	-	-	-	-	-	-	-	-	-	L	-	-	L

		Introduction to quality	TQM principles	Statistical process control	TQM tools	Quality systems
Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Definition of Quality*	*Customer satisfaction – Customer Perception of Quality*	*The seven tools of quality*	*Benchmarking*	*ISO 9000 Systems*
	SLO-2	*Dimensions of Quality*	*Customer Complaints*	*Cause-and-effect diagram*	*Reasons to Benchmark*	*ISO 9000 Systems*
S-2	SLO-1	*Quality Planning*	*Service Quality*	*Check sheet*	*Benchmarking Process*	*ISO 9000:2000 Quality System – Elements*
	SLO-2	*Quality Planning*	*Customer Retention*	*Check sheet*	*Benchmarking Process*	*ISO 9000:2000 Quality System – Elements*
S-3	SLO-1	*Quality costs*	*Employee Involvement*	*Control chart*	*Quality Function Deployment (QFD)*	*Need for Accreditation of hospitals*
	SLO-2	*Quality costs*	*Motivation*	*Control chart*	*Quality Function Deployment (QFD)*	*Need for Accreditation of hospitals*
S-4	SLO-1	*Basic concepts of Total Quality Management*	*Empowerment*	*Histogram*	*House of Quality*	*FDA Regulations*
	SLO-2	*Principles of TQM*	*Teams and Team Work*	*Histogram*	*House of Quality*	*FDA Regulations*
S-5	SLO-1	*Leadership – Concepts*	*Recognition and Reward*	*Pareto chart*	*QFD Process - Benefits*	*Joint Commission*
	SLO-2	*Role of Senior Management*	*Performance Appraisal*	*Pareto chart*	*QFD Process - Benefits*	*Joint Commission*
S-6	SLO-1	*Quality Council*	*Juran Trilogy*	*Scatter diagram*	*Total Productive Maintenance (TPM) – Concept*	*Regulatory Bodies of India*
	SLO-2	*Quality Statements*	*Juran Trilogy*	*Scatter diagram*	*Total Productive Maintenance*	*Medical Council of India*

S-7	SLO-1	*Strategic Planning*	*PDSA Cycle*	*Stratification*	*Improvement Needs*	*Pharmacy Council Of India*
	SLO-2	*Strategic Planning*	*PDSA Cycle*	*Stratification*	*Improvement Needs*	*Pharmacy Council Of India*
S-8	SLO-1	*Deming Philosophy*	*Kaizen*	*Six sigma*	*FMEA*	*Indian Nursing Council*
	SLO-2	*Deming Philosophy*	*Kaizen*	*Six sigma*	*FMEA*	*Indian Nursing Council*
S-9	SLO-1	*Barriers to TQM Implementation*	*5S*	*Six sigma*	*Stages of FMEA*	*Dental Council of India*
	SLO-2	*Barriers to TQM Implementation*	*5S*	*Six sigma*	*Stages of FMEA*	*Homeopathy Central Council*

Learning Resources	1. *Rose J.E, Total Quality Management, Kogan Page Ltd., 1993* 2. *Cesar A. Cacere, Albert Zana,The Practise of clinical Engineering, Academic Press,1997* 3. *Greg Bounds, Beyond Total Quality Management-Toward the emerging paradigm, McGraw Hill, 2013*	4. *Joseph J.Carr, Elements of Electronics Instrumentation and Measurement, 2nd ed., Pearson Education, 2003* 5. *Jerrold T. Bushberg, John M. Boone, The essential physics of medical imaging, 3rd ed., Lippincott Williams & Wilkins, 2011*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*1. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	*1. Dr. D. Kathirvelu, SRMIST*
2. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*2. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*2. Dr. D. Ashok Kumar, SRMIST*

Course Code	18ECO131J	Course Name	VIRTUAL INSTRUMENTATION	Course Category	O	Open Elective	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning 1	Learning 2	Learning 3	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12	PLO 13	PLO 14	PLO 15
CLR-1 :	To study the concepts of Virtual instrumentation and to learn the programming concepts in VI.																		
CLR-2 :	To study about the various real time data acquisition methods.																		
CLR-3 :	To study about thevarious Instrument Interfacing concepts.																		
CLR-4 :	To study the programming techniques for various control techniques using VI software																		
CLR-5 :	To study various analysis toolsfor Process control applications.																		
CLR-6 :	To study various real time measurement systems																		
Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	An ability to understand the purpose of virtual instrumentation and understand the construction of VI	2	80	70	H												H		
CLO-2 :	An ability to understand and apply various data acquisition methods.	2	85	75	H												H	H	
CLO-3 :	An ability to understand and implement the available interfacing instruments	2	75	70	H	H	H	H	H								H	H	H
CLO-4 :	An ability to understand and implement various control techniques using VI software	3	85	80	H	H	H	H	H								H		H
CLO-5 :	An ability to understand and develop a program foran engineering application.	3	85	75	H	H	H	H	H				H	H	H	H	H	H	
CLO-6 :	An ability to understand and implement various measurement systems	3	80	70	H	H	H	H	H				H	H	H	H	H	H	

Duration (hour)		12	12	12	12	12
S-1	SLO-1	Historical perspective,Need of VI,Advantages of VI,Virtual Instruments versus Traditional Instruments	A/D Converters, Organization of the DAQ VI system -	Introduction to PC Buses	Introduction to Non continuous controllers in LabVIEW	PC based digital storage oscilloscope
	SLO-2	Review of software in Virtual Instrumentation ,Software environment Architecture of VI,Introduction to the block diagram and Front panel Pallets	D/A Converters, Types of D/A	Local Buses-ISA, PCI,	Introduction to continuous controllers in LabVIEW	Sensor Technology
S-2	SLO-1	Creating and saving a VI, Front Panel Tool Bar, Block diagram Tool Bar, Palettes	plug-in Analog Input/Output cards - Digital Input and Output Cards,	RS232, RS422	Design of ON/OFF controller	Applications of sensor Technology
	SLO-2	Creating sub VI, Creating an ICON, Building a connector pane, Displaying VI'S Placing and Saving Sub VI'S on block diagram Example of full adder circuit using half adder circuit	Organization of the DAQ VI system -	RS485	Proportional controller for a mathematically described processes using VI software	Signal processing Techniques
S 3-4	SLO-1	Front Panel controls and Indicator Verification of Arithmetic Operations	Measurement of diode I-V characteristics using LabVIEW	Load cell Data acquisition using RS232	On-off temperature controller using LabVIEW	Design of DSO
	SLO-2	Verification of Half Adder Verification of Full adder.	Temperature measurement using LabVIEW and DAQ hardware.	Load cell Data acquisition using RS422	Continous Control of temperature using LabVIEW	Analysis of different signal Filters using LabVIEW
S-5	SLO-1	Loops-For Loop,	Opto Isolation need	Interface Buses-USB,PXI	Modeling of level process	Spectrum Analyser
	SLO-2	While Loop	Performing analog input and analog output	VXI,	Basic control of level process in LabVIEW	Waveform Generator
S-6	SLO-1	Arrays,	Scanning multiple analog channels	SCXI	Modeling of Reactor Processes	Data visualization from multiple locations
	SLO-2	Clusters,plotting data	Issues involved in selection of Data acquisition cards	PCMCIA	Basic control of Reactor process in LabVIEW	Distributed monitoring and control

S 7-8	SLO-1	*Program to find Addition of First n natural numbers using for loop Program to find Addition of First n odd numbers using while loop.*	*Flow measurement in water using LabVEW and DAQ hardware.*	*DC motor control using VXI*	*On-off Level controller using LabVIEW*	*Real time spectrum analysis using LabVIEW*
	SLO-2	*Implementation of Array functions. Calculation of BMI using cluster*	*Level measurement in water using LabVEW and DAQ hardware*	*GPIB with VISA functions*	*Continuous Control of pressure controller using LabVIEW*	*Arbitratory Waveform Generator using LabVIEW*
S-9	SLO-1	*Charts*	*Data acquisition modules with serial communication*	*Instrumentation Buses - Modbus and GPIB*	*Case studies on development of HMI in VI*	*Vision and Motion Control*
	SLO-2	*Graphs*	*Design of digital voltmeters with transducer input*	*Networked busses – ISO/OSI*	*Case studies on development of HMI in VI*	Examples on Integrating Measurement with vision and motion
S-10	SLO-1	*Case and Sequence Structures*	*Timers and Counters*	*Reference model,*	*Case studies on development of SCADA in VI*	NI Motion control
	SLO-2	*Formula nodes, String and File Input/Output.*	*Timers and Counters*	*Ethernet and TCP / IP Protocols*	*Case studies on development of SCADA in VI*	Speed control system
S 11-12	SLO-1	*Monitoring of temperature using Charts and Graphs.* **Program for implementing Seven segment display..**	*Design of digital voltmeters with transducer input using LabVIEW*	*Online temperature control using LabVIEW using TCP/IP*	*On-off pressure controller using LabVIEW*	*Minor Project*
	SLO-2	*Program to perform Traffic light control*	*Pressure measurement usingLabVEW and DAQ hardware DAQ.*	*Online temperature control using Webpublishing tool*	*Continuous Control of pressure controller using LabVIEW*	*Minor Project*

Learning Resources	1. *Nadovich, C., Synthetic Instruments Concepts and Applications, Elsevier, 2005* 2. *Bitter, R., Mohiuddin, T. and Nawrocki, M., Labview Advanced Programming Techniques, 2nd ed., CRC Press, 2007* 3. *Gupta, S. and Gupta, J. P., PC Interfacing for Data Acquisition and Process Control", 2nd ed., Instrument Society of America, 1994*	4. *Jamal, R., Picklik, H., Labview – Applications and Solutions, National Instruments Release.* 5. *Johnson, G., Labview Graphical programming, McGraw-Hill, 1997* 6. *Wells, L.K., Travis, J., Labview for Everyone, Prentice Hall, 1997* 7. *Buchanan, W., Computer Busses, CRC Press, 2000*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. D. Karthikeyan, Controlsoft Engineering India Pvt Ltd, karthikeyan.d@controlsoftengg.in	*1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com*	*1. Dr. K. A. Sunitha, SRMIST*
2. V. Venkateswaran, Instrumentation Consultant, vvenkat99@gmail.com	*2. Dr. D. Nedumaran, Madras University, dnmaran@gmail.com*	*2. Mrs. A. Brindha, SRMIST*

Course Code	18ECO132T	Course Name	ANALYTICAL INSTRUMENTATION	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Understand the principle and theory of analytical instruments
CLR-2 :	Understand the quantitative analysis of dissolved components
CLR-3 :	Study the concept of separation science and its applications
CLR-4 :	Study the various spectroscopic techniques and its instrumentation
CLR-5 :	Identify and solve engineering problems associated with Radiation Techniques
CLR-6 :	Understand the working of Analytical Instrument and their importance in industries

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	Apply the principles and theory of instrumental analysis	2	80	70	H	H	L	L	H	H	H	-	-	-	-	-	H	H	L
CLO-2 :	Apply the principles of various chemical analysis instruments in industries	2	80	70	H	H	L	L	H	H	-	-	-	-	-	-	H	H	L
CLO-3 :	Analyze and understand the operation of various radio chemical methods of analysis	2	80	70	H	H	L	L	H	H	-	-	-	-	-	-	H	H	L
CLO-4 :	To analyze and understand the operation of instruments based on optical properties	2	80	70	H	H	L	L	H	H	-	-	-	-	-	-	H	H	L
CLO-5 :	To identify and solve engineering problems associated with Radiation Techniques	2	80	70	H	H	L	L	H	H	-	-	-	-	-	-	H	H	L
CLO-6 :	To understand the working of analytical Instruments in industries	2	80	70	H	H	L	L	H	H	-	-	-	-	-	-	H	H	L

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Introduction to Chemical instrumental analysis	Dissolved oxygen analyzer, Importance of measuring dissolved oxygen in Industry, Principle working	Chromatography, Importance, Basic working of Chromatography	Spectral methods of analysis- Properties or parameters of electromagnetic radiation	NMR spectrometers ,Importance and basic working of NMR Spectroscopy
	SLO-2	Spectral method of analysis	Working of Dissolved oxygen analyzer	Gas chromatography Instrumentation	Electromagnetic spectrum Types of spectrometers	Magnetic assembly, Probe unit, Instrument stabilization
S-2	SLO-1	Electro analytical and seperative methods	sodium analyzer, Importance of measuring sodium in Industry, Principle working	Basic parts of a gas chromatography	Beer's law UV-visible spectrophotometers Transmittance and absorbance	Types of NMR spectrometer, Minimal type
	SLO-2	Instrumental methods of analysis-basic components and their classification	Working of sodium analyzer	Carrier gas supply Sample injection system	Beer's law Application of beer's law	Multipurpose NMR,Wideline
S-3	SLO-1	Sampling systems	Silica analyzer, Importance of measuring Silica in Industry, Principle working	Chromatographic column, Selection of column	Derivations of beer's law	Applications of NMR Spectrometer
	SLO-2	Importance of Sampling system in chemical Industries and Safety aspects	Working of Silica Analyzer	Thermal compartment Detection system Recording system	Single beam and double beam instruments	Mass Spectrometers, Basic working and Importance
S-4	SLO-1	PH Measurement, Principle of PH measurement &Importance of PH measurement in Industries	Moisture measurement Importance of Moisture measurement	Liquid chromatography-Principles, types and applications	IR spectrophotometers Instruments of IR	Components of Mass Spectrometers
	SLO-2	Types of Electrodes, Reference Electrodes and types	Types of Moisture measurement	High pressure liquid chromatography	Types of IR Components required for three types of IR	Types of Mass spectrometers Magnetic Sector analyzer ,Double focusing spectrometers
S-5	SLO-1	Secondary Electrodes and Types	Oxygen analyzer Methods of oxygen analyzers and importance	Instrumentation or basic component of HPLC	Instruments of dispersive instrument , IR Radiation Sources and types	Time of flight analyzers, Quadrupole Mass analyzers
	SLO-2	Indicator electrodes	Paramagnetic oxygen analyzer Electro analytical method	Solvent reservoir and its treatment system	Importance of Monochromators and types of Monochromators	Application of mass spectrophotometers

S-6	SLO-1	pH meters direct reading type pH meter null detector type pH meter	CO monitor,Importance of measuring CO	Pumping system, Types of working systems and Importance	Samples And Sample Cells detectors	nuclear radiation detectors, importance of measurement
	SLO-2	ion selective electrodes Types of ion selective electrodes Glass membrane electrodes Liquid membrane electrodes Solid membrane Electrodes	Types of CO monitor	Pulse dampers	FTIR spectrometers Main components Advantages disadvantages	GM counter
S-7	SLO-1	Features of Biosensor Block diagram of bio sensor	NO2 analyzer, Importance of NO_2 measurement	Sample injection system and types	Types of sources Selection factors	Working setup, advantages of GM Counter
	SLO-2	Applications of Biosensors in industries	Types of NO_2 measurement	Liquid chromatographic column working , Types of Column thermostats	Types of detectors Selection factors	proportional counter, Basic Principle
S-8	SLO-1	conductivity meters ,Importance in Chemical Industries	H_2S analyzer, Importance of H_2 S Measurement	Detection system types	atomic absorption spectrophotometer instruments for atomic absorption spectroscopy	Working setup, advantages of GM Counter
	SLO-2	Types of Conductivity meters	Types of H_2S measurement	Types of Recording system	radiation source chopper	solid state detectors, Basic Principle
S-9	SLO-1	Air pollution Monitoring Instruments	Dust and smoke measurement- dust measurement and Importance Types of dust measurement	Application of HPLC, Advantages of HPLC over gas chromatography	production of atomic vapor by flame, Parts by flame photometer Emission system	Working setup, advantages of Solid state detectors
	SLO-2	Estimation of Air pollution	Thermal analyzer , Importance of Thermal analyzers, Types of Thermal analyzer	Detectors types, Factors Influencing the Selection of Detectors	Monochromators And types, Types of Detectors and recording systems and their selection criteria	scintillation counter, Basic principle

Learning Resources	1. Khandpur. R.S, "Handbook of Analytical Instruments", Tata McGraw Hill publishing Co. Ltd., 2006 2. Bella. G, Liptak, "Process Measurement and analysis"., CRC press LLC.,2003. 3. Francis Rousseau and Annick Rouesssac "Chemical analysis Modern Instrumentation Methods and Techniques", John wiley & sons Ltd.2007.	4. James W.Robinson,"Undergraduate Instrumental Analysis", Marcel Dekker., 2005. 5. Dwayne Heard, "Analytical Techniques for atmospheric measurement", Blackwell Publishing, 2006.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
Level 2	Apply Analyze	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
Level 3	Evaluate Create	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

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2. V. Venkateswaran, Instrumentation Consultant, vvenkat99@gmail.com	2. Dr. D. Nedumaran, Madras University, dnmaran@gmail.com	2. Mrs. A. Brindha, SRMIST

Course Code	18ECO133T	Course Name	SENSORS AND TRANSDUCERS	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Electronics and Communication*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Gain knowledge on classification, and characteristics of transducers*
CLR-2 :	*Acquire the knowledge of different types of inductive and capacitive sensors*
CLR-3 :	*Acquire the knowledge of different types of thermal and radiation sensors*
CLR-4 :	*Acquire the knowledge of different types of magnetic sensors*
CLR-5 :	*Acquire the knowledgeof different types of sensors measuring non-Electrical quantity*
CLR-6 :	*Locate the Applications of sensors in industries and home appliances*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1	2	3	Program Learning Outcomes (PLO) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	*To demonstrate the various types of basic sensors.*	3	80	75	H	-	H	-	-	H	H	H	-	-	-	H	H	-	-
CLO-2 :	*Understand the inductive and capacitive sensors which are used for measuring various parameters.*	3	80	75	H	-	-	H	-	H	-	-	-	-	-	H	-	H	-
CLO-3 :	*Understand the thermal and radiation sensors*	3	80	75	-	-	-	-	-	H	-	-	H	H	-	-	H	-	-
CLO-4 :	*Have an adequate knowledgeon the various magnetic sensors*	3	80	75	-	H	H	-	-	-	-	-	-	-	-	-	-	H	-
CLO-5 :	*To demonstrate the various types of basic sensors measuring non electrical quantity*	3	80	75	-	-	H	-	H	-	-	-	-	-	-	H	-	-	H
CLO-6 :	*Select the right transducer for the given application*	3	80	75	H	-	H	-	-	H	H	H	-	-	-	H	H	-	-

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Introduction to sensors/ transducers, Principles*	*Introduction to Inductive sensor*	*Thermal sensors: Introduction*	*Magnetic sensors: Introduction*	*Measurement of Non-Electrical quantity: Introduction*
	SLO-2	*Classification based on different criteria*	*Sensitivity and linearity of the sensor*	*Thermal Expansion type.*	*Villari effect*	*Flow Measurement – Introduction.*
S-2	SLO-1	*Characteristics of measurement systems*	*Transformer type transducer*	*Acoustics temperature sensors.*	*Wiedmann effect*	*Ultrasonic Flow Meters.*
	SLO-2	*Static characteristics Accuracy, Precision, Resolution, Sensitivity*	*Electromagnetic transducer*	*Thermo-emf sensor.*	*Hall effect*	*Hot Wire Anemometers.*
S-3	SLO-1	*Dynamic characteristics.*	*Magnetosrtictive transducer*	*Materials for thermos-emf sensors.*	*Construction,*	*Electromagnetic Flow meters.*
	SLO-2	*Environmental Parameters*	*Materials used in inductive sensor*	*Thermocouple construction*	*performance characteristics,*	*Principle and types.*
S-4	SLO-1	*Characterization and its type*	*Mutual Inductance change type*	*Types.*	*and its Application*	*Measurement of Displacement.*
	SLO-2	*Electrical characterization.*	*LVDT: Construction.*	*Thermo-sensors using semiconductor device*	*Introduction to smart sensors*	*Introduction and types.*
S-5	SLO-1	*Mechanical Characterization.*	*Material, input output relationship,*	*Pyroelectric thermal sensors*	*Film sensors: Introduction*	*Measurement of Velocity/ Speed.*
	SLO-2	*Thermal Characterization*	*Synchros-Construction*	*Introduction*	*Thick film sensors*	*Introduction and types.*
S-6	SLO-1	*Optical Characterization.*	*Capacitive sensor: Introduction*	*characteristics*	*Microelectromechanical systems*	*Measurement of Liquid Level.*
	SLO-2	*Errors and its classification.*	*Parallel plate capacitive sensor*	*Application*	*Micromachining.*	*Introduction and types.*

S-7	SLO-1	*Selection of transducers.*	*Variable thickness dielectric capacitive sensor*	*Radiation sensors*	*Nano sensors*	*Measurement of Pressure.*
	SLO-2	*Introduction to mechanical sensors*	*Electrostatic transducer*	*Introduction*	*Applications: Industrial weighing systems: Link–lever mechanism.*	*Introduction and types.*
S-8	SLO-1	*Resistive potentiometer and types*	*Piezoelectric elements*	*Characteristics*	*Load cells – pneumatic, elastic and their mounting.*	*Measurement of Vibration.*
	SLO-2	*Strain gauge: Theory, type, design consideration, sensitivity.*	*Ultrasonic Sensors*	*Geiger counters*	*different designs of weighing systems.*	*Introduction and types.*
S-9	SLO-1	*Resistive transducer: RTD, materials used in RTD*	*Calculation of sensitivity.*	*Scintillation detectors*	*conveyors type.*	*Application of sensors in industries*
	SLO-2	*Thermistor: thermistor material, shape*	*Capacitor microphone, response characteristics*	*Application on radiation sensors*	*weighfeeder type.*	*Application of sensors in home appliances*

Learning Resources	1. *Patranabis, D., "Sensors and Transducers", 2nd Edition, Prentice Hall India Pvt. Ltd, 2010* 2. *Doeblin, E.O., "Measurement Systems: Applications and Design", 6thEdition, Tata McGraw-Hill Book Co., 2011* 3. *Bentley, J. P., "Principles of Measurement Systems", 4th Edition, Addison Wesley Longman Ltd., UK, 2004.*	4. *Murthy, D.V.S., "Transducers and Instrumentation", Prentice Hall of India Pvt. Ltd., New Delhi, 2010* 5. *Neubert H.K.P., "Instrument Transducers – An Introduction to their performance and Design", Oxford University Press, Cambridge, 2003*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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2. Mr. Prasad, KCP Sugar & Industries, kcpengineering@gmail.com	*2. Mr. Prashanth Ravi, NTU, prashantrar@gmail.com*	*2. Dr. G.JoselinRetna Kumar, SRMIST*

Course Code	18ECO134T	Course Name	INDUSTRIAL AUTOMATION	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Electronics and Communication*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Understand basic components of PLC*
CLR-2 :	*Understand the use of timers and counters in process automation*
CLR-3 :	*Understand DCS architecture*
CLR-4 :	*Understand operator and engineering interface in DCS*
CLR-5 :	*Understand HART signal standard and Field bus*
CLR-6 :	*Understand Field bus signal standard.*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO – 3
CLO-1 :	*Select PLC based on I/O's*	3	80	75	H	M	L	-	-	-	-	-	M	-	M	L	M		M
CLO-2 :	*Apply timers and counters in process automation*	3	80	75	H	H	H	H	H	-	L	-	H	M	L	L	H	H	H
CLO-3 :	*Select LCU based on application*	3	80	75	H	M	-	-	-	-	-	-	L	-	-	L	M	L	M
CLO-4 :	*Analyse data's in Operator displays*	3	80	75	H	H	-	H	-	-	-	-	H	M	-	L	H	L	M
CLO-5 :	*Interpret industrial data communication modes*	3	80	75	H	-	-	-	-	-	-	-	-	L	-	L	H	-	L
CLO-6 :	*Gain knowledge on field bus*	3	80	75	H	L	-	-	-	-	-	-	-	-	-	L	H	-	L

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Programmable logic controllers*	*PLC Programming Languages*	*Evolution of DCS*	*Operator Interfaces Requirements*	*Introduction to HART*
	SLO-2	*PLC vs Computer*	*Ladder Diagram*	*Hybrid System Architecture*	*Process Monitoring*	*Evolution of Signal standard*
S-2	SLO-1	*Parts of a PLC*	*Functional block*	*Central Computer system Architecture*	*Process Control*	*HART Networks: Point-to-Point*
	SLO-2	*Architecture*	*Sequential Function Chart*	*DCS Architecture*	*Process Diagnostics*	*Multi-drop*
S-3	SLO-1	*PLC size and Application.*	*Instruction List*	*Comparison of Architecture*	*Process Record Keeping*	*Split range control valve*
	SLO-2	*Fixed and Modular I/O*	*Structured Text*	*Local Control Unit Architecture*	*Low Level Operator Interface*	*HART Field Controller Implementation*
S-4	SLO-1	*Discrete Input Modules*	*Wiring Diagram*	*Architectural Parameters*	*High Level Operator Interface*	*Hart Commends: Universal*
	SLO-2	*Discrete Output Modules*	*Ladder logic Program*	*Comparison Of LCU Architecture*	*Hardware Elements In The Operator Interface*	*Common Practice*
S-5	SLO-1	*Analog Input Modules*	*On-Delay Timer Instruction*	*LCU Language Requirements*	*Operator Input And Output Devices*	*Device Specific*
	SLO-2	*Analog Output Modules*	*Off-Delay Timer Instruction*	*Function Blocks*	*Operator Display Hierarchy*	*Wireless Hart*
S-6	SLO-1	*Special I/O Modules*	*Retentive Timer*	*Function Block Libraries*	*Plant-Level Display*	*Field Bus Basics*
	SLO-2	*High Speed Counter Module*	*Cascading Timer*	*Problem-Oriented Language*	*Area- Level Display*	*Field Bus Architecture*

S-7	SLO-1	*Power Supplies*	*Up-Counter*	*LCU Process Interfacing Issues*	*Group- Level Display*	*Field Bus Standard*
	SLO-2	*Isolators*	*Down-Counter*	*Security Requirements*	*Loop- Level Display*	*Field Bus Topology*
S-8	SLO-1	*Input/output Devices: Switches*	*Cascading Counters*	*Security Design Approach*	*Engineering Interface Requirements*	*H1 Field Bus*
	SLO-2	*sensors*	*Combining Counter And Timer Functions*	*On-Line Diagnostics*	*Requirement For Operator Interface Configuration*	*H2 Field Bus*
S-9	SLO-1	*Relays*	*Math Operation*	*Redundant Controller Design*	*Low Level Engineering Interface,*	*Interoperability*
	SLO-2	*Solenoid valve*	*Program*	*One-On-One, One-On-Many Redundancy*	*High Level Engineering Interfaces*	*Interchangeability*

Learning Resources	1. *Frank D. Petruzella, Programmable Logic Controller, Tata McGraw Hill Fifth Edition, 2017* 2. *Bolton. W, Programmable Logic Controllers, 6th Edition, Elsevier Newnes, Sixth Edition 2016.* 3. *Krishna Kant, Computer Based Industrial Control, Second edition, Prentice Hall of India, New Delhi,2015*	4. *Bowten, R HART Application Guide, HART Communication foundation,2015.* 5. *Berge, J, Field Busses for process control: Engineering, operation, maintenance, ISA press,2015*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

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ACADEMIC CURRICULA

Professional Core Courses

Regulations - 2018

SRM
INSTITUTE OF SCIENCE & TECHNOLOGY
(Deemed to be University u/s 3 of UGC Act, 1956)

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Kancheepuram, Tamil Nadu, India

ACADEMIC CURRICULA

Professional Core Courses

AEROSPACE ENGINEERING

Regulations - 2018

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Kancheepuram, Tamil Nadu, India

Course Code	18ASC101T	Course Name	APPLIED ENGINEERING MECHANICS	Course Category	C	Professional Core	L	T	P	C
							3	1	0	4

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Aerospace Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Utilize the concept of equilibrium of particles and rigid bodies*
CLR-2 :	*Utilize the concept of finding centroid of planar figures and moment of inertia about different axes*
CLR-3 :	*Utilize with the dynamics of particles*
CLR-4 :	*Utilize with the dynamics of rigid bodies*
CLR-5 :	*Apply the concepts of mechanics to solve problems related to space mechanics*
CLR-6 :	*Utilize the concepts in better understanding of systems dealing with forces*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	**Learning** 1 Level of Thinking (Bloom)	2 Expected Proficiency (%)	3 Expected Attainment (%)	**Program Learning Outcomes (PLO)** 1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	13 PSO - 1	14 PSO - 2	15 PSO – 3
CLO-1 :	*Determine the forces under equilibrium*	2	85	75	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	*Identify the centroids and determine moment of inertia*	2	85	75	H	H	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	*Determine the forces acting on particle both kinetics and kinematics*	2	85	75	H	-	H	H	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	*Determine the forces acting on rigid body both kinetics and kinematics*	2	85	75	H	H	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-5 :	*Application of determining space orbit*	2	85	75	H	-	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-6 :	*Apply the concepts of fundamental mechanics and space mechanics in real time applications*	2	85	75	H	H	H	H	-	-	-	-	-	-	-	-	-	-	-

Duration (hour)		12	12	12	12	12
S-1	SLO-1	*Fundamentals of mechanics- Classification of forces, Laws of mechanics.*	*Determination of centroids by integration, centroids of lines, areas and volumes.*	*Rectilinear motion-Uniform motion and Rectangular components of velocity*	*Kinematics of rigid bodies*	*Curvilinear motion: Projectile motion*
	SLO-2	*Vector and vector operations problems*	*Determination of centroids by integration, centroids of areas*	*Rectilinear motion - Uniformly accelerated motion*	*Kinematics of rigid bodies: Linear translational motion*	*Projectile motion: Path of the projectile*
S-2	SLO-1	*Forces on particles in 2 D- Triangular law of forces & parallelogram law of forces*	*Determination of centroids in composite areas*	*Curvilinear motion-Normal and tangential components*	*Kinematics of rigid bodies: Fixed axis rotation*	*Position and velocity of the projectile after a known time*
	SLO-2	*Equilibrium on particles in 2D, Lami's Theorem, Free body diagram*	*Centroids of volumes, Centre of gravity*	*Curvilinear motion- Normal and tangential components*	*Kinematics of rigid bodies: Fixed axis rotation*	*Velocity, direction and time taken of the projectile after a known height*
S-3	SLO-1	*Action & Reaction, Equilibrium on particles in 2 D – Equations of Equilibrium*	*Pappus guildinus Theorem I*	*Curvilinear motion- Radial and transverse components*	*Kinematics of rigid bodies: relation between linear and rotation*	*Motion of particle projected horizontally*
	SLO-2	*Forces in space*	*Pappus guildinus Theorem II*	*Curvilinear motion- Radial and transverse components*	*Kinematics of rigid bodies: relation between linear and rotation*	*Projected from inclined plane*
S-4	SLO-1	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*
	SLO-2	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*
S-5	SLO-1	*Statics of rigid body in 2D – Moment & Varigon's Theorem*	*Moment of inertia*	*Cylindrical coordinates- Newtons second law, D'Alembert's principle.*	*General plane motion-Absolute and relative velocity in plane motion*	*Angular momentum of a particle. Rate Of change of angular momentum*
	SLO-2	*Statics of rigid body in 2D – Force Couple System*	*Determination of moment of inertia by Integration*	*Cylindrical coordinates- Newtons second law, D'Alembert's principle.*	*General plane motion-Absolute and relative velocity in plane motion*	*Motion under a central force, Conservation of angular momentum.*
S-6	SLO-1	*Equilibrium of Rigid bodies in 2D*	*Parallel axis theorem*	*Principle of work and energy*	*General plane motion: Crank- Rod Mechanism*	*Newton's Law of Gravitation*
	SLO-2	*Equilibrium of Rigid bodies in 2D : Support Reactions, Types of Support*	*Parallel axis theorem*	*Principle of work and energy*	*General plane motion: Crank- Rod Mechanism*	*Sample problems: Conservation of angular momentum and newton's law of gravitation*
S-7	SLO-1	*Analytical method to determine the support reactions of beam*	*Perpendicular axis theorem*	*Principle of impulse and Momentum.*	*Instantaneous centre of rotation in plane motion*	*Sample problems: Conservation of angular momentum and newton's law of gravitation*

	SLO-2	*Moment of Uniformly varying loads*	*Perpendicular axis theorem*	*Principle of impulse and Momentum.*	*Instantaneous centre of rotation in plane motion*	*Sample problems: Conservation of angular momentum and newton's law of gravitation*
S-8	SLO-1	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*
	SLO-2	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*
S-9	SLO-1	*Truss: Classification, perfect/Imperfect frame, Analysis of perfect frame*	*Polar moment of inertia,*	*Impact of Elastic bodies*	*D'Alembert's principle : Linear motion*	*Trajectory of a particle under a central force*
	SLO-2	*Determine the support Reaction in truss*	*Radius of gyration*	*Derivation of Elastic coefficient*	*D'Alembert's principle : Rotation motion*	*Trajectory of a particle under a central force: Application to space mechanics*
S-10	SLO-1	*Analysis of perfect Frame by method of joints: Simply supported*	*Mass moment of inertia of solid objects*	*Impact of Elastic bodies-Direct central*	*Principle of work and energy for a rigid body : Linear motion*	*Kepler Law of planetary motion*
	SLO-2	*Analysis of perfect Frame by method of joints: Cantilever*	*Mass moment of inertia of solid objects*	*Impact of Elastic bodies-Direct central*	*Principle of work and energy for a rigid body: Rotation motion*	*Sample problems: Central force*
S-11	SLO-1	*Analysis of perfect Frame by method of sections: Simply supported*	*Mass Moment of inertia of thin plates*	*Impact of Elastic bodies- Oblique central impact.*	*Principle of impulse, momentum for plane motion of a rigid body: Linear motion*	*Sample problems: Central force*
	SLO-2	*Analysis of perfect Frame by method of sections: Cantilever*	*Mass Moment of inertia of thin plates*	*Impact of Elastic bodies- Oblique central impact.*	*Principle of impulse, momentum for plane motion of a rigid body: Rotation motion*	*Sample problems: Periodic time*
S-12	SLO-1	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*
	SLO-2	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*

Learning Resources	1. *Ferdinand P. Beer, E. Russell Johnston Jr., David Mazurek, Philip J Cornwell, Vector Mechanics for Engineers: Statics and Dynamics, 10th ed., McGraw Hill, 2013* 2. *Shames, I.H., Krishna Mohana Rao, G., Engineering Mechanics (Statics and Dynamics), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 2006*	3. *NPTEL Engineering Mechanics Lectures by IIT Guwahati 'https://nptel.ac.in/courses/112103109/'*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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2. Dr. Vinay Kumar Gupta, National Physical Laboratory, guptavinay@nplindia.org	*2. Dr. S. Elangovan, BIHER,Chennai, email : subelango@yahoo.co.in*	*2. Mr. Iynthezhuthon, SRMIST*

Course Code	18ASC102J	Course Name	APPLIED FLUID MECHANICS	Course Category	C	*Professional Core*	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Aerospace Engineering*	Data Book / Codes/Standards	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Identify the characteristics of fluids and utilize the pressure measuring devices*
CLR-2 :	*Solve the basic fluid flow problems and apply the system and control volume concept in various fluid flow problems*
CLR-3 :	*Identify the mathematical techniques of potential flow problems*
CLR-4 :	*Solve the basic dimensional analysis and fluid flow through pipes*
CLR-5 :	*Analyze the basic concepts of boundary layer in fluid flow*
CLR-6 :	*Explore advanced level of fluid mechanics applications*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1	Learning 2	Learning 3	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12	PLO 13	PLO 14	PLO 15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	*Accrue the knowledge of fluid properties and principle and function of pressure measuring instruments*	2	85	75	H	M	M	L	-	-	-	-	L	-	-	M	L	-	-
CLO-2 :	*Analyze the fluid flow problems and system and control volume concept*	2	85	75	H	H	M	M	-	-	-	-	L	-	-	M	L	-	-
CLO-3 :	*Apply the mathematical techniques of potential flow problems*	2	85	75	H	H	M	M	-	-	-	-	-	-	-	M	-	-	-
CLO-4 :	*Apply the dimensional analysis and fluid flow through pipes*	2	85	75	H	H	M	M	-	-	-	-	L	-	-	M	L	-	-
CLO-5 :	*Accrue the knowledge about boundary layer concept*	2	85	75	H	M	M	L	-	-	-	-	-	-	-	M	-	-	-
CLO-6 :	*Accrue comprehensive knowledge in fluid mechanics applications*	2	85	75	H	H	M	M	-	-	-	-	L	-	-	M	L	-	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Introduction to fluid mechanics*	*Lagrangian and Eulerian description of fluid flow*	*Pitot – tube*	*Dimensional Analysis*	*Pipe friction major and Minor losses*
	SLO-2	*Brief history of fluid mechanics*	*Types of fluid flow, streamlines, path lines, and streak lines.*	*Numerical problems*	*Rayleigh's method, numerical problems*	*Numerical problems*
S-2	SLO-1	*Fluids and their properties*	*System and Control volume concept*	*Introduction to potential flow*	*Buckingham's Pi – theorem*	*Numerical Problems in parallel,*
	SLO-2	*Density, viscosity, surface tension*	*Introduction to Reynolds transport theorem*	*Equation of streamline*	*Buckingham's Pi – theorem procedure*	*Series and branched pipes.*
S-3	SLO-1	*Properties of fluids numerical problems*	*Reynolds transport theorem*	*Stream function, Velocity potential function*	*Numerical problems on Buckingham's Pi – theorem*	*Boundary layer theory introduction*
	SLO-2	*Compressibility and bulk modulus*	*Reynolds transport theorem and its applications*	*Basic elementary flows*	*Numerical problems*	*Fluid flow over bodies*
S 4-5	SLO-1 SLO-2	*Lab 1: Determine coefficient of discharge of orifice meter*	*Lab 4: Repeat class*	*Lab 7: Performance test on radial centrifugal air blower*	*Lab 10: Performance test on forward centrifugal air blower*	*Lab 13: Major loss due to friction in pipe flow*
S-6	SLO-1	*Fluid statics-Pascal's law*	*Reynolds transport theorem, applications in finite control volume analysis*	*Uniform parallel flow stream function and velocity potential function*	*Applications of important dimensionless numbers*	*Flow over a flat plate*
	SLO-2	*Numerical problems on Pascal's law*	*control volume analysis Numerical problems*	*Source flow and sink flow stream function and velocity potential function*	*Numerical problems*	*Boundary layer development on a flat plate*
S-7	SLO-1	*Hydrostatic law*	*Euler's equation of motion along a streamline*	*Free vortex*	*Flow through pipes*	*Displacement thickness, momentum thickness*
	SLO-2	*Piezometric head, and Numerical problems*	*Bernoulli's equation*	*Free vortex stream function and velocity potential function*	*Laminar and turbulent flow*	*Energy thickness*
S-8	SLO-1	*Manometry- simple manometer*	*Bernoulli's equation - Numerical problems*	*Forced vortex*	*Hagen - Poiseuille flow in circular pipes*	*Numerical problems on*
	SLO-2	*Numerical problems on simple manometers*	*Numerical problems on Bernoulli's equation*	*Combination of elementary flows*	*Hagen – Poiseuille equation*	*displacement thickness, momentum thickness, Energy thickness*

S 9-10	SLO-1	Lab 2: Determine coefficient of discharge of venturimeter	Lab 5: Determine Impact force of water jet on vane	Lab 8: Repeat class	Lab 11: Determine type of flow by Reynolds apparatus	Lab 14: Performance test on reciprocating air compressor
	SLO-2					
S-11	SLO-1	Differential manometer- U-tube differential manometer	Bernoulli's equation – Application venturimeter, orifice meter, pitot tube	Doublet flow	Hagen – Poiseuille equation applications	Drag on a flat plate
	SLO-2	Numerical problems on U-tube differential manometer	Venturimeter discharge equation	Doublet flow stream function and velocity potential function	Numerical problems on viscous flow through pipes	Vonkarman Momentum integral equation
S-12	SLO-1	Differential manometer- Inverted U-tube differential manometer	Numerical problems on Venturimeter	Non-lifting flow over a cylinder	Development of flow in pipes Darcy-Weisbach equation	Separation of flow over bodies, streamlined and bluff bodies
	SLO-2	Numerical problems on Inverted U-tube differential manometer	Numerical problems on Venturimeter	Pressure and velocity distributions	Pipe friction	Lift and Drag on cylinder
S-13	SLO-1	Inclined manometer	Orifice meter	Lifting flow over a cylinder	Numerical problems on Darcy-Weisbach equation	Lift and Drag on Aerofoil
	SLO-2	Numerical problems on Inclined manometer	Orifice meter discharge equation, and numerical problems	pressure and velocity distributions	Numerical problems on Pipe friction	Lift and Drag on cylinder and Aerofoil Numerical problems
S 14-15	SLO-1	Lab 3: Verify Bernoulli's theorem	Lab 6: Minor losses due to pipe fittings in pipes	Lab 9: Performance test on backward centrifugal blower	Lab 12: Repeat class	Lab 15: Repeat class
	SLO-2					

Learning Resources	1. Kumar, K.L., Engineering Fluid Mechanics, 8th ed., S. Chand, New Delhi, 2016 2. Munson, Bruce R., Young, Donald F., Okiishi, Theodore H., Huebsch, Wade W. Fundamentals of Fluid Mechanics, 7th ed., John Wiley & Sons, Inc. 2016	3. Irving H. Shames, Mechanics of Fluids, 4th ed., McGraw-Hill, 2003 4. Streeter, Victor, Bedford, K.W., Wylie, E. Benjamin, Fluid Mechanics, 2nd ed., Tata McGraw Hill, New Delhi, 1997

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	20%	20%	15%	15%	15%	15%	15%	15%	15%	15%
Level 2	Apply Analyze	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Level 3	Evaluate Create	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%
	Total	100 %		100 %		100 %		100 %		100%	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. S. Raja, National Aerospace Laboratories, Bangalore, raja@nal.res.in	1. Dr. S. Elangovan, BIHER,Chennai, email : subelango@yahoo.co.in	1. Mr. S. Rajkumar, SRMIST
2. Dr. Vinay Kumar Gupta, National Physical Laboratory, guptavinay@nplindia.org	2. Dr. K. M. Parammasivam, Madras Institute of Technology, Chennai, mparams@mitindia.edu	2. Mr. M. Abdur Rasheed, SRMIST

Course Code	18ASC103T	Course Name	AERO ENGINEERING THERMODYNAMICS	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Aerospace Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Identify the engineering and practical applications of Heat, Energy and Work
CLR-2 :	Identify the applications of Thermodynamics on Engineering systems
CLR-3 :	Identify the significance of Thermodynamic Laws
CLR-4 :	Create insights to the concepts of Entropy and Exergy
CLR-5 :	Analyze the working principle of Heat Energy driven systems
CLR-6 :	Utilize the Thermodynamic concepts in physics for the broad understanding of engineering and technology

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1	2	3	Program Learning Outcomes (PLO) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	Identify the laws of Thermodynamics and its applications to Aerospace Engineering	2	80	70	H	M	L	L	-	-	-	-	-	-	-	H	-	-	-
CLO-2 :	Comprehend the concept and applications of energy, entropy and exergy	2	80	70	H	M	M	M	-	-	L	-	-	L	-	H	M	M	M
CLO-3 :	Understand various gas and vapor power cycles with applications	2	80	70	H	M	L	M	-	-	-	-	L	-	-	H	-	-	-
CLO-4 :	Understand the gas mixture behavior and chemical reactions	2	80	70	H	M	M	M	-	-	M	M	M	M	L	H	M	M	M
CLO-5 :	Utilize the fundamental concepts for the physical understanding of engineering and technology	2	80	70	H	M	M	M	M	L	L	-	L	M	L	H	M	M	M
CLO-6 :	Apply the Thermodynamic Principles to Aerospace Engineering Applications	2	80	70	H	M	M	M	M	L	L	M	L	M	L	H	M	M	M

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Basic Concepts: Microscopic,macroscopic point of view, Path and point functions.	Limitations of first law of Thermodynamics. Introduction to Heat Reservoirs, Sources and Sinks	Limitations of Second Law of Thermodynamics	Role of Carnot cycle in Aerospace engineering	Mass fraction and mole fractions
	SLO-2	Intensive and extensive, total and specific quantities.	Heat Engine, Refrigerator, and Heat pump. Thermal efficiency of heat engines.	Explanation of the Concept of Entropy	Introduction to Otto cycle, Diesel cycle, Dual cycle	p-v-t behavior and properties of ideal gas mixtures
S-2	SLO-1	System and types. Zeroth law of thermodynamics, Thermodynamic equilibrium	Second law of Thermodynamics: C.O.P, Kelvin-Planck statement	Clausius inequality, T-s diagram	Indicator diagram Mean effective pressure	Dalton's law of partial pressures, Avogadro's law
	SLO-2	Quasi-static, reversible and irreversible processes. Heat and work transfer, sign convention	Clausius statement of second law and equivalence of statements.	Entropy change for different processes.	Comparison of Otto, Diesel and Dual cycles, Air standard efficiency	Gibbs-Dalton law, enthalpy and specific heat of a gas mixtures
S-3	SLO-1	Solving Problems	Solving Problems	Solving Problems	Solving Problems	Solving Problems
	SLO-2	Solving Problems	Solving Problems	Solving Problems	Solving Problems	Solving Problems
S-4	SLO-1	First law of Thermodynamics: First law for a closed system undergoing a cycle, concept of Internal energy, change of state	Reversible and irreversible processes- causes of irreversibility	Principle of increase of Entropy, Maxwell relations, T-ds Equations, Difference and ratio of heat capacities	Introduction to Aerospace Propulsion - Brayton cycle	Chemical reactions, Combustion, Stoichiometric coefficients, Air-Fuel ratio, Equivalence ratio
	SLO-2	Energy and Work Transfer in closed systems, P-V diagram, PMM1	Carnot Theorem and corollary	Energy equation, Joule Thomson Coefficient, Clausius-Clapeyron equation	Effect of Reheat, Regeneration and Intercooling	Combustion and Dissociation
S-5	SLO-1	Solving Problems	Absolute Thermodynamic Temperature scale	Solving Problems	Solving Problems	Solving Problems
	SLO-2	Solving Problems	Carnot cycle and Performance	Solving Problems	Solving Problems	Solving Problems

S-6	SLO-1	*First law for an Open system: Conservation of mass, energy, steady flow energy equation*	*Solving Problems*	*Entropy change of Ideal and Real gases*	*Turbine and Compressor efficiency*	*Aerospace Chemical Propulsion: Fuels in combustion*
	SLO-2	*Aerospace applications of SFEE to Nozzles, Diffusers*	*Solving Problems*	*Isentropic efficiencies of Aerospace steady flow devices*	*Factors affecting efficiency*	*Enthalpy of reaction, formation and combustion*
S-7	SLO-1	*Cases of turbine, compressor, boiler, pump*	*Engineering and Practical Applications of Second Law*	*Exergy in Aerospace Engineering: High and low-grade energy*	*Equivalent Carnot cycles: Stirling and Ericsson cycle, Humphrey cycle*	*Gravimetric and volumetric analysis*
	SLO-2	*Heat exchanger and Throttling process*	*Aerospace Engineering Applications of Second Law*	*Available and non-available energy of a source and finite body*	*Interactive session with demo on practical working of Gas Power based Engines*	*Introduction to adiabatic flame temperature*
S-8	SLO-1	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*
	SLO-2	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*
S-9	SLO-1	*Chapter Doubt clarification.*	*Chapter Doubt clarification.*	*Chapter Doubt clarification.*	*Chapter Doubt clarification.*	*Chapter Doubt clarification.*
	SLO-2	*Chapter Doubt clarification.*	*Chapter Doubt clarification.*	*Chapter Doubt clarification.*	*Chapter Doubt clarification.*	*Chapter Doubt clarification.*

Learning Resources	1. *Nag, P. K, Engineering Thermodynamics, 6th ed., Tata McGraw Hill, 2017* 2. *Rathakrishnan. E, Fundamentals of Engineering Thermodynamics, Prentice–Hall, India, 2005* 3. *Holman, J. P., Thermodynamics, 4th ed., Tata McGraw Hill, 2015* 4. *Rayner Joel, Basic Engineering Thermodynamics, 5th ed., Addison Wesley, 2016*	5. *Michael Moran, J., Howard Shapiro, N., Fundamentals of Engineering Thermodynamics, 4th ed., John Wiley & Sons, 2010* 6. *Yunus A. Cengel, Michael A. Boles, Thermodynamics an engineering approach, 7th ed., McGraw Hill, 2011*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Vinay Kumar Gupta, National Physical Laboratory, guptavinay@nplindia.org	*1. Prof. D.P. Mishra, IIT Kanpur, mishra@ iitk.ac.in.*	*1. Dr. R. Vasudevan, SRMIST*
2. Dr. S. Raja, National Aerospace Laboratories, Bangalore, raja@nal.res.in	*2. Prof. Prasanta Kumar Das, IIT Kharagpur, pkd@mech.iitkgp.ernet.in.*	*2. Dr. T. Selvakumaran, SRMIST*

Course Code	18ASC104J	Course Name	AIRCRAFT MATERIALS AND PRODUCTION TECHNIQUES	Course Category	C	*Professional Core*	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Aerospace Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Identify materials*
CLR-2 :	*Utilize the mechanical behavior of materials*
CLR-3 :	*Utilize the existing production technologies*
CLR-4 :	*Identifying the selection of materials*
CLR-5 :	*Identify material's Application*
CLR-6 :	*Utilize the experience of machining Techniques for real-time applicaions*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1 Level of Thinking (Bloom)	2 Expected Proficiency (%)	3 Expected Attainment (%)	PLO 1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	13 PSO - 1	14 PSO - 2	15 PSO – 3
CLO-1 :	*Identify materials and it properties*	2	80	70	H	H	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	*Analyze the application of materials in different aircraft components*	2	85	75	H	H	-	-	H	-	-	-	-	-	-	-	-	-	-
CLO-3 :	*Identify different treatments to strengthen materials*	2	75	70	H	-	H	H	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	*Identify different casting techniques*	2	85	80	H	H	-	-	H	-	-	-	-	-	-	-	-	-	-
CLO-5 :	*Analyze machining techniques*	2	85	75	H	-	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-6 :	*Analyze forming Techniques*	2	80	70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Introduction to materials, mechanical properties*	*Heat Treatment*	*Casting Introduction*	*Mechanical working of Materials*	*Machining Process*
	SLO-2	*Fixed-wing aircraft structures*	*Purpose of Heat Treatment*	*Basic Terms*	*Introduction to mechanical Working*	*Introduction to Machines*
S-2	SLO-1	*Classification of aircraft materials*	*Principles of Heat Treatment*	*Casting Procedure*	*Hot Working*	*Lathe*
	SLO-2	*Materials used for aircraft components*	*Stages of Heat Treatment*	*Casting Nomenclature*	*Cold Working*	*Lathe Components, tools*
S-3	SLO-1	*Helicopter structures*	*Stages of Heat Treatment, Description*	*Sand Casting*	*Hot Working- Forging*	*Working of Lathe*
	SLO-2	*Space shuttle structures*	*Types of Heat treatment*	*Making of Sand Casting, Gating and risering System*	*Forging Types, Forging Defects*	*Operations in Lathe, tools*
S 4-5	SLO-1 SLO-2	*Lab 1: Step Turning*	*Lab 4: Drilling and Boring*	*Lab 7 Surface Grinding*	*Lab 10: Spur Gear Milling*	*Lab 13: Thread Cutting*
S-6	SLO-1	*Materials used in jet engines*	*Heat treatment of carbon steel*	*Special Casting Process*	*Rolling, Types of Rolling, Rolling Mills*	*Drilling Machine, Types of Drilling machine*
	SLO-2	*Light weight material for MAV/UAV.*	*Procedures of Heat treatment of carbon steel*	*Special casting process*	*Rolling Defects*	*Operations, Tools used in Drilling Machine*
S-7	SLO-1	*Super alloys.*	*Heat treatment of - aluminum alloys,*	*Expandable Mold Casting*	*Drawing*	*Shaper Machine*
	SLO-2	*Application of Composite materials*	*Procedures of Heat treatment of - aluminum alloys,*	*Shell Mold Casting*	*Drawing Types*	*Operations*
S-8	SLO-1	*Introduction to smart materials,*	*Heat treatment of titanium alloys.*	*Investment Casting*	*Extrusion*	*Quick return Mechanism*
	SLO-2	*Shape memory alloys*	*Procedures of Heat treatment of titanium alloys*	*Investment Casting Process*	*Extrusion Types*	*Mechanism Detail*

S 9-10	SLO-1 SLO-2	*Lab 2: Taper Turning*	*Lab 5: Shaper*	*Lab 8 Cylindrical Grinding*	*Lab 11:Helical Gear Milling*	*Lab 14: Slotting*
S-11	SLO-1	*Advanced structure ceramic*	*Heat treatment of Magnesium alloys.*	*Permanent Mold Casting, Die Casting, Centrifugal Casting, Casting Defects*	*Sheet Metal Operations, Shearing Operations*	*Slotter machine, mechanisms, Grinding Machines*
	SLO-2	*intermetallics, Ni and Ti aluminide*	*Procedures of Heat treatment of Magnesium alloys*	*Casting Defects*	*Types of Shearing Dies*	*Cutting Tools in Grinding Machines*
S-12	SLO-1	*Introduction to FRP,*	*Case Hardening*	*Welding Introduction*	*Forming Operations*	*Operations in Grinding Machines*
	SLO-2	*Glass and Carbon Composites*	*Procedures of Case Hardening*	*Gas Welding, Arc Welding*	*Forming Operations*	*Types of Grinding Machines*
S-13	SLO-1	*Aerospace Applications – Plastics and Rubber.*	*Stress reliving Procedures*	*Laser Beam Welding*	*Cutting Tools in sheet metal Process*	*Milling*
	SLO-2	*Emerging trends in Aerospace materials,*	*Protective Treatments*	*Electron Beam Welding, Electric Resistance Welding*	*Striking Tools in Sheet Metals, Riveting*	*Milling Operations, Types of Milling Machines*
S 14-15	SLO-1 SLO-2	*Lab 3: Taper boring*	*Lab 6: Drilling, Reaming & Tapping*	*Lab 9: Grooving and Knurling*	*Lab 12: External keyway cutting*	*Lab 15:Gear hobbing*

Learning Resources	1. *Adrian P. Mouritz, Introduction to aerospace materials, Woodhead Publishing Limited, 2012* 2. *Dieter, G. E., Mechanical Metallurgy, McGraw Hill, Singapore, 2001*	3. *Keshu S.C, Ganapathy K.K, Aircraft production technique, Interline Publishing House, Bangalore 1993* 4. *Dr. P C Sharma, A Text book of Production Technology, 8th ed., S. CHAND and company Pvt. Ltd. 2014*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember / Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply / Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate / Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Vinay Kumar Gupta, National Physical Laboratory, guptavinay@nplindia.org	*1. Dr..Srinivasa Rao Bakshi, IITM, Chennai, sbakshi@iitm.ac.in*	*1. Mr. N Bharat, SRMIST*
2. Dr. S. Raja, National Aerospace Laboratories, Bangalore, raja@nal.res.in	*2. Dr. Ramesh Babu, N , nrbabu@iitm.ac.in*	*2. Mr. K B Ravichandra kumar, SRMIST*

Course Code	18ASC105T	Course Name	AIRCRAFT SYSTEMS AND INSTRUMENTS	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Aerospace Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Identify the type of control system and its components used in aircraft.*
CLR-2 :	*Layout the components and accessories of hydraulic & Pneumatic system.*
CLR-3 :	*Identify the type of powerplant and various system operations in aircraft engines*
CLR-4 :	*Demonstrate the cabin environmental control system, oxygen system and other auxiliary system of an airplane.*
CLR-5 :	*Identify the various aircraft instruments and their functions.*
CLR-6 :	*Utilize the knowledge acquired for design, development & maintenance of aircraft & aero engine systems.*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	**Learning** 1 Level of Thinking (Bloom)	2 Expected Proficiency (%)	3 Expected Attainment (%)	**Program Learning Outcomes (PLO)** 1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	13 PSO - 1	14 PSO - 2	15 PSO – 3
CLO-1 :	*Understand the operation of various control system in an airplane*	2	80	70	H	-	L	L	L	-	-	-	-	-	-	L	L	M	M
CLO-2 :	*Acquire knowledge on hydraulic and pneumatic system of modern jet airliner.*	2	80	70	H	-	M	L	M	-	-	-	-	-	-	-	M	M	M
CLO-3 :	*Learn the working of various systems of piston and gas turbine engine*	2	80	70	H	-	L	L	M	-	-	-	-	-	-	L	M	M	M
CLO-4 :	*Appreciate the need and functions of Cabin Environmental Systems and auxiliary systems of aircraft.*	2	80	70	H	-	L	L	L	-	M	M	-	-	-	L	M	M	M
CLO-5 :	*Gain knowledge on principle and operation of various aircraft instruments.*	2	80	70	H	L	L	L	M	-	-	-	-	M	-	L	H	H	M
CLO-6 :	*Acquire comprehensive knowledge of aircraft systems, engine systems and its instrumentation.*	2	80	70	H	L	L	L	M	-	M	M	-	M	-	L	M	M	M

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Need for Control Systems*	*Introduction to Hydraulic Systems*	*Introduction to Aircraft Engines*	*Introduction to Cabin Environmental Control Systems*	*Introduction to Aircraft Flight Instruments*
	SLO-2	*Conventional Flight Controls.*	*Applications & Advantages*	*Types, Abnormal Combustion*	*Need for Aircraft Pressurization System*	*Types*
S-2	SLO-1	*Components of Conventional Flight Control System and their functions*	*Selection & Classification of Hydraulic Fluids*	*Introduction to Aircraft Fuel System*	*Principle of Air Cycle Cooling System*	*Principle of Air Data Instruments*
	SLO-2	*Push Pull rod System*	*Open Centre & Closed Centre System*	*Types of Fuel & Fuel System Components*	*Operation & Advantages*	*Operation of Altimeter*
S-3	SLO-1	*Cable Pulley System*	*Components of Hydraulic System and its functions*	*Gravity Feed Fuel System*	*Principle of Vapour Cycle Cooling System*	*Operation of Air Speed Indicator*
	SLO-2	*Disadvantages of Mechanical Control System.*	*Automatic Operating Control Valves*	*Pressure Feed Fuel System*	*Its Operation & Advantages*	*Operation of Vertical Speed Indicator*
S-4	SLO-1	*Challenges in Power Assisted Flight Control System*	*Study of Typical Hydraulic System for Modern Jet Airliner*	*Need for Lubrication System*	*Need for Cabin Heating System*	*Principle of Gyroscopic Instruments*
	SLO-2	*Q – Feel System*	*Operation and its Advantages*	*Functions and Characteristics of Lubricating Oil.*	*Types & Operation*	*Operation of Attitude Indicator*
S-5	SLO-1	*Servo Tabs*	*Aircraft Brake System*	*Types of Lubrication System, Wet Sump System*	*Need for Aircraft Oxygen System*	*Operation of Turn Coordinator*
	SLO-2	*Fully Powered Flight Control System for heavy aircraft*	*Types and Applications*	*Dry Sump System and their Advantages*	*Types & Advantages*	*Operation of Heading Indicator*
S-6	SLO-1	*Fly by Wire System (FBW)*	*Introduction to Pneumatic Systems*	*Need For Ignition System*	*Components of Oxygen System*	*Principle & Operation of Engine Instruments – Tachometer & EGT*
	SLO-2	*Operation of FBW & its Advantages*	*Applications & Advantages*	*Types of Ignition Systems*	*Its Operation*	*Principle & Operation of EPR, CHT & Manifold Pressure Gauge*
S-7	SLO-1	*Digital Fly by Wire System (DFBW)*	*Study of Typical Pneumatic System for Modern Airliner*	*Magneto Ignition System & its Operation*	*Introduction to Fire Detection Systems*	*Principle & Operation of Electronic Instruments – EADI & EHSI*

	SLO-2	*Operation of DFBW & its Advantages*	*Operation and its Advantages*	*Components of Ignition System of Gas Turbine Engine*	*Requirements for Fire Detection System*	*Principle & Operation of Electronic Systems Monitor Displays*
S-8	SLO-1	*Need for Automatic Flight Control Systems*	*Introduction to Landing Gear System*	*Need for Starting System*	*Types*	*Principle & Operation of EICAS*
	SLO-2	*Operation of Autopilot System*	*Classification of Landing Gear System*	*Types of starters*	*Principle and Operation*	*Need for Instrument Landing System (ILS)*
S-9	SLO-1	*Auto Throttle System (ATS)*	*Components of Landing Gear System*	*Pneumatic Starting System for Modern airliner*	*Need for Anti-Icing & De-Icing System*	*Components of ILS and their functions*
	SLO-2	*Advantages of ATS*	*Applications*	*Advantages of Pneumatic Starting System*	*Types and Applications.*	*Advantages*

Learning Resources	1. *Ian Moir, Allan Seabridge, Aircraft Systems – Mechanical, Electrical and Avionics subsystems integration, 3rd ed., Professional Engineering Publishing Limited, 2008* 2. *E.H.J.Pallet, Aircraft Instruments, 2nd ed.,Pearson Publishing Company, 2009* 3. *Aviation Maintenance Technician Handbook – Airframe, Vol.2, U.S.Dept. of Transportation, Federal Aviation Administration, Flight Standards Service, 2012*	4. *Aviation Maintenance Technician Handbook – Powerplant, Vol.1, 2, U.S.Dept. of Transportation, Federal Aviation Administration, Flight Standards Service, 2012* 5. *Michael J.Kroes, William A.Watkins ad Frank Delp, Aircraft Maintenance and Repair, 7th ed., Tata McGraw Hill, 2013* 6. *Irwin Treager, Aircraft Gas Turbine Engine Technology, 3rd ed., McGraw-Hill, 1997* 7. *The Jet Engine, 5th ed., Rolls Royce, Wiley Publication, 2005*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Wg.Cdr K.Manoharan (Retd), Blue Dart Aviation Ltd., manoharank@bluedart.com	*1. Dr. A. P. Haran, Park College of Engineering & Technology, ap_haran@rediffmail.com*	*1. Dr. S. Sivakumar, SRMIST*
2. Dr. Raja S, CSIR-NAL, Bangalore, raja@nal.res.in	*2. Dr. K. M. Parammasivam, Madras Institute of Technology, Chennai, mparams@mitindia.edu*	*2. Mr. G. Mahendra Perumal, SRMIST*

Course Code	18ASC201J	Course Name	APPLIED SOLID MECHANICS	Course Category	C	*Professional Core*	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*18ASC101T*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Aerospace Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Identify the stresses generated and structural changes in different bar materials subjected to different loads*
CLR-2 :	*Identify the variation of shear force, bending moments and bending stress in various beams subjected to different loads*
CLR-3 :	*Know the variation of curvature of beams subjected to loads based on which the slope, deflection calculations be made*
CLR-4 :	*Identify the advantages and disadvantages of using solid and hallow shafts, different springs for different loads*
CLR-5 :	*Know the buckling characteristics of column for various end conditions and stresses generated in thin and thick cylinders*
CLR-6 :	*Know the behavior of different structural materials for different types of loading*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO – 3
CLO-1 :	*Differentiate a ductile material and a brittle material after performing a tension test*	2	80	70	H	H	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	*Analyze the shear force and bending diagrams in cantilever and simply supported beams*	2	80	75	H	H	-	H	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	*Make calculations for the design of a beam based on the bending stress and desired deflection*	2	75	70	H	H	H	H	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	*Design the shaft for a particular torque transmission and springs for energy absorption*	2	80	75	H	H	H	H	-	-	-	-	-	-	-	-	-	-	-
CLO-5 :	*Find the planes of principal stresses in a stressed model and hoop stress, longitudinal stress in thin walled pressure vessel*	2	85	75	H	-	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-6 :	*Calculate the various stresses generated in a particular element subjected to different loading*	2	80	70	H	H	H	H	-	-	-	-	-	-	-	-	-	-	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Concept of stress and strain in a bar element*	*Hardness and Strength*	*Relation between deflection, slope, radius of curvature*	*Theory of pure torsion*	*Stresses on inclined planes*
	SLO-2	*Hooke's law, Poisson's ratio, Elastic young's modulus*	*Ductility and brittleness*	*Shear force and bending moment Derivation explanation for different loads*	*Explain shear stress variation in a circular (solid and hollow)*	*Derivation explanation*
S-2	SLO-1	*True and Engineering stress strain curve for ductile material in tension, compression*	*Difference between static loading and dynamic loading*	*Find slope and deflection in a cantilever beam by double integration method*	*Apply torsion equation based on allowable shear stress*	*Mohr's circle derivation*
	SLO-2	*True and Engineering stress strain curve for a brittle material in tension*	*Impact loading*	*Problem solving*	*Apply torsion equation based on allowable angle of twist*	*Plane stress case*
S-3	SLO-1	*Concept of shear stress, shear strain and Rigidity modulus*	*Statically Determinate structure, examples*	*Find slope and deflection in a simply supported beam by double integration*	*Compare solid and hollow shafts for transmission of same torque*	*Mohr's circle construction*
	SLO-2	*Principle of complementary shear*	*Statically Indeterminate structure, examples*	*Problem solving*	*Applications explanation*	*Procedure to different kinds of load*
S 4-5	SLO-1 SLO-2	*Lab1: Tension test*	*Lab-4: Brinell Hardness Test and Vickers hardness test*	*Lab-7: Deflection test in a cantilever beam with a point loads*	*Lab-10: Torsion test on a circular rod using digital torsion testing machine*	*Lab 13: Charpy Impact test and Izod impact test*
S-6	SLO-1	*Biaxial and triaxial state of stress and volumetric strain*	*Beam, types of beams, types of load*	*Find slope and deflection in a simply supported beam by Macaulay's method*	*Explain shear stress variation in closed coil helical sprigs*	*Concept of pure shear, relation between Young's, Shear and bulk modulus*
	SLO-2	*Problem solving*	*Procedure of solving a beam*	*Problem solving*	*Applications*	*Derivation explanation*
S-7	SLO-1	*Analysis of prismatic bar subjected to single load*	*Shear force and bending moment diagram and their sign convention*	*Moment Area Theorem-I*	*Explain shear stress variation in open coil helical springs*	*Numerical solving*
	SLO-2	*Analysis of prismatic bar subjected to varying loads*	*Shear force and bending moment diagram for a cantilever beam subjected to point load and UDL*	*Application to cantilever and simply supported beam*	*Numerical explanation*	*Numerical solving*
S-8	SLO-1	*Analysis of non-prismatic bar subjected to single load*	*Shear force and bending moment diagram for a simply supported beam subjected to point load*	*Moment Area Theorem-II*	*Stiffness of closed coil helical spring*	*Fatigue load-Explanation*

	SLO-2	*Analysis of non-prismatic bar subjected to varying loads*	*Shear force, bending moment diagram for a simply supported beam subjected to UDL*	*Application to cantilever and simply supported beams*	*Stiffness of open coil helical spring*	*S-N curve for various materials*
S 9-10	SLO-1 SLO-2	*Lab-2: Compression test*	*Lab-5: Repeat*	*Lab-8: Deflection test: Simply supported beam*	*Lab-11: Tension test on a closed coil helical spring*	*Lab-14: Determine endurance limit of the given material by performing a fatigue test.*
S-11	SLO-1	*Analysis of composite bars*	*Shear force and bending moment diagram for a overhanging beam*	*Principle of superposition*	*Shaft subjected to combined bending and torsion*	*Thin walled pressure vessel subjected to internal pressure*
	SLO-2	*Numerical solving*	*Point of contraflexure*	*Application*	*Derivation*	*Hoop stress explanation*
S-12	SLO-1	*Thermal stresses-Support Yield*	*Explanation of bending stress variation in a beam subjected to pure bending*	*Maxwell reciprocal theorem*	*Strain energy due bending*	*Thin walled cylindrical pressure vessel*
	SLO-2	*Numerical Solving*	*Application*	*Application*	*Derivation*	*Longitudinal stress explanation*
S-13	SLO-1	*Thermal stresses-composite bars*	*Explain shear stress variation in a beam of symmetrical and unsymmetrical cross sections subjected to bending*	*Explain shear force diagram of an aircraft wing*	*Strain energy due torsion*	*Thick cylinder*
	SLO-2	*Problem solving*	*Application*	*Explain bending moment diagram of an aircraft wing*	*Derivation*	*Lame's theory*
S 14-15	SLO-1 SLO-2	*Lab-3: Study of magnified images obtained using Inverted Metallurgical Microscope on a specimen.*	*Lab-6: Rockwell Hardness Test*	*Lab-9:Repeat*	*Lab-12: Compression test on an open coil helical spring*	*Lab-15 :Repeat*

Learning Resources	*1. Ferdinand P.Beer, Rusell Johnston, John T.Dewolf, Mechanics of Materials, SI Metric, 3rd ed., Tata McGraw-Hill Education, 2011* *2. Egor P. Popov., Engineering Mechanics of Solids, 2nd ed., Prentice Hall of India, 2009*	*3. James M. Gere, Mechanics of Materials, 8th ed.,Brooks/Cole, USA, 2013* *4. Shigley, J. E., Applied Mechanics of Materials, International Student Edition, McGraw Hill, 2000* *5. V. Feodosyev. Strength of Materials, MIR Publishers, Moscow 1968*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Raja S, CSIR-NAL, Bangalore, raja@nal.res.in	*1. Dr. K. M. Parammasivam, Madras Institute of Technology, Chennai, mparams@mitindia.edu*	*1. Mr. S. Chandra Sekhar, SRMIST*
2. Wg.Cdr K.Manoharan (Retd), Blue Dart Aviation Ltd., manoharank@bluedart.com	*2. Dr. A. P. Haran, Park College of Engineering & Technology, ap_haran@rediffmail.com*	*2. Mr. K B Ravichandra kumar, SRMIST*

Course Code	18ASC202J	Course Name	INCOMPRESSIBLE AERODYNAMICS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18ASC102J	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Aerospace Engineering	**Data Book / Codes/Standards**	Nil		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Identify and utilize the lift generating devices*
CLR-2 :	*Evaluate the forces and moments acting on aero foils and wings under ideal flow conditions.*
CLR-3 :	*Evaluate and optimize the aerofoil characteristics*
CLR-4 :	*Evaluate and optimize the wing characteristics.*
CLR-5 :	*Evaluate and optimize the propeller characteristics.*
CLR-6 :	*Evaluate and optimize the aerodynamic interaction effects between different components of aircraft*

		Learning			**Program Learning Outcomes (PLO)**														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	*Understand the lift generation and lift generating devices*	1	80	75	M	M	M	H	M	-	-	-	-	-	-	M	-	H	-
CLO-2 :	*Analyze the forces and moments acting on aero foils and wings under ideal flow conditions.*	2	80	75	H	H	H	H	H	-	-	-	-	-	-	H	-	H	-
CLO-3 :	*Analyze the aerofoil characteristics.*	3	70	60	H	H	H	H	H	-	-	-	-	-	-	H	-	H	-
CLO-4 :	*Analyze the wing characteristics.*	3	70	60	H	H	H	H	H	-	-	-	-	-	-	H	-	H	-
CLO-5 :	*Analyze the propeller characteristics.*	3	70	60	H	H	H	H	H	-	-	-	-	-	-	H	-	H	-
CLO-6 :	*Analyze the aerodynamic interaction effects between different components of aircraft*	2	70	65	H	H	H	H	H	-	-	-	-	-	-	H	-	H	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Introduction to aerodynamics*	*Center of pressure*	*High lift devices*	*torque grading and efficiency equation*	*Influence of taper and twist applied to wings*
	SLO-2	*Introduction to the mathematical model of flow*	*Aerodynamic center*	*Thin airfoil theory-Flapped airfoil - circulation equation*	*Combined blade element and momentum theories velocity comparison*	*effect of sweep back and delta wings*
S-2	SLO-1	*Airfoil geometry*	*Numerical problems on Center of pressure*	*Thin airfoil theory-Flapped airfoil - coefficient of lift and moment*	*Comparison of thrust and torque equation*	*Fundamentals of potential flows*
	SLO-2	*Airfoil nomenclature*	*Numerical problems on Aerodynamic center*	*Geometry of the propeller*	*Axial flow factor equation*	*Indirect and direct methods of mathematical model of flow*
S-3	SLO-1	*Wing geometry parameters*	*Numerical problems on Center of pressure and Aerodynamic center*	*Forces acting on Propeller*	*Angular flow factor equation*	*Basic equations of potential flow*
	SLO-2	*Application of wing geometry parameters*	*Experimental characteristics of airfoil*	*Types of Propeller*	*The Biot-savart law*	*Introduction to panel methods*
S 4-5	SLO-1, SLO-2	*Lab 1: Introduction to subsonic wind tunnel*	*Lab 4: Study of flow over streamlined body by laser beam assisted smoke visualization technique*	*Lab 7: Study of flow over a tapered finite wing with wingtip by laser beam assisted flow visualization technique*	*Lab 10: Pressure distribution and Estimation of forces acting over a rough cylinder*	*Lab 13: Estimation of forces acting over a streamlined body using force balance method*
S-6	SLO-1	*Vortex motions, vortex filament, vortex sheet*	*Thin airfoil theory assumptions and limitations.*	*Propeller arrangements*	*Application of Biot-savart law*	*Source panel method*
	SLO-2	*Vortex types, Starting vortex, trailing edge vortex*	*Fundamental equation of thin airfoil theory*	*Axial momentum theory assumptions and limitations.*	*Introduction of Prandtl's lifting line theory*	*Application of Source panel method*
S-7	SLO-1	*kutta's and kelvins theorem*	*Thin airfoil theory- symmetrical airfoil – circulation equation*	*Pressure and velocity distribution across the propeller control volume*	*Governing equations of Prandtl's lifting line theory*	*Vortex panel method*
	SLO-2	*Kutta – Joukowski theorem*	*Thin airfoil theory- symmetrical airfoil – coefficient of lift and moment*	*Propeller thrust equation*	*Applications of Prandtl's lifting line theory*	*Application of Vortex panel method*
S-8	SLO-1	*Lift generation*	*Thin airfoil theory- symmetrical airfoil – location of forces*	*Propeller power equation*	*Prandtl theory- Elliptical lift Distribution – circulation equation*	*Wing- fuselage interference*

	SLO-2	*bound and horseshoe vortex*	*Numerical problems on thin airfoil theory*	*efficiency equation and comparison*	*Prandtl theory- Elliptical lift Distribution – downwash and induced angle*	*Wing-engine interference*
S 9-10	SLO-1 SLO-2	*Lab 2: Wind tunnel measurement techniques*	*Lab 5: Study of Magnus effect using rotating cylinder by laser beam assisted smoke visualization technique.*	*Lab 8: Calibration of subsonic wind tunnel*	*Lab 11: Pressure distribution and Estimation of forces acting over a sphere model*	*Lab 14: Estimation of pressure distribution acting over a symmetrical / unsymmetrical airfoil for different angle of attack*
S-11	SLO-1	*Aerodynamic forces*	*Thin airfoil theory- unsymmetrical airfoil- circulation equation*	*Numerical problems on Axial momentum theory*	*Prandtl theory- Elliptical lift Distribution- coefficient of lift and induced drag*	*Wing-landing gear interference*
	SLO-2	*Aerodynamic moments*	*Thin airfoil theory- unsymmetrical airfoil – verification of circulation equation*	*Numerical problems on Axial momentum theory*	*Fundamentals of Prandtl theory- General lift Distribution*	*Wing – propeller interference*
S-12	SLO-1	*Types of drag*	*Thin airfoil theory- unsymmetrical airfoil – coefficient of lift*	*Numerical problems on Axial momentum theory*	*Prandtl theory- General lift Distribution- circulation equation*	*Wing –tail interference*
	SLO-2	*Numerical problems on Aerodynamic forces*	*Thin airfoil theory- unsymmetrical airfoil – coefficient of moment and location of forces*	*fundamentals of blade-element theory*	*Prandtl theory- General lift Distribution- coefficient of lift and induced drag*	*interference flow over an airplane as a whole*
S-13	SLO-1	*Numerical problems on Aerodynamic forces and moments*	*Numerical problems on thin airfoil theory*	*Basic equation of thrust and torque grading*	*Lift slope relation*	*Passive Laminar flow control methods*
	SLO-2	*Numerical problems on Aerodynamic forces and moments*	*Numerical problems on thin airfoil theory*	*thrust grading equation*	*Numerical problems on Lift slope relation*	*Active Laminar flow control methods*
S 14-15	SLO-1 SLO-2	*Lab 3: Study of flow over bluff body by laser beam assisted smoke visualization technique*	*Lab 6: Study of flow over a tapered finite wing without wingtip by laser beam assisted flow visualization technique*	*Lab 9: Pressure distribution and Estimation of forces acting over a smooth cylinder*	*Lab 12: Estimation of forces acting over a bluff body using force balance method*	*Lab 15: Estimation of forces acting over a symmetrical / unsymmetrical airfoil for different angle of attack*

Learning Resources	*1. Houghton, E, L., Carruthers, N, B., Aerodynamics for Engineering Students, 6th ed., Edward Arnold Publishers Ltd., London, 2012* *2. Anderson, J,D., Fundamentals of Aerodynamics,6th ed., McGraw Hill, 2016*	*3. Clancy, L, J., Aerodynamics, Pitman, 1986* *4. Milne, L.H., Thomson, Theoretical Aerodynamics, Dover, 1985*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Raja S, CSIR-NAL, Bangalore, raja@nal.res.in	*1. Dr. K. M. Parammasivam, Madras Institute of Technology, Chennai, mparams@mitindia.edu*	*1. Mr. R. Mohamed Arif, SRMIST*
2. Wg.Cdr K.Manoharan (Retd), Blue Dart Aviation Ltd., manoharank@bluedart.com	*2. Dr. P. K Dash, Nitte Meenakshi Institute of Technology, Bangalore, drpdash@gmail.com*	*2. Mr. K B Ravichandra kumar, SRMIST*

Course Code	18ASC203T	Course Name	AIR BREATHING PROPULSION	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Aerospace Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Identify the working principles of gas turbine propulsion systems
CLR-2 :	Design of inlets, combustion chambers, nozzles used in Air breathing engines
CLR-3 :	Design of compressors in gas turbine propulsion systems
CLR-4 :	Design of turbines in gas turbine propulsion systems
CLR-5 :	Understand the principle of operation of Pulse jet, RAMJET and SCRAMJET engines
CLR-6 :	Understand the working principles of gas turbine propulsion systems

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1 Level of Thinking (Bloom)	2 Expected Proficiency (%)	3 Expected Attainment (%)	PLO 1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	13 PSO - 1	14 PSO - 2	15 PSO – 3
CLO-1 :	Analyze the performance and component efficiencies of gas turbine propulsion systems	2	80	70	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Analyze inlets, combustion chambers, nozzles used in Air breathing engines	2	85	75	H	H	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	Analyze the compressors in gas turbine propulsion systems	2	75	70	H	-	-	H	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	Analyze the turbines in gas turbine propulsion systems	2	85	80	H	H	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-5 :	Analyze the performance of Pulse Jet, RAMJET and SCRAMJET engines	2	85	75	H	-	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-6 :	Analyze the performance and component efficiencies of gas turbine propulsion systems	2	80	70	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Introduction to Air breathing engines	Inlets	Compressor	Turbine	Pulse Jet Engine-Operating Principle
	SLO-2	Ideal and actual Brayton cycle	Classification of Inlets	Classification of compressors	Classification of turbines	RAMJET Engine
S-2	SLO-1	Turbojet Engine	Subsonic Inlets	Axial flow compressor	Axial flow turbine stage	Working of RAMJET
	SLO-2	Numerical Problems on turbojet engine	Supersonic Inlets	Work and compression ratio	Velocity triangles and Power output	Working of RAMJET
S-3	SLO-1	High bypass turbofan Engine	Modes of Inlet operation	Degree of reaction	Blade Element theory	RAMJET with afterburner
	SLO-2	Low bypass turbofan engine	Starting problems and Shock swallowing methods	Characteristic performance of a single stage axial compressor	Blade Element theory	RAMJET with afterburner
S-4	SLO-1	Numerical Problems on turbofan engine	Numerical Problems on Inlets	Characteristic performance of a multistage axial compressor	Free vortex theory	RAMJET performance
	SLO-2	Numerical Problems on turbofan engine	Numerical Problems on Inlets	Cascading of axial compressor- Compressor efficiency	Free vortex theory	RAMJET performance
S-5	SLO-1	Turboshaft engine	Gas turbine combustion chamber	Numerical Problems on Single stage Axial flow compressor	Limiting Factors of gas turbine design	Numerical Problems on RAMJET
	SLO-2	Turboprop engine	Types of combustion chamber	Numerical Problems on Single stage Axial flow compressor	Limiting Factors of gas turbine design	Numerical Problems on RAMJET
S-6	SLO-1	Numerical Problems on turboprop engine	Fuel injector- Flame Tube cooling	Numerical Problems on multi stage Axial flow compressor	Turbine performance	SCRAMJET Engine
	SLO-2	Numerical Problems on turboprop engine	Flame Stabilization-Flame holders	Numerical Problems on multi stage Axial flow compressor	Turbine blade cooling	Working principle of SCRAMJET Engine
S-7	SLO-1	Typical engine performance	Nozzle	Centrifugal compressor	Turbine blade cooling methods	Problems faced in supersonic combustion

	SLO-2	*Typical engine performance*	*Classification of nozzles*	*Working Principle of a centrifugal compressor*	*Turbine and compressor matching*	*Problems faced in supersonic combustion*
S-8	SLO-1	*Methods of thrust augmentation*	*Numerical Problems on Nozzles.*	*Work and compression ratio*	*Numerical Problems on Axial flow turbine*	*Numerical Problems on SCRAMJET*
	SLO-2	*Methods of thrust augmentation*	*Numerical Problems on Nozzles.*	*Work and compression ratio*	*Numerical Problems on Axial flow turbine*	*Numerical Problems on SCRAMJET*
S-9	SLO-1	*Introduction to Air breathing engines*	*Inlets*	*Compressor*	*Turbine*	*Pulse Jet Engine-Operating Principle*
	SLO-2	*Ideal and actual Brayton cycle*	*Classification of Inlets*	*Classification of compressors*	*Classification of turbines*	*RAMJET Engine*

Learning Resources	1. *Hill, P. G., Peterson, C. R., Mechanics and Thermodynamics of Propulsion, 2nd ed., Addison-Wesley Publishing Company,1992.* 2. *Cohen. H. Rogers. G.F.C., Saravanamuttoo. H.I.H., Gas turbine theory. 4th ed., Pearson education* 3. *V.Ganesan., Gas Turbines, 3rd ed., Tata McGraw-Hill Education, 2010*	4. *Rolls-Royce , Jet Engine Manual, 3rd edition, 1983* 5. *Oats, G.C., Aerothermodynamics of Aircraft Engine Components, AIAA Education Series,1985* 6. *Mattingly, J.D., Heiser, W.H., Pratt,D.T., Aircraft Engine Design, AIAA Education Series, 2002*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Raja S, CSIR-NAL, Bangalore, raja@nal.res.in	*1. Dr. P. K Dash, Nitte Meenakshi Institute of Technology, Bangalore, drpdash@gmail.com*	*1. Mr. G. Saravanan, SRMIST*
2. Wg.Cdr K.Manoharan (Retd), Blue Dart Aviation Ltd., manoharank@bluedart.com	*2. Dr. K. M. Parammasivam, Madras Institute of Technology, Chennai, mparams@mitindia.edu*	*2. Mr. G. Mahendra Perumal, SRMIST*

ACADEMIC CURRICULA

Professional Core Courses

AUTOMOBILE ENGINEERING

Regulations - 2018

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Kancheepuram, Tamil Nadu, India

Course Code	18AUC201J	Course Name	MANUFACTURING TECHNOLOGY FOR AUTOMOTIVE ENGINEERS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Automobile Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Utilize knowledge of various manufacturing processes and machine tools and also familiarize the process parameters
CLR-2 :	Utilize the work and tool holding devices
CLR-3 :	Identify the various surface finishing process and coating techniques
CLR-4 :	Produce Prismatic Components and Gears
CLR-5 :	Compare various surface finishing operations
CLR-6 :	Utilize different welding, casting processes, shaping, forming, machining and surface finishing processes

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	Program Learning Outcomes (PLO) 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO - 3
CLO-1 :	Apply different welding and casting process.	2	85	75	H	M	H	L	H	M	M	H	H	M	L	H	H	H	H
CLO-2 :	Compare various shaping and forming process	2	80	75	H	M	H	H	H	M	M	H	H	M	L	M	H	H	H
CLO-3 :	Solve problems on cutting forces, tool life and analytical methods of estimating cutting temperature	2	90	85	H	H	H	H	L	M	M	H	M	M	M	H	H	H	M
CLO-4 :	Produce Prismatic Components and Gears	2	85	80	H	M	H	H	H	H	H	H	H	H	M	H	H	H	H
CLO-5 :	Compare various surface finishing operations	2	80	75	H	M	M	M	H	H	H	H	H	H	M	H	H	H	H
CLO-6 :	Apply different welding, casting processes, shaping, forming, machining and surface finishing processes	2	85	75	H	M	H	L	H	M	M	H	H	M	L	H	H	H	H

		Welding and Casting	Shaping and Forming	Machining of Axi-Symmetrical Components	Machining of Prismatic Components and Gear Manufacturing	Surface Finishing and Treatments
Duration (hour)		15	15	15	15	15
S-1	SLO-1	Introduction to welding, Basics, Classifications	Forging - Introduction	Introduction - Machining	Introduction – Milling machine & types	Introduction – Finishing operations
	SLO-2	Material properties, material selection and Manufacturing process	Forging Processes and Defects	Theory of Metal Cutting	Milling cutters and work holding device	Grinding machine – Surface, Cylindrical – External, Internal, Centreless
S-2	SLO-1	Arc Welding – working principle and types	Rolling – Blooms, Billets, slabs	Mechanics of chip formation and types of chips	Milling operation and indexing	Grinding wheel types and specifications
	SLO-2	Working principles of MIG welding	Rolling – Billets, slabs	Calculation of cutting force and temperature in cutting.	Operating parameters- cutting speed, feed rate, depth of cut.	Grinding Operating parameters – surface finish, accuracy attainable by various process
S-3	SLO-1	Working principles of TIG welding	Forces and Geometrical relationship in rolling	Cutting tool materials – Tool life calculation,	Material Removal rate, Accuracy, Surface roughness	Lapping – process - application
	SLO-2	Friction and Friction Stir Welding	Types of Rolling Mills	Cutting tool materials - Tool Wear	Drilling Machine – Types, Process Capabilities	Honing – process - applications
S 4-5	SLO-1 SLO-2	Lab 1: Facing, Turning and Step turning	Lab 3: External thread cutting	Lab 5: V block shaping	Lab 7: Milling – Spur Gear	Lab 9: Cylindrical Grinding
S-6	SLO-1	Welding defects	Rolling Defects	Tool signature for single point cutting tool	Drill types and reaming operations	Buffing – process - applications
	SLO-2	Casting introduction, Pattern Materials, Types, allowance	Extrusion process – types	Tool signature for multi-point cutting tool.	Broaching- Principle, Tool Nomenclature	Deburring – Shot blasting
S-7	SLO-1	Expandable mold- sand,	Extrusion process – defects	Lathe machine – Bench Lathe	Types of Broaching machine	Deburring –Abrasive flow machining
	SLO-2	Expandable mold- shell	Wire and tube drawing – types and its defects	Lathe machine – Capstan and turrent	Gear Forming process-Extrusion, Stamping	Shot peening process and its application

S-8	SLO-1	*Expandable mold-Investment*	*Drawing force Calculation*	*Lathe machine – Special types of lathe*	*Gear Manufacturing Process - Powder Metallurgy*	*Super finishing process- cylindrical micro honing*
	SLO-2	*Permanent mold – Pressure die casting, Centrifugal casting*	*Sheet metal operations – shearing, slitting,*	*Specification and chip collection system*	*Gear Hobbing - Axial*	*Super finishing process- centreless micro honing*
S 9-10	SLO-1 SLO-2	*Lab 2: Taper Turning*	*Lab 4: Radial Drilling*	*Lab 6: Gear Hobbing – Helical Gear*	*Lab 8: Surface Grinding*	*Lab 10: Slotting - keyway*
S-11	SLO-1	*Design of runner, riser,*	*Sheet metal operations - fine blanking, perforating*	*Cutting fluids and machinability*	*Gear Hobbing - Tangential*	*Polishing: Chemical Mechanical polishing*
	SLO-2	*Design of gating and sprue*	*Bending – types and defects*	*Work and tool holding devices*	*Gear Hobbing - Radial*	*Electro-chemical polishing*
S-12	SLO-1	*Solidifcation time, Shrinkage allowances*	*Bending Load calculations*	*Surface machining – external*	*Gear Hobbing – Application and its limitations*	*Protective and Decorative coatings – Material selection*
	SLO-2	*Casting Defects*	*Stretch forming, Deep drawing.*	*Surface machining – internal*	*Gear Shaping -Types and working principle*	*Protective and Decorative coatings – Process*
S-13	SLO-1	*Application of Casting in Automotive Industries.*	*Ironing, seaming process*	*Design consideration in turning operation*	*Gear Shaping-Advantages and Demerits*	*Protective and Decorative coatings – Coating techniques*
	SLO-2	*Application of Welding in Automotive Industries.*	*Hydroforming.*	*Material Removal rate and cutting forces*	*Tooling and selection of cutting parameters for gears.*	*Protective and Decorative coatings – Applications*
S 14-15	SLO-1 SLO-2	*Lab: Assessment 1*	*Lab: Assessment 2*	*Lab: Assessment 3*	*Lab: Repeat class*	*Lab: Mini Project*

Learning Resources	*1. Seropkalpakjian, Steven Schmid, Manufacturing Engineering and Technology, 7th ed., Pearson Education, 2013* *2. Mikel P Groover, Fundamentals of Modern Manufacturing, 4th ed., John Wiley and Sons, 2009*	*3. P N Rao, Manufacturing Technology – Machining and Machine tools, Vol. 2, 3rd ed., Tata Mc Graw Hill, 2017* *4. P N Rao, Manufacturing Technology – Foundry forming and Welding, Vol. 1, 4th ed., Tata Mc Graw Hill, 2013* *5. Sharma P C, A Text Book of Production Technology - Manufacturing Processes, S Chand & Company, New Delhi*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Silambarasan Ramadoss, Renault Nissan, silambarasan.ramadoss@rntbci.com	*1. Dr. A. Siddharthan, MIT Chrompet, sidharth@mitindia.edu*	*1. Dr. J. Chandradass, SRMIST*
2. Mr. N. Vijayakumar, Mahindra and Mahindra, vijayakumar.n@mahindra.com	*2. Dr. S. Renold Elson, VIT Vellore, renoldelsen.s@vit.ac.in*	*2. Mr. S. Palanisamy, SRMIST*

Course Code	18AUC204L	Course Name	AUTOMOTIVE COMPONENTS AND ASSEMBLY DRAWING	Course Category	C	Professional Core	L	T	P	C
							0	0	4	2

Pre-requisite Courses	18MES101L	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Automobile Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Recognize simple projection and argumentation development of surface.
CLR-2 :	Recognize the conventional representation of the standard automotive parts and make use of it in drawing the component
CLR-3 :	Make use of appropriate standards in drawing the component
CLR-4 :	Comprehend and apply the geometric dimensioning & tolerancing
CLR-5 :	Analyze the functional requirement of Automotive parts and components
CLR-6 :	Synthesis the Automotive components from the given part diagram

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO – 3
CLO-1 :	Draw orthographic projection for simple 3D part diagrams	1	90	85	H	M	M	M	M	L	L	L	M	M	L	M	H	M	M
CLO-2 :	Represent the standard Automotive parts in conventional symbols and representations	1	90	85	M	H	L	M	M	L	L	L	M	L	L	H	H	M	H
CLO-3 :	List drawing standards	2	90	85	H	M	M	M	M	L	L	L	M	M	L	M	M	M	H
CLO-4 :	Apply the principle of geometric dimensioning & tolerancing in assembly drawing	3	85	80	M	M	L	H	M	L	L	L	M	M	L	H	M	M	H
CLO-5 :	Describe and draw the part drawings of Automotive component	3	85	80	M	M	L	H	M	L	M	L	M	M	L	M	H	L	M
CLO-6 :	Assemble and draw the part drawings into a finished Automotive component	3	85	80	M	M	H	M	H	L	M	L	M	M	L	M	H	L	H

Duration (hour)		12	12	12	12	12
S 1-4	SLO-1	Topic 1: Orthographic Projection, Development of surface & Section of solids	Topic 3: Abbreviations and symbols used in technical drawings. Symbols and method of indication on the drawing for surface finish, welding and riveted joints.	Topic 5: System of Fits -Hole Basis Systems (Quantitative approach for three types of fit)	Topic 7: Geometric tolerances – Form and positional. Datum and datum features symbols used to represent geometric tolerances. (Qualitative approach)	Topic 9: Jigs types-plate, latch, channel, box, post, pot jigs, automatic drill jigs.
	SLO-2	Drawing 1: ORTHOGRAPHIC PROJECTIONS	Drawing 3: ASSEMBLY OF SLEEVE & COTTER JOINT; FLANGE COUPLING	Drawing 5: ASSEMBLY OF SINGLE PLATE CLUTCH	Drawing 7: ASSEMBLY OF FUEL PUMP	Drawing 9: MAKE THE PART DIAGRAM OF PISTON CONNECTING ROD
S 5-8	SLO-1	Topic 2: BIS Code of Practice for Engineering Drawing: general principles of presentation, conventional representation of dimensioning (7 Types) and sectioning, threaded parts, gears, springs and common features.	Topic 4: Tolerance types and representation on the drawing – Fits types and selection for different applications, Limit System	Topic 6: System of Fits - Shaft Basis Systems (Quantitative approach for three types of fit).	Topic 8: Allowances for ferrous, non-ferrous & Non-metal- plastics/elastomers. Types- Casting & Machining allowances.	Topic 10: Fixture components- clamps, fixture base & set blocks, Types of fixtures-indexing milling fixture, turning fixture, welding fixture.
	SLO-2	Drawing 2: CONENTIONAL REPRESENTATION OF ENGG. PARTS AND DIMENSIONING.	Drawing 4: ASSEMBLY OF PLUMMER BLOCK	Drawing 6: ASSEMBLY OF FUEL INJECTOR	Drawing 8: MAKE THE PART DIAGRAM OF SPARK PLUG.	Drawing 10: MAKE THE PRODUCTION DRAWING OF A SIMPLE JIG & HELICAL GEAR
S 9-12	SLO-1 SLO-2	Lab: Assessment 1	Lab: Assessment 2	Lab: Assessment 3	Lab: Assessment 4	Lab: University Examination

Learning Resources		
	1. Narayana.K.L, Kanniah.P, Venkata Reddy.K, Machine Drawing, 5th ed., New Age International, 2016 2. Gopalakrishnan.K.R, Machine Drawing, 20th ed., Subash Publishers, 2007 3. Sidheswar N, Kannaiah.P, Sastry.V.V. S, Machine Drawing, Tata McGraw Hill, 2014	4. Bhatt N. D, Machine Drawing, 50th ed., Charotar publishing house pvt ltd, Anand, 2014 5. Junnarkar N. D, Machine Drawing, 2nd ed.,Pearson Education (Singapore) Pvt. Ltd., 2009

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	-	*40%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*
Level 2	Apply Analyze	-	*40%*	-	*40%*	-	*40%*	-	*40%*	-	*40%*
Level 3	Evaluate Create	-	*20%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. N. Varatharaj, Comstar Automotive Technologies Pvt, Ltd, nvaratha@comstarauto.com	*1. Dr. P. Ramkumar, IIT Madras, ramkumar@iitm.ac.in*	*1. Dr. Rajendran R, SRMIST*
2. Mr. D. Srinivasan, Ford India LTD., dsriniv9@ford.com	*2. Dr. M. Murugan, VIT Vellore, hod.me@vit.ac.in*	*2. Mr. Jerome Stanley M, SRMIST*

Course Code	18AUC203T	Course Name	APPLIED THERMAL ENGINEERING FOR AUTOMOTIVE ENGINEERS	Course Category	C	Professional Core	L	T	P	C
							3	1	0	4

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Automobile Engineering*	**Data Book / Codes/Standards**	*Steam Table and Mollier chart*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Utilize the various gas power cycles*
CLR-2 :	*Utilize knowledge in engine testing*
CLR-3 :	*Utilize various heat transfer concepts*
CLR-4 :	*Enlighten the knowledge in air compressors and refrigeration systems*
CLR-5 :	*Construct knowledge on air conditioning systems*
CLR-6 :	*Utilize knowledge on engines, heat transfer systems and air conditioning systems*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO – 3
CLO-1 :	*To learn the basic assumptions, significance and efficiency of various air standard cycles*	2	80	75	H	H	M	M	L	L	M	L	M	L	L	L	H	H	M
CLO-2 :	*Acquire understanding and numerically applying the methods to determine engine performance parameters*	3	80	75	H	H	M	M	M	L	M	L	M	L	L	M	H	H	M
CLO-3 :	*Understand and apply basic heat transfer concepts in real world applications*	3	80	75	H	H	M	M	M	L	M	L	M	L	L	M	H	H	H
CLO-4 :	*Apply the knowledge in calculating the performance of air compressors and refrigerators*	3	80	75	H	H	M	M	M	L	H	H	M	L	L	M	H	H	H
CLO-5 :	*Calculate performance of air conditioning system using Psychrometric chart and applications in automotive climate control*	3	80	75	H	H	M	M	M	L	M	M	M	L	L	M	H	H	H
CLO-6 :	*Identify knowledge on engines, heat transfer systems and air conditioning systems*	3	80	75	H	H	M	M	L	L	M	L	M	L	L	L	H	H	M

		Air Standard cycle	Engine Performance Characteristics and Testing	Fundamentals of Heat Transfer Conduction	Air compressor and Refrigeration	Air Conditioning Processes and Application
Duration (hour)		12	12	12	12	12
S-1	SLO-1	*Introduction, Air standard cycles – Different air standard cycles*	*Introduction to performance parameters, Brake power, Frictional power*	*One-dimensional Heat Conduction Plane wall*	*Introduction of Air Compressor and its types*	*Properties of atmospheric air, Psychrometric chart, dry bulb temperature and wet bulb temperature*
	SLO-2	*Otto cycle significance, PV and TS diagram -processes*	*Indicated Power, Torque, Maximum brake torque*	*One-dimensional Heat Conduction Plane wall*	*Construction and Working of Single acting and double acting air compressors*	*Psychrometric Processes- Sensible heating and cooling*
S-2	SLO-1	*Otto Cycle- Brake thermal efficiency derivation*	*Fuel consumption Vs brake power, Specific fuel consumption*	*One-dimensional Heat Conduction Cylinder*	*Basics of Intercooler, Construction, Working - Multi stage Air Compressor*	*Psychrometric Processes - Humidification, Dehumidification,*
	SLO-2	*Compression ratio its effect on Brake thermal efficiency*	*Specific Energy consumption – definition, significance considering calorific values of different conventional fuels*	*One-dimensional Heat Conduction Cylinder*	*Compressor - work required –Isentropic, adiabatic and polytropic*	*Cooling and dehumidification Heating and Humidification*
S-3	SLO-1	*Otto Cycle- Mean Effective Pressure Mean Effective Pressure and work done*	*Volumetric efficiency, Ambient temperature, Mechanical efficiency*	*One-dimensional Heat Conduction Composite walls*	*Compressor - work required –Isentropic, adiabatic and polytropic*	*Bypass factor for heating and cooling coils*
	SLO-2	*Derivation for Mean effective pressure*	*Thermal efficiency – definition, heat input work done -significance*	*One-dimensional Heat Conduction Composite walls- Numericals*	*Work done without clearance volume*	*Bypass factor for heating and cooling coils*
S-4	SLO-1 SLO-2	*Tutorial 1: Otto Cycle -Determine brake thermal efficiency, compression ratio, mean effective pressure*	*Tutorial 4: Brake power, frictional power, Indicated Power, specific fuel consumption*	*Tutorial 7: Plane walls, Cylinder and composite walls numericals*	*Tutorial 10: Work done with and without clearance - Problems*	*Tutorial 13: Psychrometric Processes*
S-5	SLO-1	*Diesel cycle Introduction to diesel cycle – significance*	*Engine specific weight, and heat balance Definition and significance*	*Heat transfer through extended surfaces (simple fins)*	*Free air delivery (FAD)*	*Summer Air conditioning system – construction and working*
	SLO-2	*PV and PV and TS diagram - processes*	*Heat balance – computation procedure, Shankey diagram*	*Critical thickness of insulation- Definition and significance*	*Rotary air compressors, -types and working*	*Summer Air conditioning system – construction and working*
S-6	SLO-1	*Diesel Cycle- Derive Brake thermal efficiency*	*Measurement of friction power - Different Methods*	*Convection: Types, Rate equation, Heat transfer coefficient*	*Fundamentals of refrigeration, COP,*	*Winter Air conditioning system – Construction and working*

	SLO-2	Compression ratio, cut off ratio - its effect on Brake thermal efficiency	Measurement of friction power - Different Methods	Classes of convective flows, Introduction to dimensionless groups	Reversed Carnot cycle – PV, TS	Air conditioning - year-round air conditioning system
S-7	SLO-1	Diesel Cycle- Mean Effective Pressure, Mean Effective Pressure and work done	Measurement of different engine Performance Parameters	Introduction to hydrodynamic boundary layer	Simple vapour compression refrigeration system	Cooling load calculations
	SLO-2	Derivation for Mean effective pressure	Measurement of different engine Performance Parameters	Introduction to thermal boundary	PV-TS diagram analysis and COP	Cooling load calculations
S-8	SLO-1	Tutorial 2: Diesel cycle - Determine brake thermal efficiency, compression ratio, mean effective pressure	Tutorial 5: Brake thermal efficiency, volumetric efficiency, mechanical efficiency	Tutorial 8: Simple numerical's on heat transfer coefficient and heat transfer rate	Tutorial 11: Volumetric efficiency – Problems, FAD- Air compressor	Tutorial 14: Summer Air conditioning - Numericals
	SLO-2					
S-9	SLO-1	Dual cycle: Introduction to Dual cycle – significance	Fuel consumption, Air induction	Heat transfer in internal and external flow- Basics and examples	Simple vapour absorption refrigeration system –construction and working	Application of Air conditioning systems in automobiles
	SLO-2	PV and TS diagram -processes	Ambient temperature, exhaust temperature	Heat Exchangers: Types of heat Exchangers	Source of heat input, Determination of COP	Study of Automotive air conditioning systems
S-10	SLO-1	Dual Cycle- Brake thermal efficiency derivation	Introduction to manifold pressure and in-cylinder pressure measurement	LMTD method and NTU - concept	Desirable properties of an ideal refrigerants	Automotive climate control – climate governing factors
	SLO-2	Compression ratio, cut off ratio - its effect on Brake thermal efficiency	Case study: Engine testing facility requirements	Heat Exchangers: Effectiveness - Overall Heat Transfer Coefficient	Different Types of Refrigerants	Climatic control and its governing factors.
S-11	SLO-1	Dual Cycle - Mean Effective Pressure, Mean Effective Pressure and work done	Case study on Engine testing facility requirements	Fouling Factor, A real time case study on radiator	Methods to improve efficiency of vapour compression refrigeration. Eg: Avoiding two phase entry into compressor	Considerations for energy efficient heat exchange
	SLO-2	Derivation for Mean effective pressure	Case study: Real-time Engine parameters measurement, Eg: Ambient air conditioning fuel temperature compensation etc.	A real-time case study on radiator	Methods to improve efficiency of vapour absorption refrigeration or problems to be avoided	Considerations for energy efficient heat exchange
S-12	SLO-1	Tutorial 3: Dual cycle - Determine brake thermal efficiency, compression ratio, mean effective pressure	Tutorial 6: Numerical related to heat balance	Tutorial 9: Heat Exchangers: LMTD and NTU- Numericals	Tutorial 12: Vapour compression refrigeration Cycles – COP - Problems	Tutorial 15: Summer Air conditioning - Numericals
	SLO-2					

Learning Resources	1. R. Rudramoorthy, Thermal Engineering, 4th ed., Tata McGraw-Hill, 2007 2. Michael A. Boles, Yungus A. Cengel Thermodynamics: An Engineering Approach, 2nd ed., Tata McGraw-Hill, 2011 3. Yunus A Cengel, Afshin J. Ghajar, Heat and Mass Transfer: Fundamentals and Applications, 5th ed., Tata McGraw-Hill, 2015 4. C.P. Kothandaraman, Fundamentals of Heat And Mass Transfer, 4th ed., New Age International Publishers, 2012	5. R. K. Rajput, Thermal Engineering, 10th ed., Laxmi Publications(P)Ltd., 2015 6. https://www.edn.com/Pdf/ViewPdf?contentItemId=4403883 7. http://www.gbv.de/dms/ilmenau/toc/54857491X.PDF 8. https://www.airah.org.au/Content_Files/HVACRNation/2017/05-17-HVAC-001.pdf

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
Level 2	Apply Analyze	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
Level 3	Evaluate Create	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Gunabalan, Manager, R&D Turbo Energy, Chennai,	1. Dr. Chandramohan, NIT Warangal,	1. Mr. C. Prabhu, SRMIST
2. Mr. Shantha Kumar, Lead Engineer, Royal Enfield,	2. Dr. Ganesh, Anna University, Chennai	2. Dr. S. Thiyagarajan, SRMIST

ACADEMIC CURRICULA

Professional Core Courses

BIOTECHNOLOGY

Regulations - 2018

SRM
INSTITUTE OF SCIENCE & TECHNOLOGY
(Deemed to be University u/s 3 of UGC Act, 1956)

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Kancheepuram, Tamil Nadu, India

Course Code	18BTC101J	Course Name	BIOCHEMISTRY	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Interpret the various aspects of biological macromolecules
CLR-2 :	Interrelate between metabolism of biomolecules and the enzymes involved
CLR-3 :	Comprehend principles behind estimation and analysis of biomolecules in the body fluids
CLR-4 :	Evaluate the role of biochemistry in various biological processes and the role of biochemistryin making them economical
CLR-5 :	Assess the metabolic diseases and disorders related to biomolecules
CLR-6 :	Evaluate the basics of practical biochemistry and have an understanding on biomolecules

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO – 3
CLO-1 :	Discuss in details the structures and reactions of biomolecules (proteins, lipids, nucleic acids, and carbohydrates)	1	80	70	L	-	-	H	H	-	-	-	H	H	-	H	H	H	H
CLO-2 :	Describethe synthesis of biomolecules and their role in metabolic pathways along with their regulation	1	80	70	-	L	-	H	H	-	-	-	H	H	-	H	H	H	H
CLO-3 :	Demonstrate an understanding of the metabolic pathways - the energy-yielding andenergy-requiring reactions in life	2	80	70	-	H	-	H	H	-	-	-	H	H	-	H	H	H	H
CLO-4 :	Describe how these biochemical processes are not isolated but tightly integrated, with specific control sites and key junctions	2	80	70	-	L	-	H	H	-	-	-	H	H	-	H	H	H	H
CLO-5 :	Demonstratethe role of biomolecules in metabolic diseases and disorders	2	80	70	-	H	-	H	H	-	-	-	H	H	-	H	H	H	H
CLO-6 :	Explain the importance of laboratory safety and standard operating procedures of lab equipment	1	80	70	-	H	-	H	H	-	-	-	H	H	-	H	H	H	H

Duration (hour)		15	15	15	15	15
S-1	SLO-1	History of Biochemistry, Chemical bonds	Introduction to metabolism	Introduction to amino acid metabolism	Introduction of Fatty acids metabolism	Metabolic relationships among the major human organs
	SLO-2	pH and Buffers	Carbohydrate metabolism	Transamination	Hormones role in the release of fatty Acids from adipose tissue	Introduction –Bioenergetics
S-2	SLO-1	Introduction and classification of carbohydrates	Glycolysis - Introduction	Deamination	Fatty acid oxidation - Introduction	High energy compounds
	SLO-2	Monosaccharaides – structure and function	Role of enzymes in glycolysis	Metabolism of ammonia	Oxidation	ATP synthesis
S-3	SLO-1	Disaccharides– structure and function	Pyruvate metabolism	Urea cycle	Energetics of fatty acid oxidation	Electron transport chain (ETC)
	SLO-2	Polysaccharides – structure and function	Regulation of glycolysis	Importance of urea cycle	Ketone bodies	Biological oxidation
S 4-5	SLO-1 SLO-2	Lab 1 - Introduction to commonly used instruments and laboratory safety	Lab 4 - Qualitative analysis of Disaccharides in food samples	Lab 7 - Estimate blood glucose, compare normal and diabetes mellitus samples	Lab 10: Repeat/Revision of experiments	Lab 13 - Quantitative analysis of proteins (Lowry's method)
S-6	SLO-1	Introduction and classification of amino acids	Citric acid cycle - Introduction	Biosynthesis of amino acids	Ketogenesis	Electron Carriers
	SLO-2	Introduction and classification of proteins	Regulation of Citric acid cycle	Tyrosine synthesis	Biosynthesis of fatty acids	Overview of pathway in the mitochondrial ETC
S-7	SLO-1	Primary Structure of proteins	Gluconeogenesis and energetics	Phenylalanine synthesis	Regulation of fatty acid synthesis	Various complexes in the mitochondrial ETC
	SLO-2	Secondary, Tertiary and Quaternary structure of proteins	Cori and Glucose-alanine cycle	Tryptophan synthesis	Eicosanoids and cholesterol biosynthesis	Chemiosmotic theory
S-8	SLO-1	Functions and biotechnological applications of proteins	Glycogen metabolism	Molecules derived from amino acids	Lipoproteins	Oxidative Phosphorylation
	SLO-2	Biological important peptides Enzymes – structure and function	Hormones regulate muscle use of glycogen	Neurotransmitters	Disorders of Lipid metabolism	Inhibitors of oxidative phosphorylation

S 9-10	SLO-1 SLO-2	*Lab 2 - Preparation and measurement of pH of standard buffers*	*Lab 5 - Qualitative analysis of Polysaccharides in food samples*	*Lab 8 - Acid hydrolysis and action of salivary amylase on starch*	*Lab 11 - Separation of amino acids on Thin Layer Chromatography*	*Lab 14 - Quantitative estimation of serum cholesterol*
S-11	SLO-1	*Enzyme kinetics*	*Various bioproducts produced from carbohydrate metabolism*	*Biosynthesis of lignin, tannin, and auxin*	*Biosynthesis of Pyrimidines*	*Glycerol phosphate Shuttle*
	SLO-2	*Industrial application of enzymes*	*Disorders of carbohydrate metabolism*	*Regulation of amino acid synthesis*	*Biosynthesis of Purine*	*Malate aspartate Shuttle*
S-12	SLO-1	*Introduction to Nucleic acids – DNA and RNA*	*Diabetes Mellitus – Types and diagnosis*	*Disorders of tyrosine metabolism*	*Degradation of purine and pyrimidines nucleotides*	*Photosynthesis*
	SLO-2	*Classification of lipids*	*Biochemical aspects of Diabetes mellitus*	*Disorders of phenyl alanine metabolism*	*Disorders of purine metabolism*	*Light and dark reactions*
S-13	SLO-1	*Classification of fatty acids*	*Oral medications of Diabetes mellitus*	*Disorders of heme metabolism*	*Disorders of pyrimidine metabolism*	*Carbon Dioxide Fixation: Calvin-Benson Cycle*
	SLO-2	*Cholesterol and cell membranes*	*Hyperglycemia and diabetic nephropathy*	*Medically important peptides and amino acid derivatives*	*Deoxyribonucleotide Biosynthesis*	*Regulation of Carbon Dioxide Fixation*
S 14-15	SLO-1 SLO-2	*Lab 3 - Qualitative analysis of Monosaccharide in food samples*	*Lab 6 - Qualitative analysis of lipids (triglycerides, cholesterol, phospholipids)*	*Lab 9 - Estimation of enzyme kinetic parameters*	*Lab 12 - Enzymatic hydrolysis of glycogen by α and β amylase*	*Lab 15 - Quantitative analysis of urea in serum*

Learning Resources	*1. U. Satyanarayana, U. Chakrapani, Biochemistry, 4th ed., Elsevier India, 2013* *2. David L. Nelson, Michael M. Cox, Lehninger Principles of Biochemistry, 7th ed., W.H. Freemen & Co., 2017*	*3. Jeremy M. Berg, John L. Tymoczko, Gregory J. Gatto, Lubert Stryer, Biochemistry, 8thed., 2015* *4. Donald Voet, Judith G. Voet, Charlotte W. Pratt, Fundamentals of Biochemistry: Life at the Molecular Level", 5th ed., John Wiley & Sons Inc., 2016*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

\# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1 Dr. P. Bala Kumaran, Proklean Technologies (P) Limited, Chennai, genbalu86@gmail.com	*1.Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	*1. Dr. S. ThyagaRajan, SRMIST*
2. Dr. Karthik Periyasamy, Aurobindo Pharma Limited, Hyderabad karthikmpk@gmail.com	*2.Prof. R. B. Narayanan, SVCE, Chennai, rbn@svce.ac.in*	*2. Dr. V. Vinoth Kumar SRMIST*

Course Code	18BTC102J	Course Name	CELL BIOLOGY	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*State the basic concepts and understanding of cell structure and function*
CLR-2 :	*Analyze the different strategies of organization of organelles*
CLR-3 :	*Restate the concepts of structural and functional orientation in eukaryotes*
CLR-4 :	*Create a platform to study the molecular mechanism of cellular transport*
CLR-5 :	*Relate the applications of various receptors and their role in diseases*
CLR-6 :	*Analyze the concept of cell signaling and their role in diseases*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1 Level of Thinking (Bloom)	Learning 2 Expected Proficiency (%)	Learning 3 Expected Attainment (%)	PLO 1 Engineering Knowledge	PLO 2 Problem Analysis	PLO 3 Design & Development	PLO 4 Analysis, Design, Research	PLO 5 Modern Tool Usage	PLO 6 Society & Culture	PLO 7 Environment & Sustainability	PLO 8 Ethics	PLO 9 Individual & Team Work	PLO 10 Communication	PLO 11 Project Mgt. & Finance	PLO 12 Life Long Learning	PLO 13 PSO - 1	PLO 14 PSO - 2	PLO 15 PSO – 3
CLO-1 :	*Discuss on the basic concepts of cell biology*	2	80	70	M	M	-	H	-	-	-	H	-	-	-	-	H	H	H
CLO-2 :	*Plan on designing and conducting experiments involving cell structures and functions*	2	85	75	M	M	H	H	-	-	-	H	H	-	-	-	H	H	H
CLO-3 :	*Recognize the basis of cell structure and its function in development and cell death*	2	75	80	M	M	H	H	H	-	-	H	H	-	-	-	H	H	H
CLO-4 :	*Describe the steps involved in cell-cell signaling in mammalian cell systems*	2	85	80	M	M	H	H	H	H	H	H	H	-	-	-	H	H	H
CLO-5 :	*Devise examples and advances in the different areas of diagnostic and therapeutic applications of cells*	3	85	80	M	M	H	H	H	M	H	H	H	-	-	-	H	H	H
CLO-6 :	*Design the experiments using routine and specialized cells to study cell proliferation, mitosis spread and karyotyping*	3	80	75	M	M	H	H	H	M	H	H	H	-	-	-	H	H	H

Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Introduction to cell biology*	*Cell structure and function: Nucleus*	*Cytoskeleton*	*Principles of cell signaling*	*Cancer*
	SLO-2	*Origin and history of life*	*Internal organization of Nucleus*	*Types and function*	*Models of cell signaling*	*Introduction to cancer*
S-2	SLO-1	*Evolution of cell*	*Endoplasmic reticulum*	*Microfilaments*	*Intracellular signal transduction*	*Stages of cancer*
	SLO-2	*Evolution of metabolism*	*Protein folding and processing in ER*	*Intermediate filaments*	*Pathways in signal transduction*	*Types of cancer*
S-3	SLO-1	*Origin of prokaryotes*	*Lipid synthesis in SER*	*Microtubules*	*Function of cell surface receptors*	*Development of cancer*
	SLO-2	*Endosymbiosis*	*Export of proteins and lipids from ER*	*Re-organization of microtubules during mitosis*	*GPCR pathway*	*Hallmarks of cancer*
S 4-5	SLO-1 SLO-2	*Lab 1: Cell Morphology: Microscopic observation of eukaryotic cells*	*Lab 4: Cell Organelles: Nuclear staining of cells*	*Lab 7: Cell Proliferation: Mitotic index determination*	*Lab 10: Repeat/Revision of experiments*	*Lab 13: Cell differentiation: L6 myoblasts to L6 myotubes*
S-6	SLO-1	*Origin of eukaryotes*	*Golgi apparatus*	*Transport of molecules in cell*	*cAMP pathway*	*Oncogenes and tumor suppressor genes*
	SLO-2	*Differences between Prokaryotes & Eukaryotes*	*Protein sorting from Golgi*	*Passive diffusion*	*Receptor tyrosine kinase pathway*	*Targeted drug therapy*
S-7	SLO-1	*Development of multicellular organisms: Yeast, Amoeba & Volvox*	*Lysosomes*	*Active diffusion*	*MAPK pathway*	*Epithelial cell cancer*
	SLO-2	*Plant cells & Animal cells*	*Phagocytosis and autophagy*	*Ion channels*	*Cell division*	*Oral cancer*
S-8	SLO-1	*Cells as experimental models*	*Bioenergetics*	*Endocytosis*	*Cell cycle*	*Lung cancer*
	SLO-2	*Tools of cell biology*	*Metabolism*	*Phagocytosis*	*Mitosis and stages*	*Breast cancer*

S 9-10	SLO-1 SLO-2	*Lab 2: Cell development: Embryogenesis in fruit fly and Zebrafish*	*Lab 5: Osmosis: Stomatal opening and closing*	*Lab 8: Karyotyping: G banding*	*Lab 11: Cell division: Mitotic cell division in onion root tip*	*Lab 14: Heterochromatin: Polytene chromosomes*
S-11	SLO-1	*Molecular composition of cell*	*Mitochondria- structure and function*	*Cell-cell interactions*	*Meiosis*	*Classification of breast cancer*
	SLO-2	*Biosynthesis of cellular constituents*	*Genetic system of mitochondria*	*Cell junctions*	*Programmed cell death:Necrosis and apoptosis*	*Treatment of breast cancer*
S-12	SLO-1	*Enzymes as biocatalysts*	*Chemiosmotic coupling*	*Adhesion junctions*	*Intrinsic and extrinsic pathway*	*Neurodegenerative diseases*
	SLO-2	*Central role of Enzymes*	*Chloroplasts*	*Tight junctions*	*Cell differentiation*	*Dementia*
S-13	SLO-1	*Cell membrane*	*Photosynthesis*	*Gap Junctions*	*Stem cells adult and embryonic*	*Alzheimer's disease*
	SLO-2	*Glycocalyx*	*Peroxisomes*	*Plasmodesmata*	*Therapeutic applications of stem cells*	*Diagnosis and treatment*
S 14-15	SLO-1 SLO-2	*Lab 3: Chromosome preparation: Metaphase spread preparation*	*Lab 6: Cellular fractionation: chloroplast*	*Lab 9: Cell viability: Determination of cell viability using typhan blue dye exclusion*	*Lab 12: Cell division: Meiosis in grass hopper*	*Lab 15: Histology: Sectioning of tissues using microtome and staining*

Learning Resources	*1. Channarayappa, Cell biology, Universities Press, 2010* *2. Rastogi, S.C, Cell Biology, New Age International publishers, 2005*	*3. ThyagaRajan et al., Biology for Engineers, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2012* *4. Ajoy Paul, Text book of cell and molecular biology, 2nd ed., Books & Allied (P) Ltd., 2009*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	*1. Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	*1. Dr. S. ThyagaRajan, SRMIST*
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Course Code	18BTC103J	Course Name	MICROBIOLOGY	Course Category	C	*Professional Core*	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Illustrate the fundamentals of Microbiology and different types of microorganisms and their characteristics*
CLR-2 :	*Demonstrate the fine structure of bacteria, their functions, growth and cultivation of microorganisms*
CLR-3 :	*Illustrate various infectious diseases and their mode of actions*
CLR-4 :	*Demonstrate the host-microbe interactions*
CLR-5 :	*Illustrate the various applications of microorganisms in various fields*
CLR-6 :	*Analyze the importance of Microbiology in various field applications*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO – 3
CLO-1 :	*Illustrate the roles and characteristics of microorganisms*	2	80	70	-	H	-	-	-	-		-	H	-	-	-	H	H	H
CLO-2 :	*Identify growth of microorganisms, its impact in environment, applications of advanced microscopical techniques*	2	85	75	-	H	H	-	-	-	H	-		-	-	-	H	H	H
CLO-3 :	*Explain the role of microbes in public health and antimicrobial agents*	2	75	80	H	-	H	M	H	-	H	-	H	-	H	-	H	H	H
CLO-4 :	*Discuss various interactions of microbes with various microbes, animals and plants*	2	85	80	H	-	H		H	-	M	-	H	-	H	-	H	H	H
CLO-5 :	*Explain the applications of microbes and their products in various field*	3	85	80	H	H	H	H	H	-	M	-	H	-	H	-	H	H	H
CLO-6 :	*Illustrate the fundamental and applied Microbiology*	2	80	75	H	H	H	H	H	-	M	-	H	-	H	-	H	H	H

Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Introduction to Microbiology*	*Nutritional requirements of bacteria*	*Fungi-Importance of fungi in various field applications*	*Microbial infections, transmission, and their mode of action*	*Introduction to Applied Microbiology*
	SLO-2	*Prokaryotes and Eukaryotes*	*Nutritional types of bacterium*	*Morphology of fungi*	*Sources of infection*	*Beneficial microbes and Microbial metabolites-overview*
S-2	SLO-1	*Basics of microbial existence- History of Microbiology*	*Physical nutrients requirement of the bacteria*	*Structural characteristics and ecological association of fungi*	*Portals of entry and Exit of microbes.*	*Microbial applications in Biotechnological field*
	SLO-2	*Characterization of microorganisms*	*Chemical nutrients requirement of the bacteria*	*Classification of fungi*	*Epidemiological terminologies-Infectious diseases caused by Vibrio cholerae*	*Microbial enzymes in various biotechnological applications*
S-3	SLO-1	*Classification and nomenclature of microorganisms*	*Types of culture media; Factors influencing bacterial growth*	*Sexual and Asexual Reproduction of fungi*	*Vibrio cholera-Mode of action*	*Microbial secondary metabolites-antibiotics*
	SLO-2	*Microscopic examination ofmicroorganisms Light Microscopy-Bright field; Dark field*	*Microbial growth phases*	*Cultivation of fungi*	*Vibrio cholera-Treatment*	*Microbial applications in agricultural field*
S 4-5	SLO-1 SLO-2	*Lab 1: Aseptic techniques and Media preparation (Both liquid and solid)*	*Lab 4: Staining Techniques (Simple staining, Gram staining, spore staining)*	*Lab 7: Enzyme based biochemical characterizations-Catalase test*	*Lab 10: Repeat/Revision of experiments*	*Lab 13: Antibiotic sensitivity test-Kirby-Bauer assay*
S-6	SLO-1	*Phase contrast; Fluorescent Microscopy*	*Types of bacterial culturing/fermentations with respect to growth phases*	*Preservation techniques of fungi*	*Sexually Transmitted diseases*	*Microbial applications in agricultural field*
	SLO-2	*Differential and specific staining methods*	*Microbial growth curve and kinetics*	*Fungal toxins*	*Acquired Immuno Deficiency syndrome (AIDS)*	*Advancements in agricultural field*
S-7	SLO-1	*Electron Microscopy techniques: Scanning and Transmission Electron Microscopy*	*Different methods of quantitative bacterial growth-Direct method*	*Bacterial viruses-Bacteriophages*	*HIV-Replication; Opportunistic Infections associated with AIDS; Treatment*	*Biocontrol agents-Biofertilizer*
	SLO-2	*Sample preparation techniques for SEM and TEM*	*Different methods of quantitative bacterial growth-Indirect method*	*Types of bacteriophages and their General characteristics*	*Fungal diseases*	*Microbial applications in Pharmaceutical field*
S-8	SLO-1	*Advanced Microscopic techniques-Confocal Microscopy*	*Utilization of energy in non-biosynthetic processes- Energy utilization-Bacterial motility*	*Morphology and structure of bacteriophages*	*Antibacterial agents-classification*	*Microbial applications in Environmental field*

	SLO-2	*Scanning Probe Microscopy-Scanning Tunneling*	*Bacterial nutrient uptake mechanisms- Simple Diffusion, Active Transport, Group Translocation*	*Replication-Viruses of bacteria*	*Mode of actions of antibiotics*	*Microbes in the pollution removal and bioplastic syntheis*
S 9-10	SLO-1 SLO-2	*Lab 2: Isolation and enumeration of microorganisms from given sample*	*Lab 5: Motility test by Hanging drop method*	*Lab 8: Enzyme based biochemical characterizations-oxidase test*	*Lab 11: Triple sugar Iron agar test-H2S production*	*Lab 14: Identification of bacteria using 16s-rRNA sequencing*
S-11	SLO-1	*Scanning Probe Microscopy - Atomic Force Microscopy*	*Bioenergetics- utilization of energy in biosynthetic processes*	*Animal viruses-Classification*	*Multidrug resistance in bacterial pathogens-MDROs, MRSA, VRE*	*Control of Microorganisms-Physical, chemical and biological methods*
	SLO-2	*Morphology and fine structure of Bacteria*	*Biosynthesis of small molecules-synthesis of amino acids*	*Animal virus- Replication*	*Mechanisms of antibiotic resistance*	*Host-microbe interactions: Microbe-Microbe interaction*
S-12	SLO-1	*Size, Shape, And Arrangement of Bacterial Cells*	*Biosynthesis of macromolecules-synthesis of peptidoglycan*	*Viruses of cancer*	*Antifungal agents*	*Host-microbe interactions: Plant-microbe interaction*
	SLO-2	*External structure of bacteria*	*Synthesis of organic cell material in chemoautotrophic bacteria*	*Viroids and Prions*	*Mode of action of antiviral agents*	*Host-microbe interactions: Animal-microbe interaction*
S-13	SLO-1	*Cell organization*	*Bioenergetics of microbial metabolism*	*Plant viruses-Classification*	*Antiviral agents*	*Normal/indigenous flora and opportunistic flora of human body*
	SLO-2	*Internal structures of bacteria*	*Aerobic respiration and Anaerobic bioenergetics*	*Replication of plant viruses*	*Mode of action of antiviral agents*	*Probiotics and Prebiotics*
S 14-15	SLO-1 SLO-2	*Lab 3: Purification and preservation techniques of bacterial cultures*	*Lab 6: Biochemical Characterization of Bacteria–IMViC test*	*Lab 9: Enzyme based biochemical characterizations-Urease test*	*Lab 12: Casein and Starch Hydrolysis*	*Lab 15: Differentiation of live and dead cells using fluorescence Microscopy*

Learning Resources	*1. Pelczar et al., Microbiology, 7th ed., Mc Graw Hill, 2011* *2. Madigan et al., Brock Biology of microorganisms, 12th ed., Prentice Hall,2008* *3. Davis et al., Microbiology, 6th ed., Lippincott Williams and Wilkins, 2010*	*4. Prescott et al., Microbiology, 11th ed., Mc Graw Hill, 2011* *5. Brooks et al., Medical Microbiology, 26th ed., Lange Med. 2012*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	20%	20%	15%	15%	15%	15%	15%	15%	15%	15%
Level 2	Apply Analyze	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Level 3	Evaluate Create	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. S. Sam Gunasekar, Orchid Chemicals and Pharmaceuticals Ltd., sam@orchidpharma.com	*1. Dr. A. Gnanamani, CSIR-Central Leather Research Institute, agmani_2000@yahoomail.com*	*1. Dr. K. Ramani, SRMIST*
2.Dr. D. Gunaseelan, BIOCON Ltd., guna.sachin@gmail.com	*2. Dr. Anbumani Sadasivam, CSIR-Indian Institute of Toxicology Research,anbumani@iitr.res.in*	*2. Dr. R. Muthukumar, SRMIST*

Course Code	18BTC104T	Course Name	GENETICS AND CYTOGENETICS	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*18BTC105J*
Course Offering Department	*Biotechnology*	Data Book / Codes/Standards	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Analyze the pattern of inheritance of genes in eukaryotes*
CLR-2 :	*Use two and three factor cross in mapping of genes*
CLR-3 :	*Use Karyotype in detecting mutation*
CLR-4 :	*Apply different methods for mapping of genes in bacteria.*
CLR-5 :	*Analyze genetic variations in a population.*
CLR-6 :	*Analyze genetic variation and inheritance in living organisms.*

		Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Describe the fundamental Laws of Genetics and interaction of genes*	1	80	80	H	H	H	H	-	M	L	H	H	H	H	H	H	H	H
CLO-2 :	*Explain the concepts and experiments in the preparation of linkage map*	2	85	75	H	H	H	H	-	-	M	H	H	H	H	H	H	H	H
CLO-3 :	*Recognize the pattern of genetic disorders*	2	75	80	M	H	M	H	M	M	-	M	H	H	H	H	H	H	H
CLO-4 :	*Discuss the different methods in the construction of linkage map in bacteria*	2	85	80	H	H	H	H	-	-	H	L	H	H	H	H	H	H	H
CLO-5 :	*Analyze genes in the population*	3	85	75	H	H	H	H	-	M	H	H	H	L	H	H	H	H	H
CLO-6 :	*Explain the basic concepts and principles of nucleic acids in prokaryotic and eukaryotic organisms*	2	80	80	H	H	H	H	L	M	M	M	H	H	H	H	H	H	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Mendel's Experiments*	*Chromosome structure*	*Mutation*	*Bacterial genetics*	*Population genetics*
	SLO-2	*Law of segregation*	*Chromosome organization*	*Classification of mutation*	*Mechanisms of recombination*	*Allele frequency*
S-2	SLO-1	*Law of independent assortment*	*Giant chromosomes- polytene chromosome*	*Structural chromosomal aberration*	*Transformation in bacteria*	*Calculation of allele frequency in a population*
	SLO-2	*Problems in Mendelein inheritance*	*Lampbrush chromosome*	*Types of structural aberration*	*Mapping by transformation*	*Solving Problems*
S-3	SLO-1	*Allelic interaction*	*Linkage*	*Numerical chromosomal aberration - Aneuploidy*	*Recombination by generalized transduction*	*Calculation of genotype frequency in a population*
	SLO-2	*Lethal genes*	*Arrangement and types of linkage*	*Euploidy*	*Mapping by generalized transduction*	*Hardy-Weinberg equilibrium*
S-4	SLO-1	*Non-allelic interaction*	*Crossing over*	*Non-disjunction*	*Specialized transduction by lambda phage*	*Applications of Hardy Weinberg equilibrium*
	SLO-2	*Epistatis*	*Frequency of recombination*	*Aneuploids in humans*	*Mapping by specialized transduction*	*Solving Problems*
S-5	SLO-1	*Duplicate genes*	*Cytological basis of crossing over*	*Mosaics*	*Conjugation*	*Changes in allele frequency*
	SLO-2	*Complementary and inhibitory genes*	*Stern's experiment*	*Position effect*	*Recombination by conjugation*	*Changes in allele frequency by mutation*
S-6	SLO-1	*Multiple allelism -ABO*	*Mapping by two factor cross*	*Chromosome preparation from leukocyte culture*	*Interrupted mating analysis*	*Changes in allele frequency by migration*
	SLO-2	*Rh factor in Humans*	*Solving Problems*	*Chromosome preparation from bone marrow*	*Mapping by conjugation*	*Migration dynamics*
S-7	SLO-1	*Cytoplasmic inheritance*	*Mapping by three factor cross*	*Chromosome preparation from amniotic fluid and chorionic villi*	*Preparation of linkage maps in bacteria*	*Changes in allele frequency by selection*

	SLO-2	*Pedigree analysis - Solving Problems*	*Solving Problems*	*Banding technique*	*Solving Problems*	*Selection dynamics*
S-8	SLO-1	*Mechanisms of sex determination*	*Combining of map segments*	*Karyotype preparation and analysis*	*Merozygote analysis*	*Random genetic drift*
	SLO-2	*Sex linked inheritance*	*Preparation of linkage map*	*Prenatal diagnosis*	*Fine structure mapping*	*Dynamics of random genetic drift*
S-9	SLO-1	*Epigenetics - reprogramming*	*Somatic cell hybridization*	*Fluorescent in situ hybridization*	*Solving Problems*	*Genetic equilibrium*
	SLO-2	*X-inactivation*	*HAT selection procedure*	*Comparative Genomic hybridization*	*Solving Problems*	*Solving Problems*

Learning Resources	*1. Gardner, Simmons, Sunstad, Principles of Genetics, 8th ed., John Wiley and Sons, Inc., 2006*	*2. Monroe W. Strickberger, Genetics, 3rd ed., PHI Learning, 2008*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	*1. Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	*1. Dr. S. Barathi, SRMIST*
2. Dr. Karthik Periyasamy, Aurobindo Pharma Limited, Hyderabad, karthikmpk@gmail.com	*2. Prof. R. B. Narayanan, SVCE, Chennai, rbn@svce.ac.in*	*2. Dr. K. T. Ramyadevi, SRMIST*

Course Code	18BTC105J	Course Name	MOLECULAR BIOLOGY	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18BTC104T	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Illustrate the chemistry of polynucleotides
CLR-2 :	Demonstrate the mode of DNA replication
CLR-3 :	Demonstrate transcription and the processing of RNA
CLR-4 :	Demonstrate protein synthesis and modification in regulation of cellular activities
CLR-5 :	Illustrate the various regulatory elements that control gene expression at the transcriptional level
CLR-6 :	Analyze the chemical and molecular processes that occur in the cells

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO - 3
CLO-1 :	Discuss on the basic concepts and principles of nucleic acids from the perspective of engineers	2	80	70	-	H	-	-	-	-	-	-	H	-	-	-	H	H	H
CLO-2 :	Illustrate the mechanism involved in the duplication of hereditary material.	2	85	75	-	H	H	-	-	-	H	-		-	-	-	H	H	H
CLO-3 :	Illustrate the mechanism and role of the nucleic acids in gene expression.	2	75	80	H	-	H	M	H	-	H	-	H	-	H	-	H	H	H
CLO-4 :	Discuss the structure and machinery of nucleic acids responsible for cell functioning.	2	85	80	H	-	H		H	-	M	-	H	-	H	-	H	H	H
CLO-5 :	Explain the regulation of gene expression under anabolic and catabolic conditions.	3	85	80	H	H	H	H	H	-	M	-	H	-	H	-	H	H	H
CLO-6 :	Explain the role of biological macromolecules which are essential to life.	2	80	75	H	H	H	H	H	-	M	-	H	-	H	-	H	H	H

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Scope and history	Basic rules for replication	RNA polymerases in prokaryotic and eukaryotic cells	Genetic code	Gene regulation
	SLO-2	Proof for DNA as the genetic material	Chemistry of DNA synthesis	Types and function of RNA polymerases	wobble hypothesis	Principles of gene regulation
S-2	SLO-1	Proof for semi conservative replication	Semi discontinuous replication	Structure and function of the promoters	Translation in prokaryotic cells	Transcriptional gene regulation
	SLO-2	DNA constituents	Pulse chase and pulse labeling experiment	Fine structure of prokaryotic and eukaryotic genes	Initiation of translation	Post transcriptional gene regulation
S-3	SLO-1	Nucleoside and Nucleotide	Enzymes involved in replication	Transcription of RNA in prokaryotes - initiation	Elongation of translation	Activators
	SLO-2	Structure of DNA	Types and functions of DNA polymerases in prokaryotic and eukaryotic replication	Elongation and termination	Translocation	Co-activators
S 4-5	SLO-1 SLO-2	Lab 1: Isolation of genomic DNA from bacteria	Lab 4: Plasmid DNA isolation	Lab 7: Polyacrylamide gel electrophoresis of DNA	Lab 10: Repeat/Revision of experiments	Lab 13: Ligation of digested DNA
S-6	SLO-1	Base pairing and base stacking	Proof reading activity	Transcription in eukaryotes	Termination of translation	Suppressors – Co-suppressors
	SLO-2	Models of DNA	5'-3' exonuclease activity and Topoisomerase activity	Structure of promoters in mRNA, rRNA, and tRNA genes	Ribosome recycling	Moderators, Silencers and Enhancers
S-7	SLO-1	Double helix	Events in the replication fork	Transcription of mRNA	Translation in eukaryotic cells	Operons
	SLO-2	Features of Watson and crick model	Telomeric DNA replication	Steps in transcription by RNA polymerase II	Polyribosome	Positive and negative regulation
S-8	SLO-1	Major and minor groove	Models of DNA replication – Bidirectional replication	Transcription of tRNA by RNA polymerase III	Post translational modifications	Lac Operon
	SLO-2	Forms of DNA - A, B, Z	Plasmid replication-theta model	Transcription of rRNA by RNA polymerase I	Protein folding	Regulation of Lac operon by glucose

S 9-10	SLO-1 SLO-2	*Lab 2: Qualitative analyses of genomic DNA*	*Lab 5: Qualitative analyses of plasmid DNA*	*Lab 8: Isolation of RNA*	*Lab 11: Restriction digestion of Plasmid DNA*	*Lab 14: Effect of UV rays in the bacterial cell growth*
S-11	SLO-1	*Structure and function of RNAs– mRNA, rRNA and tRNA*	*Strand displacement model*	*Processing of tRNA*	*Protein sorting and targeting*	*Trp Operon*
	SLO-2	*Secondary structures in RNA*	*Rolling circle model*	*Processing of rRNA*	*Types of Protein targeting*	*Control of Trp operon by Attenuator*
S-12	SLO-1	*DNA Topology*	*Bidirectional replication*	*Post transcriptional processing of mRNAs – 5'capping*	*Principles of protein sorting and targeting into mitochondria*	*Ara Operon*
	SLO-2	*Supercoiling – Twist - Writhe*	*Unidirectional replication*	*Polyadenylation*	*Principles of protein sorting and targeting into endoplasmic reticulum*	*Regulation of Ara operon*
S-13	SLO-1	*Linking number*	*DNA repair: Nucleotide excision and Mismatch repair*	*Splicing (including different types)*	*Principles of protein sorting and targeting into nucleus*	*Gal Operon*
	SLO-2	*Change in linking number*	*Photo-reactivation, Recombination repair and SOS repair*	*Alternative splicing*	*Principles of protein sorting and targeting into chloroplast*	*Regulation of Gal operon*
S 14-15	SLO-1 SLO-2	*Lab 3: Quantitative analyses of genomic DNA*	*Lab 6: Quantitative analyses of plasmid DNA*	*Lab 9: Qualitative and quantitative analyses of RNA*	*Lab 12: Restriction digestion of genomic DNA*	*Lab 15: Polymerase Chain Reaction*

Learning Resources	*1. James D Watson, Molecular Biology of Gene, Pearson Education, 2017* *2. Robert Weaver, Molecular Biology, McGraw-Hill, 2011*	*3. Benjamin Lewin, Genes IX, Benjamin Cummings, 2007* *4. G.M. Malacinski, David Friefelder, Essentials of Molecular Biology, 4th ed., Narosa Publishers 2008*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. S. Sam Gunasekar, Orchid Chemicals and Pharmaceuticals Ltd., sam@orchidpharma.com	*1. Dr. A. Gnanamani, CSIR-Central Leather Research Institute, agmani_2000@yahoomail.com*	*1. Dr. K. Ramani, SRMIST*
2. Dr. D. Gunaseelan, BIOCON Ltd., guna.sachin@gmail.com	*2. Dr. Anbumani Sadasivam, CSIR-Indian Institute of Toxicology Research,anbumani@iitr.res.in*	*2. Dr. R. Muthukumar, SRMIST*

Course Code	18BTC106J	Course Name	IMMUNOLOGY	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	*Biotechnology*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Examine the science of immunology and a detailed study of various types of immune cells*
CLR-2 :	*Distinguish immune systems produced molecules and their classification, structure and function*
CLR-3 :	*Choose methods used in immunology, particularly the use of specific antibody in bio-molecular applications*
CLR-4 :	*Evaluate knowledge about immune system, their cells, its interaction and how they fight against infectious diseases*
CLR-5 :	*Analyze the dysregulation of immune system functioning and ways to strengthen immune system*
CLR-6 :	*Evaluate the knowledge about how human body is designed and protected to fight against various pathogens*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO – 3
CLO-1 :	*Describe the immune system and their structure and classification*	1	80	70	M	-	H	H	L	L	L	H	-	H	M	H	M	H	H
CLO-2 :	*Discuss about genetic control of antibody production, cellular immunology*	2	80	70	M	M	-	H	H	M	H	H	-	H	M	H	M	H	H
CLO-3 :	*Explain various methods to assess immune function, their application and interpretation of the results*	2	80	70	M	M	L	H	H	-	-	H	M	H	M	H	H	H	H
CLO-4 :	*Describe the role of the immune molecules in infectious diseases, autoimmunity, and cancer will be discussed*	2	80	70	-	-	-	H	H	M	H	H	M	H	M	L	H	H	H
CLO-5 :	*Discuss about hypersensitive immune reaction, vaccination and cancer immunology*	2	80	70	M	M	-	H	H	-	H	H	M	H	H	M	H	H	H
CLO-6 :	*Describe how immune cells, organ and processes function to protect human body against infective agents and cancer cells.*	2	80	70	M	L	M	H	H	M	M	H	M	H	H	M	H	H	H

Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Overview of the immune system*	*Immunoglobulin structure*	*Isolation of immune cells from Human and animals*	*Major histo-compatibility Complex(MHC)*	*Hypersensitive reactions*
	SLO-2	*Development and differentiation of the hematopoietic stem cells*	*Immunoglobulin types and function*	*Antigen- antibody interaction*	*MHC – types and function*	*Type I and Type II reaction*
S-2	SLO-1	*Myeloid and Lymphoid lineage*	*Antibodies biological and functional properties*	*antibody affinity and avidity*	*MHC Class I*	*Type III and Type IV reaction*
	SLO-2	*Lymphatic system*	*Proteolytic digestion of antibodies*	*Hemaagglutination reaction*	*MHC Class II*	*Immune responses to infectious diseases introduction*
S-3	SLO-1	*Lymphoid organs - types*	*Monoclonal antibodies production*	*Coombs test – direct and indirect*	*antigen processing and presentations – Endogenous and Exogenous*	*Viral disease-HIV infection*
	SLO-2	*Innate lymphoid cells*	*Monoclonal antibodies applications*	*precipitation reaction*	*Diversity of MHC molecules*	*Bacterial disease-Tuberculosis*
S 4-5	SLO-1 SLO-2	*Lab 1:Laboratory safety principles and Blood grouping*	*Lab 4: Antigen – Antibody reaction I – Widal test*	*Lab 7: Ouchterlony gel diffusion*	*Lab 10: Active immunodiffusion – II – Counter Current Immunoelectrophoresis*	*Lab 13: Enzyme linked Immunosorbent assay (ELISA) – DOT*
S-6	SLO-1	*Agglutination principle, blood group types Rhesus group types*	*Widal test - slide method and test tube method*	*Single radial immunodiffusion (SRID)*	*Antigen – Antibody interaction*	*Types of ELISA, Direct vs Indirect ELISA, Dot ELISA Sandwich ELISA*
	SLO-2	*incompatible blood transfusion and hemolytic disease*	*B Cell differentiation*	*titer value, zone of equivalence Quantitative Immuno assays*	*Standard and test antigen Rocket Immunoelectrophoresis*	*Parasitic disease-Malaria*
S-7	SLO-1	*Receptors of Innate Immune system*	*B cell receptor structure and B cell signal transduction*	*passive Immunodiffusion*	*Biology of T lymphocyte*	*Evading Mechanisms of pathogens*
	SLO-2	*Types of Immune cells, Innate Immunity*	*Antibody diversity*	*Precipitation reaction*	*T cell receptors and interaction with MHC*	*Vaccine history and principle*
S-8	SLO-1	*Anatomical and Physiological barriers*	*Light chain synthesis*	*Active Immunodiffusion – Rocket immunoelectrophoresis*	*T-cell maturation*	*Active and passive Immunization*
	SLO-2	*Acquired Immunity, clonal selection theory*	*Heavy chain synthesis Cytokine receptor structure*	*SDS-PAGE and Western blot*	*T-cell activation and differentiation*	*DNA vaccine, Edible vaccine and Adjuvants*

S 9-10	SLO-1 SLO-2	*Lab 2: Total Leukocyte count*	*Lab 5: Antigen – Antibody reaction II -rapid plasma reagin (RPR) test*	*Lab 8: Repeat/Revision of experiments*	*Lab 11: Immunoprecipitation*	*Lab 14: Enzyme linked Immunosorbent assay (ELISA) – Plate*
S-11	SLO-1	*Types of blood cells Leukocyte counting*	*Flocculation reaction Rapid Plasma Reagin (RPR) test*	*Quantitative Immuno assays - Radio-immunoassay*	*Thymic selection – Positive and negative selection*	*Tumor Immunology introduction*
	SLO-2	*Comparative immunity - Plant Immune system*	*Cytokine types and function*	*Precipitation reaction, Immunoprecipitation*	*T-cell activation and cytokine secretion*	*Evidence for Tumor Immunity*
S-12	SLO-1	*Vertebrate and Invertebrate Immune system*	*Role of cytokines in diseases*	*Immunofluorescence – Direct and indirect*	*Result interpretation Counter current immuno electrophoresis*	*Tumor immuno therapy*
	SLO-2	*Immunogens, Antigens and Haptens*	*Complement system*	*Immunohistochemistry*	*Cytokine control of TH1 and TH2 CD4+*	*Autoimmunity introduction*
S-13	SLO-1	*Requirements for immunogenicity; major classes of antigens*	*Regulation of complement pathway*	*flow cytometry, ELISA and types*	*Function of CD8+ T cells, T Regulatory cells*	*Genetic Basis of Autoimmunity*
	SLO-2	*antigen recognition by T and B lymphocytes*	*Role of complement proteins in diseases*	*Cell culture and experimental models, analysis of gene expression*	*T-cell and B-cell cooperation, Pathways of Activation*	*Classification of auto-immunity*
S 14-15	SLO-1 SLO-2	*Lab 3: Differential Leukocyte count*	*Lab 6: Single radial immunodiffusion (SRID)*	*Lab 9: Active Immunodiffusion I - Rocket Immunoelectrophoresis*	*Lab 12: SDS-PAGE*	*Lab 15: Western blotting*

Learning Resources	*1. Sudha Gangal, Shubhangi Sontakke, Textbook of basic and clinical immunology, Universities Press, 2013*	*2. Jenni Punt, Sharon Stranford, Patricia Jones, Judith A Owen, Kuby Immunology, 8th ed., W. H. Freeman and Company, 2018*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember / Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply / Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate / Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	*1. Dr. Joe Varghese, CMC Vellore, joevarghese@cmcvellore.ac.in*	*1. Dr. S. Thyagarajan, SRMIST*
2. Dr. Karthik Periyasamy, Aurobindo Pharma Limited, Hyderabad, karthikmpk@gmail.com	*2. Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	*2. Dr. S. Nageswaran, SRMIST*

Course Code	18BTC107J	Course Name	BIOPROCESS PRINCIPLES	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18BTC103J	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	**Data Book / Codes/Standards**	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Select the proper design offermenters and the fermentation process
CLR-2 :	Examine the process of media formulation and sterilization kinetics
CLR-3 :	Assess the metabolic stoichiometry and energetics of the biochemical process
CLR-4 :	Manage the various modes of operating and designing a bioreactor
CLR-5 :	Interpret the microbial growth and kinetics during formation of products
CLR-6 :	Analyze the basic principles of bioprocess engineering and the working of living cells

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO - 3
CLO-1 :	Explain the various aspects of fermenter and types of fermentation process	2	80	70	H	L	H	H	L	-	H	-	H	H	-	H	H	H	H
CLO-2 :	Practice the components of media and its prerequisites to produce bioproducts	3	80	70	H	M	H	H	L	-	H	-	H	H	-	H	H	H	H
CLO-3 :	Interpret the stoichiometry and energetics of product formation mediated by cell growth	3	80	70	H	H	H	H	L	-	H	-	H	H	-	H	H	H	H
CLO-4 :	Analyze and interpret key elements of the fermentation data to operate the bioreactor accordingly	2	80	70	H	M	H	H	M	-	H	-	H	H	-	H	H	H	H
CLO-5 :	Apply various models to understand the kinetics and mechanism of microbial growth	3	80	70	H	H	H	H	H	-	H	-	H	H	-	H	H	H	H
CLO-6 :	Employ fermentation skills to synthesize value added bioproducts	3	80	70	H	H	H	H	H	-	H	-	H	H	-	H	H	H	H

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Outline of an integrated bioprocess	Criteria for a good medium	Stoichiometric of cell growth	Types of bioreactor	Mathematical models
	SLO-2	Upstream and downstream bioprocess	Types of media	Stoichiometric of product formation	Strategies for choosing a bioreactor	Mathematical Models - Classification
S-2	SLO-1	Process flow sheets of primary metabolite production	Various commercial media for microbial biotechnology	Elemental balance, degree of reduction	Modes of operation of bioreactor	Model formulation
	SLO-2	Process flow sheets of secondary metabolite production	Medium formulation – Carbon and Nitrogen source	Substrate and biomass	Batch operation – Theory	Unstructured, Nonsegregated models
S-3	SLO-1	Types of fermentation	Medium formulation – Growth factor and inducers	Electron balance	Growth kinetics of batch culture	Monod model
	SLO-2	Fermented products	Natural and synthetic media	Yield coefficient of biomass and product formation	Solving problem in growth kinetics	Blackman, tessier, moser and contois models
S 4-5	SLO-1 SLO-2	Lab 1 - Types of fermentation	Lab 4 - Medium formulation to maximize the biomass production	Lab 7 - Batch growth kinetics - Evaluation of doubling time	Lab 10: Repeat/Revision of experiments	Lab 13 - Quantification of biomass, ethanol and glucose
S-6	SLO-1	Fermenter – Various components	Animal culture media	Maintenance coefficients	Batch reactor – Logistic equations	Monod model modified for substrate inhibition
	SLO-2	Fermenter design	Plant culture media	Determination of stoichiometric coefficients	Performance equation of a batch reactor	Modified Monod models
S-7	SLO-1	Standard geometry of stirred tank bioreactor (STR)	Design of experiments	Solving problem in stoichiometric coefficients	Solving problem related to batch reactor	Unstructured Batch Growth Models
	SLO-2	Basic features of STR – Agitation	Plackett - Burman design (PBD)	Solving problem in stoichiometric coefficients	Fed-batch operation – theory	Product Formation Kinetics
S-8	SLO-1	Basic features of STR – Aeration	Response surface methodology (RSM)	Energetic analysis of microbial growth and product formation	Performance equation of a fed- batch reactor	Structured kinetics Model
	SLO-2	Basic features of STR – Miscellaneous items	Artificial neural network (ANN)	Oxygen transfer in aerobic culture	Solving problem related to fed-batch reactor	Structured product formation kinetic modeling

S 9-10	SLO-1	*Lab 2 - Bioreactor operation (demonstration)*	*Lab 5 - Screening of process parameters for bacterial biomass production by PBD*	*Lab 8 - Batch growth kinetics - Evaluation of specific growth rate*	*Lab 11 - Preparation of immobilized cells/enzyme*	*Lab 14 - Production of ethanol by Saccharomyces cerevisae*
	SLO-2					
S-11	SLO-1	*Summary of conventional bioreactor systems*	*Sterilization*	*Oxygen transfer in aerobic culture – problem*	*Continuous operation - Theory*	*Compartment model*
	SLO-2	*Summary of novel bioreactor systems*	*Kinetics of thermal death of microorganism*	*Determination of yield coefficients*	*Chemostat and Turbidostat*	*Williams two compartment model*
S-12	SLO-1	*Monitor and Control of physical parameters*	*Solving problem in sterilization kinetics*	*Solving problem in yield coefficients*	*Performance equation of a continuous reactor*	*Ramakrishna Model*
	SLO-2	*Monitor and Control of chemical parameters*	*Types of sterilization - batch*	*Solving problem in yield coefficients*	*Dopt – Significance*	*Product formation models*
S-13	SLO-1	*Monitor and Control of biological parameters*	*Types of sterilization - Continuous*	*Heat evolution in aerobic culture*	*Solving problem related to Dopt*	*Luedeking-piret Model*
	SLO-2	*Summary of Monitor and Control of fermentation parameters*	*Air sterilization*	*Analyze thermodynamic efficiency of cell growth*	*Stability analysis of bioreactor*	*Growth and non-growth associated kinetics*
S 14-15	SLO-1	*Lab 3 - Real-time monitoring of process (pH, temp etc.) parameters in bioreactor*	*Lab 6 - Media Sterilization*	*Lab 9 - Batch growth kinetics - Evaluation of yield coefficient*	*Lab 12 - Comparison of free and immobilized enzyme/cells kinetics*	*Lab 15 - Evaluation of ethanol yield and productivity by S. cerevisae*
	SLO-2					

Learning Resources	*1. Hall, Stephen J., Stanbury, Peter F., Whitaker, Allan, Principles of Fermentation Technology, 3rd ed., Butterworth– Heinemann, 2017* *2. Pauline M. Doran, Bioprocess Engineering Principles, 2nd ed., Academic press, 2012*	*3. Carl-Fredrik Mandenius, Bioreactors: design, operation and novel applications, 1st ed., Wiley-VCH Verlag GmbH & Co, 2016*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. P. BalaKumaran, Proklean Technologies (P) Limited, Chennai,genbalu86@gmail.com	*1. Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	*1. Dr. M. VenkateshPrabhu,SRMIST*
2. Dr. Karthik Periyasamy, Aurobindo Pharma Limited, Hyderabad, karthikmpk@gmail.com	*2. Prof. R. B. Narayanan, SVCE, Chennai, rbn@svce.ac.in*	*2. Dr. V. Vinoth Kumar, SRMIST*

Course Code	18BTC108J	Course Name	PLANT BIOTECHNOLOGY	Course Category	C	*Professional Core*	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*18BTC103J*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Biotechnology*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Illustrate the genome organization in plants and its regulations*
CLR-2 :	*Employ the different methods for the development of transgenic plants*
CLR-3 :	*Use the plants as production systems by altering the plant hormones for growth and developments*
CLR-4 :	*Interpret the mechanisms for plant to cope up for biotic and abiotic stresses*
CLR-5 :	*Apply the classical and modern plant breeding techniques for crop improvements*
CLR-6 :	*Use the knowledge to increase plant production and protection through biotechnological approaches*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO – 3
CLO-1 :	*Discuss on the basics of plant genomes organizations and expressions*	2	80	70	-	H	-	H	-	-	-	-	H	-	-	-	H	H	H
CLO-2 :	*Demonstrate the various methods of genetic manipulations in plants*	2	85	75	H	H	H	H	H	-	H	H	H	-	H	-	H	H	H
CLO-3 :	*Illustrate the mechanism and role of plant tissue culture for mass multiplications*	2	75	80	H	H	H	H	H	-	H	-	H	-	H	-	H	H	H
CLO-4 :	*Discuss the molecular aspects of plant adaptability to various stresses*	2	85	80	H	M	H	M	-	-	M	-	H	-	H	-	H	H	H
CLO-5 :	*Explain the significance of plant breeding and genetic manipulations of plants for economic importance*	3	85	80	H	H	H	H	H	-	M	H	H	-	H	-	H	H	H
CLO-6 :	*Explain the basic concepts and to use the plant biotechnology techniques for crop improvements*	2	80	75	H	H	H	H	H	-	H	H	H	-	H	-	H	H	H

Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Introduction and scope of plant molecular biology*	*Agrobacterium mediated gene transfer*	*Plant Tissue culture*	*Plant stresses*	*Introduction to crop improvement*
	SLO-2	*DNA, Chromatin, and Chromosome structure*	*The biology of Agrobacterium*	*Plasticity and totipotency of plant cells*	*Biotic stress*	*The distant past - Crop plant domestication and beyond*
S-2	SLO-1	*Chloroplast genome*	*Vector for plant transformations*	*The culture environment*	*Plant – pathogen interactions*	*The recent past -*
	SLO-2	*Genome Structure, evolution, expression, gene regulations*	*Ti plasmid*	*Physical and chemical factors*	*Prokaryotes, fungi and viruses*	*Hybrid seed production*
S-3	SLO-1	*Mitochondrial genome*	*t-DNA transfer and integration*	*Plant growth hormones*	*Disease resistance*	*Importance of green revolution*
	SLO-2	*Genome Structure, evolution, expression, gene regulations*	*transformation in plant with an example of Arabidopsis thaliana*	*Culture types*	*Natural disease resistance in plants*	*The (First) Green Revolution*
S 4-5	SLO-1 SLO-2	*Lab 1: Isolation of genomic DNA from plant tissues*	*Lab 4: Isolation and recombinant preparation of Ti plasmid*	*Lab 7: Preparation of plant tissue culture media*	*Lab 10: Repeat/Revision of experiments*	*Lab 13: Protoplast –Isolation, electro-fusion and regeneration*
S-6	SLO-1	*Nuclear genome*	*Direct gene transfer methods*	*Production of secondary metabolites*	*Biotechnological approach*	*Breeding technologies*
	SLO-2	*Genome size and organization*	*Advantages and disadvantages*	*Carbohydrates*	*Over expression of PR-proteins*	*Advances in breeding technologies*
S-7	SLO-1	*Introduction to gene and expression*	*Vectors*	*Metabolic engineering*	*Herbs as biotic stress factors*	*Practicing Now and*
	SLO-2	*Regulation of gene expressions*	*Optimization and binary vectors*	*Lipids*	*Types of herbicides*	*into the future*
S-8	SLO-1	*Gene transcription*	*Alternative markers and reporter genes*	*Molecular farming*	*Transgenic approach for improving tolerance to herbicide*	*Applications of breeding*
	SLO-2	*Organellar Self-Splicing Introns and Horizontal DNA transfer*	*Effect of selectable marker system to environment*	*Proteins*	*Plant based detoxification*	*Breeding for improved human health*

S 9-10	SLO-1 SLO-2	*Lab 2: Extraction of total RNA from plant tissues*	*Lab 5: Agrobacterium mediated gene transformation in Arabidopsis thaliana*	*Lab 8: Direct organogenesis of plants*	*Lab 11: Enhanced production of secondary metabolites in suspension cultures by using elicitors*	*Lab 14: Haploid productions/ Somatic embryogenesis*
S-11	SLO-1	*RNA modification*	*The genetic manipulation of pest resistance crop plants*	*Emerging applications*	*Abiotic stresses - nature*	*Breeding*
	SLO-2	*Post Transcriptional Gene Silencing (PTGS)*	*Bacillus thuringiensis (Bt) approach*	*Producing fine chemicals*	*Plant responses*	*For drought tolerance*
S-12	SLO-1	*Micro RNA*	*The use of Bt as a biopesticide*	*Plant derived compounds*	*The nature of water deficit stress*	*Innovations*
	SLO-2	*Production and interfering with gene for silencing*	*Bt-based genetic modification of plants*	*As a drugs*	*Various approaches for tolerance*	*In agriculture*
S-13	SLO-1	*DNA instability*	*Development of pest resistant crops*	*Current demand from plants*	*Salt stress*	*Revolutions*
	SLO-2	*Transposable Elements in plants*	*Clean gene technology – Copy nature strategy*	*Alternative fuels*	*Cold and heat stress*	*The Second Green Revolution*
S 14-15	SLO-1 SLO-2	*Lab 3: Qualitative and Quantitative analysis of nucleic acids from plant tissues*	*Lab 6: Demonstration of electroporation method of gene transformation in plants*	*Lab 9: Callus induction and indirect organogenesis*	*Lab 12: Quantification of stress induced secondary metabolites using HPLC*	*Lab 15: Quantification of t-DNA expressions from plants*

Learning Resources	*1. Slater. A, Scott.N.W, Fowler,M.R, Plant Biotechnology - The genetic manipulation of plants, Oxford University Press 2008* *2. C Neil Stewart Jr. Plant Biotechnology and Genetics, John Wiley & Sons, Inc., New Jersey 2008*	*3. Carole L. Bassett, Regulation of gene expression in plants - The role of transcript structure and processing. Springer, 1st ed., 2007* *4. Murray.D.R, Advanced methods in plant breeding and biotechnology, CAB International 1998*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	20%	20%	15%	15%	15%	15%	15%	15%	15%	15%
Level 2	Apply Analyze	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Level 3	Evaluate Create	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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1. Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	*2. Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	*2. Dr. Pachaiappan, SRMIST*

ACADEMIC CURRICULA

Professional Core Courses

CHEMICAL ENGINEERING

Regulations - 2018

SRM
INSTITUTE OF SCIENCE & TECHNOLOGY
(Deemed to be University u/s 3 of UGC Act, 1956)

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Kancheepuram, Tamil Nadu, India

Course Code	18CHC203T	Course Name	CHEMICAL PROCESS CALCULATIONS	Course Category	C	Professional Core	L	T	P	C
							3	1	0	4

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Chemical Engineering*	Data Book / Codes/Standards	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Explain the system of units, predict the PVT properties of Ideal gases, understand the composition of various mixtures*
CLR-2 :	*Formulate and solve material balance for non-reactive chemical process systems*
CLR-3 :	*Formulate and solve material balance for reactive chemical process systems*
CLR-4 :	*Formulate and solve energy balance for chemical process systems*
CLR-5 :	*Formulate and solve material balance for simple process flow sheets.*
CLR-6 :	*Explain mass and energy balance for reactive and non-reactive systems*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Do unit conversions, Predict PVT properties of gases using ideal gas equation, calculate the composition of mixtures*	2	80	75	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-2 :	*Solve the material balance for non-reactive Chemical process systems*	2	80	75	H	H	-	-	-	-	-	-	-	-	-	-	H	H	-
CLO-3 :	*Solve the material balance for the reactive chemical process systems*	2	80	75	H	H	M	-	-	-	-	-	-	-	-	-	H	H	-
CLO-4 :	*Solve the energy balance for chemical process systems*	2	80	75	H	H	M	-	-	-	-	-	-	-	-	-	H	M	M
CLO-5 :	*Solve the material balances including recycle, purge streams for simple process flow sheets.*	2	80	75	H	H	M	-	-	-	-	-	-	-	-	-	H	L	M
CLO-6 :	*Perform mass and energy balances for varied chemical systems*	2	80	75	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-

Duration (hour)		12	12	12	12	12
S-1	SLO-1	*Concept of various systems of Units and dimensions.*	*Law of conservation of mass*	*Chemical reactions and stoichiometric equations*	*Thermo physics: Heat capacity, Kopp's rule*	*Introduction to material balance for sequential processes.*
	SLO-2	*Unit conversions*	*Formulation of overall and individual component balance equations*	*Limiting reactant, excess reactant,*	*Sensible heat, latent heat and enthalpy*	*Introduction to material balance for sequential processes.*
S-2	SLO-1	*Various Temperature scales*	*Material balance for non-reactive chemical process systems: mixing*	*Conversion, Degree of completion, selectivity and yield.*	*Energy balance for non-reactive systems*	*Basic concepts of recycle and purge streams*
	SLO-2	*Types of Pressure*	*Material balance for non-reactive chemical process systems: mixing*	*Conversion, Degree of completion, selectivity and yield.*	*Energy balance for non-reactive systems*	*Basic concepts of recycle and purge streams*
S-3	SLO-1	*Temperature and Pressure unit conversions*	*Problems in mixing*	*Problem solving in Conversion*	*Problem solving on sensible heat*	*Basic concepts of bypass stream*
	SLO-2	*Concept of mole*	*Problems in mixing*	*Problem solving in Degree of completion, selectivity and yield.*	*Problem solving on sensible heat*	*Basic concepts of bypass stream*
S-4	SLO-1	*Predicting PVT properties of gases using ideal gas law*	*Material balance problems on crystallization process*	*Material balances for processes with reactions.*	*Thermo chemistry*	*Material balances for systems with recycle stream.*
	SLO-2	*Predicting PVT properties of gases using ideal gas law*	*Material balance problems on crystallization process*	*Material balances for processes with reactions.*	*Standard Heat of formation, standard heat of combustion*	*Material balances for systems with recycle stream.*
S-5	SLO-1	*Problems using Ideal gas law*	*Material balance problems on drying Process*	*Tutorial in Material balances for processes with reactions.*	*Hess law*	*Tutorial on Recycle Stream*
	SLO-2	*Problems using Ideal gas law*	*Material balance problems on drying Process*	*Tutorial in Material balances for processes with reactions.*	*Tutorial on Thermochemistry*	*Tutorial on Recycle Stream*
S-6	SLO-1	*Basis of calculations*	*Material balance problems on membrane separation process*	*Combustion as a special case of material balance with reactions.*	*Heat of reaction from heat of formation or combustion*	*Material balances for non-reactive systems with bypass and purge stream*
	SLO-2	*Basis of calculations*	*Material balance problems on membrane separation process*	*Combustion as a special case of material balance with reactions.*	*Tutorial on Thermochemistry*	*Material balances for non-reactive systems with bypass and purge stream*

S-7	SLO-1	*Composition of mixtures – Solids*	*Material balance problems on distillation process*	*Fuels, types of fuel, flue gas*	*Tutorial on Thermochemistry*	*Tutorial on Multiple processes*
	SLO-2	*Composition of gas mixtures - mole, mass, volume and partial pressure.*	*Material balance problems on distillation process*	*Orsat analysis, theoretical air, excess air*	*Tutorial on Thermochemistry*	*Tutorial on Multiple processes*
S-8	SLO-1	*Density of gas mixtures*	*Tutorial on distillation*	*Problems on Combustion*	*Enthalpy changes in reactions with different temperatures*	*Material and energy balance analysis for multi-unit processes*
	SLO-2	*Density of gas mixtures*	*Tutorial on distillation*	*Problems on Combustion*	*Problem solving on Enthalpy for reactive systems*	*Case studies with simple process flow sheets*
S-9	SLO-1	*Problems on composition*	*Material balance problems on extraction process*	*Problems on Combustion*	*Problem solving on Enthalpy for reactive systems*	*Case study 1*
	SLO-2	*Problems on composition*	*Material balance problems on extraction process*	*Problems on Combustion*	*Problem solving on Enthalpy for reactive systems*	*Case study 1*
S-10	SLO-1	*Problems on composition*	*Partial saturation and humidity, types of humidity*	*Analysis of products of combustion*	*Problem solving on Enthalpy for reactive systems*	*Case study 2*
	SLO-2	*Problems on composition*	*Relative humidity and percentage humidity*	*calculation of excess air*	*Theoretical flame temperature.*	*Case study 2*
S-11	SLO-1	*Solutions and their concentrations*	*Material balances involved in two-phase gas-liquid systems as in humidification and dehumidification.*	*Tutorial on excess air*	*Theoretical flame temperature.*	*Case study 3*
	SLO-2	*Solutions and their concentrations*	*Tutorial on Humidification*	*Tutorial on excess air*	*Tutorial on Energy Balance*	*Case study 3*
S-12	SLO-1	*Tutorial on concentrations*	*Tutorial on Humidification*	*Tutorial on Reactive systems*	*Tutorial on Energy Balance*	*Tutorial on Mass balance for process flowsheets*
	SLO-2	*Tutorial on concentrations*	*Tutorial on Humidification*	*Tutorial on Reactive systems*	*Tutorial on Energy Balance*	*Tutorial on Mass balance for process flowsheets*

Learning Resources	1. *David M. Himmelblau, James B. Riggs, Basic Principles and Calculations in Chemical Engineering, 8th ed., Pearson - Prentice Hall International* 2. *B. I. Bhatt, S. B Thakore., Stoichiometry, 5th ed., Tata McGraw-Hill Publishing Company, New Delhi*	3. *B. Lakshmikutty, K. V. Narayanan, Stoichiometry and Process Calculations, PHI Publishers, Delhi* 4. *Richard M. Felder, Ronald W. Rousseau, Elementary Principles of Chemical Processes, 3rd ed., John Wiley & Sons, Inc.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
Level 2	Apply Analyze	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
Level 3	Evaluate Create	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. A. Subramaniam, PESCO Beam Environmental Solutions Pvt. Ltd.,	*1. Dr. Lima Rose Miranda, Anna University, limamiranda2007@gmail.com*	*1. Mr. V. Ganesh, SRMIST*
2. Mr. S. T. Kalaimani, CPCL, Chennai	*2. Dr. T. R. Sundararaman, Rajalakshmi Engineering College, sundararaman.tr@rajalakshmi.edu.in*	*2. Ms. E. Kavitha, SRMIST*

Course Code	18CHC205T	Course Name	CHEMICAL ENGINEERING FLUID MECHANICS	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Chemical Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Describe the behavior of fluids, mechanics of fluids (fluid statics and fluid dynamics) and fluid flow phenomena*
CLR-2 :	*Demonstrate the Kinematics of flow*
CLR-3 :	*Analyze the flow past immersed bodies*
CLR-4 :	*Elucidate the transportation of fluids*
CLR-5 :	*Compare the metering of fluids*
CLR-6 :	Describe fluid flow and the its transportation.

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO - 3
CLO-1 :	*Describe fundamental knowledge in fluids properties, classification, flow in boundary layers, and pressure measurements*	1	80	70	H	H	L	-	-	-	-	-	-	-	-	-	H	H	-
CLO-2 :	*Interpret Bernoulli equation, Friction factor and pressure measurements*	2	85	75	H	H	M	M	M	-	-	-	-	-	-	-	H	H	-
CLO-3 :	*Interpret the Ergun equation, Navier–Stokes, settling velocity and fluidization*	2	80	75	H	M	M	-	M	-	-	-	-	-	-	-	H	H	-
CLO-4 :	*Differentiate types of seals, valves and pumps*	2	85	75	M	L	M	M	M	-	-	-	-	-	-	-	L	H	-
CLO-5 :	*Differentiate flow meters and flow rate calculations*	2	85	75	H	H	H	-	M	-	-	-	-	-	-	-	L	H	-
CLO-6 :	*Understand the flow behavior of fluids and their handling.*																		

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Introduction to fluids*	*Streamlines and stream tubes*	*Drag, drag coefficients*	*Introduction to: pipe and tubing*	*Introduction to: Metering of fluids*
	SLO-2	*Continuum hypothesis, Forces on fluids*	*Eulerian and Lagrangian descriptions Continuity equation*	*Drag coefficients of typical shapes*	*Transportation of fluids*	*Types of metering of fluids*
S-2	SLO-1	*Tutorial on forces*	*Bernoulli equation*	*Ergun equation*	*Joints and fittings, Flanges*	*Constructional features of venturi meter*
	SLO-2	*Newtonian and Non-Newtonian fluids*	*Pump work in Bernoulli equation*	*Navier–Stokes equation*	*Stuffing boxes, Mechanical seals*	*working principles of venturi meter*
S-3	SLO-1	*Hydrostatic equilibrium*	*Tutorial on Bernoulli equation*	*Settling velocity*	*Gate valves and globe valves*	*Derivation for flow measurement by using Bernoulli equation*
	SLO-2	*Fluid statics - pressure distribution*	*Tutorial on Bernoulli equation*	*Free and hindered settlings*	*Plug cocks, ball valves, check valves*	*Tutorial on venturi meter*
S-4	SLO-1	*Tutorial on pressure*	*Friction factor*	*Terminal settling velocity*	*Classification and selection and design of pumps*	*Constructional features of orificemeter*
	SLO-2	*Eddy viscosity*	*relationships between skin-friction parameters*	*Tutorial on Settling velocity*	*Design of blowers and compressors*	*working principles of orificemeter*
S-5	SLO-1	*Reynolds number*	*Flow of incompressible fluids*	*Tutorial on Settling velocity*	*Compressible flow*	*Derivation for flow measurement by using Bernoulli equation*
	SLO-2	*laminar and turbulent nature*	*Flow of incompressible fluids in conduits and thin layers*	*Tutorial on Free and hindered settlings*	*Pumps: developed head, suction lift, power requirement*	*Tutorial on orificemeter*
S-6	SLO-1	*laminar and turbulent flow in boundary layers, boundary layerformation in tubes*	*Friction factor, Moody diagram*	*Stokes' law*	*Constructional features of single suction volute centrifugal pump*	*Constructional features and working principles of Pitot tube*
	SLO-2	*Unsteady flows*	*Relationships between average velocity and maximum velocity*	*Newton's law for settling*	*Working principle of single suction volute centrifugal pump*	*Derivation for flow measurement by using Bernoulli equation*

S-7	SLO-1	*Dimensional analysis*	*roughness parameter, Vorticity and Circulation*	*criterion for settling regime*	*Characteristic curves of centrifugal pump, comparison of devices for moving fluids*	*Constructional features and working principles of Rotameters*
	SLO-2	*Dimensional analysis derivation for pressure drop*	*Equivalent diameter, form friction losses in Bernoulli equation, couette flow.*	*Tutorial on Newton's law for settling*	*Tutorial on pumps*	*Derivation for flow measurement*
S-8	SLO-1	*Boundarylayer*	*Hagen-Poiseuille equation*	*Fluidization*	*Constructional features of reciprocating pump*	*Tutorial on flow measurement*
	SLO-2	*Boundary layer formation in flat plate*	*Hydraulically smooth pipe, von Karman equation*	*Types of fluidization*	*working principle of reciprocating pump*	*Tutorial on flow measurement*
S-9	SLO-1	*Manometer, types of manometers*	*Tutorial on Hagen-Poiseuille equation*	*Conditions for fluidization,*	*Tutorial on pumps*	*Target meter, turbine meter*
	SLO-2	*Tutorial on Manometer*	*Tutorial on Hagen-Poiseuille equation*	*Minimum fluidization velocity*	*Constructional features and working principle of jet ejectors*	*Vortex shedding meter, Magnetic flow meter*

Learning Resources	1. *McCabe, W.L., Smith, J.C., Harriot, P., Unit Operations in Chemical Engineering, 7th ed., McGraw-Hill, 2005* 2. *Noel de Nevers, Fluid Mechanical for chemical Engineers, 2nd ed., McGraw Hill International Editions, 1991*	3. *Badger W.L. and Banchero J.T., Introduction to Chemical Engineering, Tata McGraw Hill, 1997* 4. *Coulson. J.M, Richardson. J.F, Backhurst.. J.R. Harker. J.M, Coulson & Richardson's Chemical Engineering, Vol. II, 5th ed., Butter worth Heinemann, Oxford, 2002*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Mr. A. Subramaniam, PESCO Beam Environmental Solutions Pvt. Ltd.,	*1. Dr. Lima Rose Miranda, Anna University, limamiranda2007@gmail.com*	*1. Dr. K. Anbalagan SRMIST*
2. Mr. S. T. Kalaimani, CPCL, Chennai	*2. Dr. T. R. Sundararaman, Rajalakshmi Engineering College, sundararaman.tr@rajalakshmi.edu.in*	*2. Dr. S. Vishali, SRMIST*

Course Code	18CHC206T	Course Name	MECHANICAL OPERATIONS	Course Category	C	*Professional Core*	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Chemical Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Illustrate the process of Characterizing, handling and storage of solids, and Screening concepts*
CLR-2 :	*Explain the principle of size reduction and size enlargement of solid particles*
CLR-3 :	*Describe the methods of separations of particles through fluids*
CLR-4 :	*Elucidate the principles of filtration and working of various industrial filtration equipment*
CLR-5 :	*Explain the concept of agitation and mixing, and various types of impellers, design of turbines*
CLR-6 :	Describe the concepts of size reduction and particle handling

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO - 3
CLO-1 :	*Characterize the particles size analysis*	2	85	70	-	H	-	H	L	-	-	-	-	-	-	M	H	-	-
CLO-2 :	*Describe the size reduction machineries*	1	90	80	H	H	-	M	-	-	-	-	-	-	-	-	H	-	-
CLO-3 :	*Demonstrate the fluid-solid separation techniques*	3	85	75	H	H	M	H	-	-	M	-	-	-	-	-	H	-	-
CLO-4 :	*Formulate the filtration concepts and design the equipment*	2	85	75	H	H	H	H	-	-	M	-	-	-	-	-	H	-	-
CLO-5 :	*Apply the concepts of agitation and mixing in processes*	3	80	70	H	H	M	H	-	-	-	-	-	-	-	-	H	-	-
CLO-6 :	*Understand particle separation based on size and their handling*	3	80	70	H	H	M	H	-	-	-	-	-	-	-	-	H	-	-

Duration (hour)		**9**	**9**	**9**	**9**	**9**
S-1	SLO-1	*Characterization of solids: Particle shape and size*	*Purposes of size reduction*	*Motion of particles in fluid*	*Principles of Filtration*	*Introduction and purposes of mixing and agitation*
	SLO-2	*Mixed Particle size measurement techniques*	*Principles of Comminution*	*Free settling and Hindered settling*	*Mechanism of filtration*	*Agitation equipment*
S-2	SLO-1	*Specific surface area of mixture, Average particle size*	*Power and Energy requirements in size reduction*	*Gravity settling processes, Classifier and Clarifier*	*Filter Medium and Filter aids*	*Impellers : Turbines*
	SLO-2	*Tutorial on particle size*	*Crushing efficiency*	*Drag forces and Lift forces, Drag coefficient Terminal settling velocity*	*Cake and Filter medium Resistances*	*Propellers and Paddles*
S-3	SLO-1	*Tutorial on particle size*	*Empirical relationships-Rittinger's law, Kick's law, Bond's law*	*Settling under Stoke's law regime*	*Principles of cake filtration - Pressure drop through filter cake*	*Standard turbine design*
	SLO-2	*Tutorial on particle size*	*Tutorial on power required for size reduction*	*Newton's law regime*	*Compressible and incompressiblefilter cakes*	*Flow patterns inside the agitation vessel*
S-4	SLO-1	*Screen analysis: Differential and cumulative method*	*Tutorial on power required for size reduction*	*Tutorial on Stoke's law*	*Constant pressure Filtration*	*Prevention of swirling and vortex formation*
	SLO-2	*Standard screen series*	*Tutorial on power required for size reduction*	*Tutorial on Stoke's law*	*Constant rate filtration*	*Draft tubes*
S-5	SLO-1	*Screening equipment - Stationary screens and Grizzlies*	*Classification of size reduction equipments Crushers: Jaw crushers-Blake jaw*	*Sorting Classifiers: Sink and Float method*	*Tutorial on filtration*	*Flow number*
	SLO-2	*Gyrating screens, Vibrating screens*	*Gyratory crushers*	*Differential settling method and Equal settling*	*Tutorial on filtration*	*Calculation of power consumption in Newtonian liquids*
S-6	SLO-1	*Ideal and actual screens*	*Grinders: hammer mills, Impactors*	*Batch Sedimentation*	*Tutorial on filtration*	*Dimensional analysis*
	SLO-2	*Capacity and Screen effectiveness*	*Tumbling mills : Ball mill*	*Equipment for Sedimentation: thickeners*	*Tutorial on filtration*	*Power number correlation through Buckingham's π theorem*

S-7	SLO-1	*Tutorial on Screen effectiveness*	*Critical speed of Ball mill*	*Kynch theory of sedimentation*	*Filtration equipments*	*Power correlation*
	SLO-2	*Tutorial on Screen effectiveness*	*Tutorial on Ball mill*	*Design of thickener*	*Pressure Filters-Batch Process-Plate and Frame Filter press*	*Significance of dimensionless groups*
S-8	SLO-1	*Tutorial on Screen effectiveness*	*Ultrafine grinders - Fluid energy mills*	*Tutorial on sedimentation*	*Vacuum Filters*	*Tutorial on Power correlation*
	SLO-2	*Tutorial on Screen effectiveness*	*Cutting machines: Knife cutters*	*Tutorial on sedimentation*	*Continuous filters- Rotary Drum Vacuum filter*	*Tutorial on Power correlation*
S-9	SLO-1	*Storage and transportation of solids*	*Size enlargement*	*Flocculation and Froth floatation*	*Centrifugal filters–Types of centrifuges*	*Blending of miscible liquids*
	SLO-2	*Silos, Bins, Hoppers and conveyors*	*Open and Closed circuit operation*	*Cyclone Separators, Centrifugal decanters*	*Working mechanism of Suspended batch centrifuge*	*Type of Mixers and its application*

Learning Resources	1. *McCabe, W.L., Smith, J.C., Harriot, P., Unit Operations in Chemical Engineering, 7th ed., McGraw-Hill, 2005* 2. *Foust, A. S., Wenzel, L.A., Clump, C.W., Naus, L., Anderson, L.B., Principles of Unit Operations, 2nd ed., John Wiley & Sons, 2008*	3. *Badger W.L., Banchero J.T., Introduction to Chemical Engineering, Tata McGraw Hill, 1997* 4. *Coulson. J.M, Richardson. J.F, Backhurst.. J.R., Harker. J.M, Coulson & Richardson's Chemical Engineering, Vol. II, 5th ed., Butter worth Heinemann, Oxford, 2002* 5. *Swain. A, Patra H, Roy. G K, Mechanical Operations, Tata McGraw Hill, 2010*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts	
1. Dr. Mr. A. Subramaniam, PESCO Beam Environmental Solutions Pvt. Ltd.,	*1. Dr. Lima Rose Miranda, Anna University, limamiranda2007@gmail.com*	*1. Dr. K. Deepa, SRMIST*	
2. Mr. S. T. Kalaimani, CPCL, Chennai	*2. Dr. T. R. Sundararaman, Rajalakshmi Engineering College, sundararaman.tr@rajalakshmi.edu.in*	*2. Mr. K. Selvam, SRMIST*	*3. Mrs. D. Nanditha, SRMIST*

Course Code	18CHC207T	Course Name	HEAT TRANSFER	Course Category	C	Professional Core	L	T	P	C
							4	0	0	4

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Chemical Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Utilize heat transfer modes, evaluate rate of heat transfer, analyze steady, unsteady state conduction, evaluate heat transfer coefficient*
CLR-2 :	*Explain and analyze the basic concepts of natural and forced convection as applied to various flows and geometry.*
CLR-3 :	*Demonstrate the application of heat transfer principles in heat exchanger design*
CLR-4 :	*Explain the principles of radiation heat transfer*
CLR-5 :	*Describe the principles of evaporation and evaporator design*
CLR-6 :	*Describe the different modes of heat transfer, concepts and applications.*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1 Level of Thinking (Bloom)	Learning 2 Expected Proficiency (%)	Learning 3 Expected Attainment (%)	PLO 1 Engineering Knowledge	PLO 2 Problem Analysis	PLO 3 Design & Development	PLO 4 Analysis, Design, Research	PLO 5 Modern Tool Usage	PLO 6 Society & Culture	PLO 7 Environment & Sustainability	PLO 8 Ethics	PLO 9 Individual & Team Work	PLO 10 Communication	PLO 11 Project Mgt. & Finance	PLO 12 Life Long Learning	PLO 13 PSO - 1	PLO 14 PSO - 2	PLO 15 PSO - 3
CLO-1 :	*Evaluate rate of heat transfer, analyze steady state and unsteady state conduction and evaluate heat transfer coefficient*	2	80	75	H	M	L	-	-	-	-	-	-	-	-	-	M	-	-
CLO-2 :	*Evaluate heat transfer coefficient of natural, forced convection as applied to various flows and geometry*	2	80	75	H	M	L	-	-	-	-	-	-	-	-	-	M	M	-
CLO-3 :	*Design the heat exchangers*	2	80	75	H	H	H	L	-	-	-	-	-	-	-	-	M	M	L
CLO-4 :	*Analyze the principles of radiation heat transfer*	2	80	75	H	M	L	-	-	-	-	-	-	-	-	-	M	-	-
CLO-5 :	*Design the evaporators*	2	80	75	H	H	M	L	-	-	-	-	-	-	-	-	M	M	L
CLO-6 :	*Understand the concepts of heat transfer and the equipments*	2	80	75	H	M	L	-	-	-	-	-	-	-	-	-	M	-	-

Duration (hour)		12	12	12	12	12
S-1	SLO-1	*Introduction to various modes of heat transfer*	*Concept of heat transfer by convection. Natural and forced convection*	*Types of heat exchange equipments*	*Basic concepts of radiation*	*Introduction to Evaporation and its applications*
	SLO-2	*Concept of resistance to heat transfer.*	*Forced convection in systems of simple geometries- Flow over a flat plate*	*Co-current and counter -current flow in heat exchangers - Temperature distribution*	*Emissive power, Black body*	*Single effect and multiple effect evaporation*
S-2	SLO-1	*Fourier's law of heat conduction*	*Thermal boundary layer, flow across a cylinder*	*Double pipe heat exchanger*	*Gray body, emissivity, radiation intensity*	*Types of evaporators*
	SLO-2	*Effect of temperature on thermal conductivity*	*Mean temperature difference, LMTD*	*Shell and tube heat exchanger-single pass and multipass*	*Laws of radiation: Stefan-Boltzmann law, Planck's law, Wien's displacement law*	*Working principle of Long tube vertical evaporators: Falling film evaporators*
S-3	SLO-1	*Steady state conduction of heat through a plane wall*	*Application of dimensional analysis for convection*	*Baffles and tube arrangements*	*Kirchhoff's law*	*Climbing film evaporators*
	SLO-2	*Steady state conduction of heat through a hollow cylinder*	*Heat transfer correlations for natural Convection- Free convection from a flat surface, cylinder*	*multi -pass shell and tube heat exchanger, LMTD correction factor*	*View factor*	*Agitated film evaporators*
S-4	SLO-1	*Tutorial on conduction*	*Tutorial on LMTD*	*Fouling of a heat exchanger*	*Tutorial on Stefan-Boltzmann law*	*Evaporator capacity and economy*
	SLO-2	*Tutorial on conduction*	*Tutorial on LMTD*	*Tutorial on heat exchangers*	*Tutorial on Stefan-Boltzmann law*	*Boiling point elevation, Duhring's rule*
S-5	SLO-1	*Steady state conduction of heat through a composite plane wall*	*Heat transfer correlations for forced Convection*	*Process design considerations*	*Energy exchange between black bodies*	*Enthalpy balance equation for single effect evaporator*
	SLO-2	*Steady state conduction of heat through coaxial cylinders*	*Forced convection in laminar and turbulent flow in circular pipes*	*Enthalpy balance and heat duty calculation in double pipe heat exchanger*	*Gray surfaces: Energy exchange between two large parallel planes*	*Tutorial on Enthalpy balance*
S-6	SLO-1	*Problem solving on composite layers*	*Overall heat transfer coefficient.*	*Tutorial on heat exchangers*	*Energy exchange between two large parallel planes of different emissivity*	*Tutorial on Enthalpy balance*
	SLO-2	*Problem solving on composite layers*	*Relationship between individual and overall heat transfer coefficients*	*Tutorial on heat exchangers*	*Energy exchange between a small object placed in a large enclosure*	*Tutorial on evaporators*

S-7	SLO-1	*Problem solving on composite layers*	*Problem solving on Overall heat transfer coefficient.*	*Enthalpy balance and heat duty calculation in shell and tube heat exchanger*	*Problem solving on energy exchange*	*Tutorial on evaporators*
	SLO-2	*Steady state conduction in bodies with heat sources - The plane wall*	*Problem solving on Overall heat transfer coefficient.*	*Tutorial on heat exchangers design*	*Problem solving on energy exchange*	*Multiple effect evaporators: Methods of feeding*
S-8	SLO-1	*Steady state conduction in bodies with heat sources - The cylinder*	*Momentum and heat transfer analogies*	*Tutorial on heat exchangers design*	*Problem solving on energy exchange*	*Comparison between the methods of feeding*
	SLO-2	*Combined conductive and convective heat transfer and the concept of Heat Transfer Coefficient*	*Heat transfer to fluids with phase change- The Condensation Phenomenon*	*Tutorial on heat exchangers design*	*Problem solving on energy exchange*	*Effect of boiling point elevation in a multiple effect evaporator*
S-9	SLO-1	*Heat transfer between fluids separated by a plane wall*	*Film wise and drop wise condensation*	*The effectiveness- NTU method of heat exchanger analysis*	*Radiation shield*	*capacity and economy of multiple effect evaporators*
	SLO-2	*Heat transfer between fluids separated by a cylindrical wall*	*Heat transfer coefficientfor film wise condensation -condensation on vertical and horizontal cylinders*	*Expression for Effectiveness of parallel flow double pipe heat exchanger*	*Radiation intercepted by a shield placed between two large parallel planes*	*Enthalpy balance equation for multiple effect evaporator*
S-10	SLO-1	*Tutorial on Combined conductive and convective heat transfer*	*Tutorial on condensation*	*Expression for Effectiveness of counter current flow double pipe heat exchanger*	*Radiation intercepted by a shield in a cylindrical enclosure*	*Problem solving on evaporators effect*
	SLO-2	*Tutorial on Combined conductive and convective heat transfer*	*Tutorial on condensation*	*Tutorial on heat exchangers design*	*Radiation intercepted by a shield in a spherical enclosure*	*Tutorial on multiple effect evaporators*
S-11	SLO-1	*Critical insulation thickness, applications*	*Effect of non-condensable gases*	*Tutorial on heat exchangers design*	*Tutorial on Radiation shield*	*Tutorial on multiple effect evaporators*
	SLO-2	*Heat transfer from Extended surfaces – The Fins*	*The boiling phenomenon*	*Tutorial on heat exchangers design*	*Tutorial on Radiation shield*	*Tutorial on multiple effect evaporators*
S-12	SLO-1	*Unsteady state heat conduction - Introduction*	*The regimes of boiling in pool boiling*	*Tutorial on heat exchangers effectiveness*	*Tutorial on Radiation shield*	*Tutorial on multiple effect evaporators*
	SLO-2	*Unsteady state heat conduction –Cartesian coordinates*	*Correlations for pool boiling heat transfer*	*Tutorial on heat exchangers effectiveness*	*Tutorial on Radiation shield*	*Evaporator selection*

Learning Resources	1. *Holman J.P, Heat Transfer, 10th ed. Tata McGraw Hill, 2010* 2. *Binay K Dutta, Heat Transfer: Principles and Applications, PHI Learning Private Limited, 2010*	3. *Warren L. McCabe, Julian C. Smith, Peter Harriott, Unit Operations of Chemical Engineering, 7th ed., McGraw Hill Education, 2014*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

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2. Mr. S. T. Kalaimani, CPCL, Chennai	*2. Dr. T. R. Sundararaman, Rajalakshmi Engineering College, sundararaman.tr@rajalakshmi.edu.in*	*2. Ms. E. Kavitha, SRMIST*

	18CHC208T		PRINCIPLES OF MASS TRANSFER		*C*	*Professional Core*	L	T	P	C

Course Code		Course Name		Course Category			3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	18CHC303T
Course Offering Department	Chemical Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	*Explain the basic principles of mass transfer, Diffusion phenomena and rate of mass transfer*
CLR-2 :	*Illustrate various theories of mass transfer, dimensionless numbers and rate of mass transfer across fluid interfaces*
CLR-3 :	*Apply the principles of gas absorption and design an ideal tray/packed absorption tower*
CLR-4 :	*Demonstrate humidification and dehumidification operations and design the cooling tower*
CLR-5 :	*Explain the principles of drying, different types of driers and drying time for different drying periods*
CLR-6 :	*Describe the basics of mass transfer and their concepts*

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	Program Learning Outcomes (PLO) 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO - 3
CLO-1 :	*Gain basic knowledge of mass transfer principles, and solve diffusion problems for fluids*	2	80	75	H	H	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-2 :	*Determine mass transfer coefficients and identify rate controlling mechanism*	2	80	75	H	H	M	L	-	-	-	-	-	-	-	-	M	M	-
CLO-3 :	*Design the absorption column and analyze the performance of packed and plate columns*	3	80	75	H	H	M	M	-	-	-	-	-	-	-	-	M	M	-
CLO-4 :	*Solve humidification and dehumidification problems and design cooling towers*	3	80	75	H	H	M	L	-	-	-	-	-	-	-	-	M	M	-
CLO-5 :	*Gain knowledge on the basic principles of drying, selection of driers and calculate drying time*	2	80	75	H	H	M	M	-	-	-	-	-	-	-	-	M	M	-
CLO-6 :	*Understand the fundamentals of mass transfer and the equipments*																		

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Introduction to Mass Transfer operations*	*Introduction to Mass transfer coefficients*	*Introduction to Gas absorption*	*Introduction to humidification*	*Introduction, Importance of drying in processes*
	SLO-2	*Diffusion and its types, Fick's I law of Diffusion*	*Types of mass transfer coefficients*	*Packing Characteristics*	*Humidity, dry bulb temperature, saturated gas, saturation humidity*	*principles of drying, wet Basis and dry basis calculations*
S-2	SLO-1	*Steady state molecular diffusion in fluids at rest and in laminar flow*	*Relationship between mass transfer coefficients*	*Types of tower packings*	*Relative humidity, percentage humidity, humid volume*	*Free moisture, equilibrium moisture, bound and unbound moisture*
	SLO-2	*Molecular diffusion in gases: steady state diffusion of A through non diffusing B*	*Dimensionless groups in mass transfer*	*Characteristics of solvent*	*Humid heat, total enthalpy, dew point*	*Mechanism of drying*
S-3	SLO-1	*Tutorial on diffusion*	*Simultaneous momentum, heat and mass transfer*	*Contact between liquid and gas*	*Concept of adiabatic saturation*	*Constant and falling rate period*
	SLO-2	*Gas phase equimolal counter diffusion. Diffusion in Multicomponent gas mixtures*	*Theories of mass transfer: film theory*	*pressure drop and limiting flow rates*	*Adiabatic saturation temperature*	*Rate of drying curve, critical moisture content*
S-4	SLO-1	*Tutorial on diffusion*	*Penetration theory*	*Material balances*	*Wet-bulb temperature, theory of wet-bulb temperature*	*Calculate drying time under constant drying conditions: constant rate period*
	SLO-2	*Tutorial on diffusion*	*surface-renewal Theory*	*limiting gas-liquid ratio*	*psychrometric line and Lewis relation*	*Calculate drying time: falling rate period Total drying time*
S-5	SLO-1	*Molecular diffusion in liquids: steady state diffusion of A through non diffusing B*	*Interphase Mass Transfer*	*Rate of absorption*	*Humidity chart, use of humidity chart*	*Tutorial on constant and falling rate period*
	SLO-2	*Tutorial on diffusion*	*Equilibrium between phases*	*calculation of tower height*	*Tutorial on humidification*	*Tutorial on drying*
S-6	SLO-1	*Tutorial on diffusion*	*Concentration profile in Interphase mass transfer*	*number of transfer units, height of transfer unit*	*Tutorial on humidification*	*Tutorial on drying*
	SLO-2	*Liquid phase equimolal counter diffusion*	*Two film theory*	*alternate forms of transfer coefficients*	*Tutorial on humidification*	*Classification of dryers, solids handling in dryers*
S-7	SLO-1	*Tutorial on counter diffusion*	*Mass transfer using Film Mass transfer Coefficients and Interphase concentrations*	*Tutorial on absorption*	*Types of Cooling towers*	*equipment's for batch and continuous drying processes*

	SLO-2	*Tutorial on counter diffusion*	*Overall Mass transfer Coefficients and Driving Forces*	*Tutorial on absorption*	*Working principle of cooling towers*	*Working principle of tray drier*
S-8	SLO-1	*Pseudo – steady state Diffusion.*	*Relation between individual and overall mass transfer coefficient*	*Absorption in plate columns: Determination of number of plates, Tray efficiencies*	*Design of a cooling tower*	*Working principle of rotary drier*
	SLO-2	*Tutorial on counter diffusion*	*Tutorial on mass transfer coefficient*	*Height equivalent to a theoretical plate (HETP)*	*NTU, HTU concept*	*Working principle of spray drier*
S-9	SLO-1	*Effect of temperature and pressure on diffusivity*	*Experimental determination of mass transfer coefficients*	*Tutorial on HETP*	*Tutorial on design of a cooling tower*	*Working principle of fluidized bed drier*
	SLO-2	*Tutorial on diffusivity*	*Tutorial on mass transfer coefficient*	*Introduction to absorption with chemical reaction*	*Tutorial on design of a cooling tower*	*Concept of freeze drying*

Learning Resources	1. *Robert E. Treybal, Mass-Transfer Operations, 3rd ed., McGraw Hill Education, 2012* 2. *Warren L. McCabe, Julian C. Smith, Peter Harriott, Unit Operations of Chemical Engineering, 7th ed., McGraw Hill Education, 2014*	3. *Christie John Geankoplis, Transport Processes and Separation Process Principles (Includes Unit Operations), 4th ed., Pearson India Education Services Pvt. Ltd., 2015* 4. *Binay K. Dutta, Principles of Mass transfer and Separation Processes, Prentice- Hall of India, New Delhi, 2007*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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2. Mr. S. T. Kalaimani, CPCL, Chennai	*2. Dr. T. R. Sundararaman, Rajalakshmi Engineering College, sundararaman.tr@rajalakshmi.edu.in*	*2. Ms. E. Kavitha, SRMIST*

Course Code	18CHC209L	Course Name	CHEMICAL ENGINEERING LAB - I	Course Category	C	Professional Core	L	T	P	C
							0	0	4	2

Pre-requisite Courses	18CH206T, 18CHC205T	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Chemical Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Utilize solid handling techniques as size reduction & particle separation techniques using Crushing, grinding and screening equipments
CLR-2 :	Demonstrate the of Filtration techniques and design of filters
CLR-3 :	Analyze the fluid - Solid separation techniques and to design of thickener
CLR-4 :	Analyze the metering of fluids and Frictional loss calculation
CLR-5 :	Compare the transportation devices and design the pumps
CLR-6 :	Demonstrate the concepts of mechanical operation and the fluid mechanics.

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO - 3
CLO-1 :	Handle the size reduction machineries	1	80	75	M	L							H						
CLO-2 :	Learn the fundamentals and understand the design of filters	2	80	75	H	M	M	M					L						
CLO-3 :	Differentiate the fluid–Solid separation techniques and can implement the knowledge in design the equipments	3	90	80	H	M	M	M					L			H			
CLO-4 :	Interpret the knowledge in design of piping system	2	80	75	M	M	L	M					L			H			
CLO-5 :	Operate and execute the knowledge to design of pumps	2	80	75	L	L	L						L			H			
CLO-6 :	Analyze the various size reduction techniques and fluid flow.	1	80	75	M	L							H						

Duration (hour)		12	12	12	12	12
S 1-4	SLO-1	Determine Average Particle Size using Sieve Analysis method	Calculate efficiency of given cut diameter opening of Sieve using Screen Effectiveness method	Find size reduction ratio of the given Solid material Using Jaw crusher	Calculate size reduction ratio of the given substance using Ball Mill and to find the critical speed of mill	Analyze settling of particle under gravity using batch sedimentation set up and design of thickener
	SLO-2					
S 5-8	SLO-1	Find the particle size and collection efficiency using Cyclone separator	Calculate Cake and medium resistance using plate and frame filter press	Determine Conveyance efficiency of Screw Conveyor	Calculate Cake and Medium resistance using Vacuum leaf filter	Find the size reduction ratio of the given material using Drop Weight Crusher
	SLO-2					
S 9-12	SLO-1	Find the Orifice Coefficient using Orifice Meter and Venturi meter	Determine discharge coefficient on V-Notch in open flow channel	Verify relationship between Reynolds number and friction factor using pipe friction test Rig.	Verify performance Characteristics of pumps	Calculate Pressure drop of flow through packed bed
	SLO-2	Find the discharge coefficient using Rota Meter	Calculate pressure loss coefficient of contraction, Expansion and fittings on pipe			Calculate minimum fluidization velocity of flow through Fluidized bed

Learning Resources	1. McCabe, W.L., Smith, J.C., and Harriot, P., Unit Operations in Chemical Engineering, 7th ed., McGraw-Hill, 2005.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember / Understand	-	40 %	-	30 %	-	30 %	-	30 %	-	30%
Level 2	Apply / Analyze	-	40 %	-	40 %	-	40 %	-	40 %	-	40%
Level 3	Evaluate / Create	-	20 %	-	30 %	-	30 %	-	30 %	-	30%
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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1. Mr. A. Subramaniam, PESCO Beam Environmental Solutions Pvt. Ltd.,	1. Dr. Lima Rose Miranda, Anna University, limamiranda2007@gmail.com	1. Dr. K. Selvam, SRMIST
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ACADEMIC CURRICULA

Professional Core Courses

CIVIL ENGINEERING

Regulations - 2018

SRM
INSTITUTE OF SCIENCE & TECHNOLOGY
(Deemed to be University u/s 3 of UGC Act, 1956)

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Kancheepuram, Tamil Nadu, India

Course Code	18CEC201T	Course Name	ENGINEERING GEOLOGY	Course Category	C	*Professional Core*	L	T	P	C
							3	1	0	4

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Identify the various geological processes*
CLR-2 :	*Analyze the Minerals of Earth crust*
CLR-3 :	*Analyze about the Rocks of the Earth Crust*
CLR-4 :	*Interpret the various geological structures*
CLR-5 :	*Utilize the geological investigations Techniques*
CLR-6 :	*Identify Geological considerations for civil engineering projects*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO - 3
CLO-1 :	*Identify the geological agencies and their actions*	2	85	80	H	-	-	-	-	-	M	-	L	-	-	H	H	-	-
CLO-2 :	*Identify the physical property of rock forming minerals*	2	85	75	H	-	-	-	-	-	M	-	L	-	-	H	H	-	-
CLO-3 :	*Classify, Structure, Identify texture and the distribution of various types rocks*	2	80	75	H	-	-	-	-	-	H	-	L	-	-	H	H	-	-
CLO-4 :	*Interpret the various geological structure*	2	85	80	H	-	-	-	-	-	H	-	L	-	-	H	H	-	-
CLO-5 :	*Analyze the investigation techniques*	3	85	75	H	-	H	M	-	-	H	-	M	-	-	H	H	-	-
CLO-6 :	*Analyze the primary measures for civil Engineering projects*	3	80	75	H	H	H	H	-	-	H	-	M	-	-	H	H	-	-

Duration (hour)		12	12	12	12	12
S-1	SLO-1	*Applications of Geology in Civil Engineering*	*Physical properties of minerals and its identification methods*	*Rocks of the earth crust*	*Discontinuities in the rock &Structure of the Rock*	*Geology for Engineering Projects - Topography and types of land forms, reading of Toposheet*
	SLO-2	*Internal structure of Earth*	*chemical and optical properties of minerals and its role in Alkalinity reactivity*	*Types of rocks and kinds of building materials*	*Contour and drainage map analysis to determine topography, slope of the ground*	*Geological mapping methods of a construction site*
S-2	SLO-1	*Endogenous process- Earthquake & Plate Tectonics*	*Physical properties of quartz group minerals and its optical properties- strained quartz analysis –cement bonding effects*	*Igneous Rocks- Types, composition, alteration process*	*Attitude of rocks- DIP & Strike*	*Geological mapping of subsurface topography*
	SLO-2	*Physical weathering-process, merits and demerits of weathering zones in project area*	*Physical properties of Feldspar group minerals and optical properties. Chemical reaction of feldspars and formation of clay*	*Igneous Rocks- structure, veins, caves,*	*Geological Structures – Folds*	*Geophysical Investigations –Self potential method*
S-3	SLO-1	*Chemical and biological Weathering process, merits and demerits of weathering zones in project area*	*Mica group of minerals, types and deleterious minerals*	*Engineering Properties, of the Igneous rocks – Granite, Diorite, dolerite, Basalt, Biotite granite, felsic granite*	*Fold Classification*	*Geophysical Investigations –equipotential and potential drop method*
	SLO-2	*Products of weathering**,** Weathering grade analysis- with strength of the rocks*	*Mafic minerals, types and deleterious minerals**,** Identification of minerals Quartz minerals-strained quartz analysis –cement bonding effects*	*Igneous rocks – composition and structure; response to rock strength Engineering properties of Igneous rocks as foundation rock and aggregates*	*Fold signification in geological investigations**,** Fold axis and determination of orientation of rock*	*Seismic methods-Reading seismic lines and deciphering subsurface stratal geology*
S-4	SLO-1 SLO-2	*Tutorial*	*Tutorial*	*Tutorial*	*Tutorial*	*Tutorial*
S-5	SLO-1	*Groundwater- origin, factors of formation, types, water table, Groundwater quality*	*Pyroxene group of Minerals*	*Sedimentary Rocks- Types*	*Geological Structures – Fault*	*GPR technology and subsurface mapping Gravitational techniques*
	SLO-2	*Rainwater harvesting methods, Drainage patterns*	*Amphibole group of Minerals*	*Conglomerate, breccia, Sand, sandstone, composition, quality analysis, alteration signatures*	*Fault Classification*	*Remote Sensing Techniques for civil engineering*

S-6	SLO-1	Exploration method of Groundwater-Electrical resistivity survey technique	Gem group of Minerals	Limestone, types, composition, properties, solution reactivity and cave formation	Fault Classification	Applications of satellite mapping methods
	SLO-2	Geomorphic landforms performed at-Desert, lands (wind) merits and demerits for civil engineering. projects	Properties of Gypsum	Clay minerals types formation and Engineering properties	Geological Structures – Joints	Geological Considerations for Dam
S-7	SLO-1	Geomorphic landforms performed by sea erosion, merits and demerits for civil engineering. projects	Physical Properties of Calcite	Engineering Properties of the Sedimentary rocks-, Breccia and Conglomerate, sandstone and limestone	Joint Classification	Geological Considerations for Dam
	SLO-2	Geomorphic landforms performed at ice covered lands merits and demerits for civil engineering. projects	Physical Properties of Gypsum,mica	Metamorphic Rock types, description of gneiss, quartzite, marble, slate, schist, phyllite	Joint Classification	Geological Considerations for Dam
S-8	SLO-1 SLO-2	Tutorial	Tutorial	Tutorial	Tutorial	Tutorial
S-9	SLO-1	Geomorphic landforms performed at River Erosion its merits and demerits for civil engineering. projects	Clay minerals and, types	Metamorphic rocks Textures and structures,	Engineering Considerations of Fold	Geological Considerations for Reservoirs
	SLO-2	Landforms performed at River deposition, its merits and demerits for civil engineering. projects	Clay properties as lining and filter materials	Engineering properties of metamorphic rocks	Engineering Considerations of Fold	Geological Considerations for Reservoirs
S-10	SLO-1	Coastal erosional and depositional land forms	Engineering properties of Clay	Preparation of Fence diagram and delineation of subsurface rock layers	Engineering Considerations of Fault	Geological Considerations for hard and soft Tunnels
	SLO-2	Sea water dynamics and Coastal protection structures	Coal deposits and mines in India	Litho core/Borehole rock analysis	Engineering Considerations of Fault	Geological Considerations for Tunnels and Road Cuts
S-11	SLO-1	Landslides, causes for landslides, factors.	Coal properties	Rock litho core analysis,	Engineering Considerations of Joint	Demonstration of Clinometer, Brunton, GPS, GPR
	SLO-2	Types of landslides, landslide mitigation structures	Petroleum deposits of India	Determination of rock strength	Engineering Considerations of Joint	Identification of maps, type of soils,
S-12	SLO-1 SLO-2	Tutorial	Tutorial	Tutorial	Tutorial	Tutorial

Learning Resources	1. Garg .S.K, Physical and Engineering Geology, Khanna Publication, New Delhi, 1999 2. Parbin Singh, Engineering and General Geology, Katson Publication House, 2010 3. Maruthesha Reddy M.T, Engineering Geology Practical, New Age International Pvt Ltd, 2003 4. Legeet, Geology and Engineering, McGraw Hill Book Company, 1998	5. Blyth, Geology for Engineers, ELBS, 1995 6. NPTEL: Earth Sciences for Civil Engineering Part I. https://onlinecourses.nptel.ac.in/noc18_ce12/preview 7. NPTEL: Subsurface exploration :importance and techniques. https://onlinecourses.nptel.ac.in/noc19_ce10/preview

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
Level 2	Apply Analyze	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
Level 3	Evaluate Create	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts	
1. Dr. Sarunjith K J, National Centre for Sustainable Coastal Management, sarunjith@ncscm.res.in	Dr. R. Nagendra, Anna University, geonag@gmail.com	Dr. R Annadurai, SRMIST	Dr. Sachikanta Nanda, SRMIST
2. Dr. Nagasundaram M, Geological Survey of India, nagasundaram.m@gsi.gov.in	Dr. S. G. D. Shreedhar, University of Madras, sgd.sri@unom.ac.in	Dr. Aparna S Bhaskar, SRMIST	

Course Code	18CEC202T	Course Name	FLUID MECHANICS	Course Category	C	*Professional Core*	L	T	P	C
							2	1	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*18CEC202L*	Progressive Courses	*18CEC206T*
Course Offering Department	*Civil Engineering*	Data Book / Codes/Standards	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Utilize the various properties of fluids*
CLR-2 :	*Analyze hydrostatics, buoyancy; stability of floating and submerged bodies*
CLR-3 :	*Utilize pressure measuring devices*
CLR-4 :	*Analyze concepts of fluid kinematics*
CLR-5 :	*Apply fluid dynamics for practical applications*
CLR-6 :	*Utilize the concepts of flow through pipes in real time applications*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1 Level of Thinking (Bloom)	Learning 2 Expected Proficiency (%)	Learning 3 Expected Attainment (%)	PLO 1 Engineering Knowledge	PLO 2 Problem Analysis	PLO 3 Design & Development	PLO 4 Analysis, Design, Research	PLO 5 Modern Tool Usage	PLO 6 Society & Culture	PLO 7 Environment & Sustainability	PLO 8 Ethics	PLO 9 Individual & Team Work	PLO 10 Communication	PLO 11 Project Mgt. & Finance	PLO 12 Life Long Learning	PLO 13 PSO - 1	PLO 14 PSO - 2	PLO 15 PSO - 3
CLO-1 :	*Identify the various properties of fluid*	2	85	80	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-2 :	*Analyze hydrostatic pressure force*	3	85	75	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-3 :	*Apply hydrostatic laws in various pressure measuring devices*	3	85	75	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-4 :	*Identify the importance of fluid kinematics*	2	85	80	H	H	-	M	-	-	-	-	-	-	-	-	H	-	-
CLO-5 :	*Identify the applications of fluid dynamics*	2	80	75	H	H	-	M	-	-	-	-	-	-	-	-	H	-	-
CLO-6 :	*Analyze laminar and turbulent flow in pipes*	3	85	75	H	H	-	M	-	-	-	-	-	-	-	-	H	-	-

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Fluid properties Importance, application of fluid mechanics*	*U tube differential manometer, upright and inverted differential manometer*	*Stream line, path line, streak line and stream tube*	*Momentum equation*	*Pipes in series and parallel*
	SLO-2	*Distinction between fluid and solid, mass density, specific weight, specific gravity*	*Mechanical gauges*	*Velocity potential function*	*Force exerted by a flowing fluid on a pipe bend*	*Equivalent pipes*
S-2	SLO-1	*Newton's law of viscosity, kinematic and dynamic viscosity*	*Fluid statics: Hydrostatic pressure force: horizontal and vertical surfaces*	*Stream function*	*Free liquid jets, Maximum height attained by the jet*	*Flow through syphon*
	SLO-2	*Variation of viscosity with temperature and pressure*	*Hydrostatic pressure force: inclined surfaces*	*Flow net*	*Time of flight, time to reach highest point, horizontal range of the jet*	*Branching of pipes*
S-3	SLO-1	*Solving problems using tutorial sheet 1*	*Solving problems using tutorial sheet 4*	*Solving problems using tutorial sheet 7*	*Solving problems using tutorial sheet 10*	*Solving problems using tutorial sheet 13*
	SLO-2	*Solving problems using tutorial sheet 1*	*Solving problems using tutorial sheet 4*	*Solving problems using tutorial sheet 7*	*Solving problems using tutorial sheet 10*	*Solving problems using tutorial sheet 13*
S-4	SLO-1	*Surface tension on liquid droplet, hollow bubble and liquid jet*	*Hydrostatic pressure force on curved surfaces*	*Control volume, continuity equation in cartesian coordinate system*	*Flow through pipes*	*Two reservoir problem*
	SLO-2	*Capillarity*	*Buoyancy, center of buoyancy*	*Forced vortex flow and free vortex flow*	*Laminar flow in circular pipes, Hagen–Poiseuille equation*	*Three reservoir problem*
S-5	SLO-1	*Bulk modulus of elasticity, compressibility*	*Metacenter and metacentric height*	*Fluid dynamics*	*Turbulent flow in pipes, Velocity distribution for turbulent flow*	*Water hammer in pipes*
	SLO-2	*Vapour pressure, boiling point and cavitation*	*Stability of floating and submerged bodies*	*Euler's equation and Bernoulli's equation*	*Reynolds experiment, frictional loss in pipe flow, Darcy Weisbach equation, minor energy losses*	*Power transmission through pipe*
S-6	SLO-1	*Solving problems using tutorial sheet 2*	*Solving problems using tutorial sheet 5*	*Solving problems using tutorial sheet 8*	*Solving problems using tutorial sheet 11*	*Solving problems using tutorial sheet 14*
	SLO-2	*Solving problems using tutorial sheet 2*	*Solving problems using tutorial sheet 5*	*Solving problems using tutorial sheet 8*	*Solving problems using tutorial sheet 11*	*Solving problems using tutorial sheet 14*

S-7	SLO-1	*Fluid pressure at a point, Pascal's law*	*Fluid kinematics*	*Practical applications of Bernoulli's equation, venturimeter*	*Loss due to sudden enlargement and contraction*	*Condition for maximum power transmission*
	SLO-2	*Pressure variation in a fluid at rest; absolute and gauge pressures*	*Classification of fluid flow*	*Horizontal, vertical and inclined venturimeters*	*Loss of head at the entrance and exit of the pipe*	*Boundary layer theory Boundary layer definitions, characteristics*
S-8	SLO-1	*Piezometer, U-tube manometer*	*Velocity and acceleration*	*Orificemeter*	*Loss of head due to an obstruction in a pipe*	*Boundary layer thickness and displacement thickness*
	SLO-2	*Single column manometer*	*Local acceleration and convective acceleration*	*Pitot tube*	*Hydraulic Gradient Line (HGL) and Total Energy Line (TEL)*	*Momentum thickness and energy thickness*
S-9	SLO-1	*Solving problems using tutorial sheet 3*	*Solving problems using tutorial sheet 6*	*Solving problems using tutorial sheet 9*	*Solving problems using tutorial sheet 12*	*Solving problems using tutorial sheet 15*
	SLO-2	*Solving problems using tutorial sheet 3*	*Solving problems using tutorial sheet 6*	*Solving problems using tutorial sheet 9*	*Solving problems using tutorial sheet 12*	*Solving problems using tutorial sheet 15*

Learning Resources	1. *Modi, P.N., Seth S.M., Hydraulics and Fluid Machines, Standard book house, 2005* 2. *Subramanya, K., Theory and application of fluid mechanics, Tata McGraw Hill, 2002*	3. *Rajput R.K., Fluid Mechanics and Hydraulic Machines, S.Chand, 2014* 4. *Bansal R.K., Fluid Mechanics and Hydraulic Machines, Laxmi Publication, 2017* 5. *NPTEL Course - Introduction to Fluid Mechanics https://onlinecourses.nptel.ac.in/noc19_me15/preview*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Abdul Hakeem, National Remote Sensing Center, Hyderabad, abdulhakeem_k@nrsc.gov.in	*1. Dr. R. Saravanan, Anna University, rsaran@annauniv.edu*	*1. Dr. R. Sathyanathan, SRMIST*
2. Dr. Sat Kumar Tomer, Satyukt Analytics Pvt Ltd., Bengaluru, sat@satyukt.com	*2. Dr. S. Saravanan, NIT Trichy, saravanans@nitt.edu*	*2. Dr. Deeptha Thattai, SRMIST*

Course Code	18CEC202L	Course Name	FLUID MECHANICS LABORATORY	Course Category	C	Professional Core	L	T	P	C
							0	0	2	1

Pre-requisite Courses	*Nil*	Co-requisite Courses	*18CEC202T*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Utilize pressure measurement for real-time applications*
CLR-2 :	*Utilize buoyancy for real-time applications*
CLR-3 :	*Analyze the applications of Bernoulli's principle*
CLR-4 :	*Utilize the functions of orificemeter, venturimeter and pitot tube*
CLR-5 :	*Identify the losses in pipes*
CLR-6 :	*Utilize the functions of orifice and mouthpiece*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO - 3
CLO-1 :	*Apply the concept of Pascal's law*	3	90	85	H	M		-	-	-	-	-	H	-	-	-	H	-	H
CLO-2 :	*Identify the applications of buoyancy*	3	85	80	H	M	-	-	-	-	-	-	H	-	-	-	H	-	H
CLO-3 :	*Identify the applications of Bernoulli's principle*	3	90	85	H	M	-	-	-	-	-	-	H	-	-	-	H	-	H
CLO-4 :	*Identify the working principle, components and functions of orificemeter, venturimeter and pitot tube*	3	85	80	H	M	-	-	-	-	-	-	H	-	-	-	H	-	H
CLO-5 :	*Estimate the losses in pipes*	3	85	80	H	M	-	-	-	-	-	-	H	-	-	-	H	-	H
CLO-6 :	*Identify the working principle, and functions of orifice and mouthpiece*	3	85	80	H	M	-	-	-	-	-	-	H	-	-	-	H	-	H

Duration (hour)		6	6	6	6	6
S 1-2	SLO-1 / SLO-2	*Determine pressure using U-tube manometer*	*Verify Bernoulli's equation*	*Determine coefficient of discharge for orificemeter*	*Determine coefficient of velocity for pitot tube*	*Determine loss coefficient for sudden enlargement*
S 3-4	SLO-1 / SLO-2	*Determine metacentric height for a ship model*	*Determine coefficient of discharge for venturimeter*	*Measure flow using orificemeter*	*Determine friction factor of the pipe material*	*Determine coefficient of discharge of orifice*
S 5-6	SLO-1 / SLO-2	*Determine metacentric height for a rectangular log*	*Measure flow using venturimeter*	*Determine coefficient of discharge for rotameter*	*Determine loss coefficient for sudden contraction*	*Determine coefficient of discharge of mouthpiece*

Learning Resources	
	1. *Modi, P.N., Seth S.M., Hydraulics and Fluid Machines, Standard book house, 2005*
	2. *Subramanya, K., Theory and application of fluid mechanics, Tata McGraw Hill, 2002*
	3. *Rajput. R. K, Fluid Mechanics and Hydraulic Machines, S. Chand and Company Ltd.,2013*
	4. *Laboratory Manual for Hydraulic Engineering Laboratory, SRMIST*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember / Understand	-	40 %	-	30 %	-	30 %	-	30 %	-	30%
Level 2	Apply / Analyze	-	40 %	-	40 %	-	40 %	-	40 %	-	40%
Level 3	Evaluate / Create	-	20 %	-	30 %	-	30 %	-	30 %	-	30%
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Abdul Hakeem, National Remote Sensing Center, Hyderabad, abdulhakeem_k@nrsc.gov.in	*1. Dr. R. Saravanan, Anna University, rsaran@annauniv.edu*	*1. Dr. R. Sathyanathan, SRMIST*
2. Dr. Sat Kumar Tomer, Satyukt Analytics Pvt Ltd., Bengaluru, sat@satyukt.com	*2. Dr. S. Saravanan, NIT Trichy, saravanans@nitt.edu*	*2. Mr. Shaik Niyazuddin Guntakal, SRMIST*

Course Code	18CEC203T	Course Name	MECHANICS OF STRUCTURES	Course Category	C	*Professional Core*	L	T	P	C
							2	1	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*18CEC203L*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Utilize the concepts of stresses in compound sections and principal stresses and principal strains*
CLR-2 :	*Analyze determinate beams for bending moment and shear force*
CLR-3 :	*Utilize Computation of stresses in beam cross section*
CLR-4 :	*Utilize Computation of slope and deflection of beams and analysis of determinate and indeterminate trusses*
CLR-5 :	*Analyze columns and application of theories of failures*
CLR-6 :	*Utilize concepts of static indeterminacy and analysis of indeterminate beams*

		Learning			**Program Learning Outcomes (PLO)**														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Analyze the state of stress, evaluate principal stresses and principal strains including stresses in compound sections*	3	80	75	H	H	-	-	-	-	-	-	-	-	-	-	H	-	H
CLO-2 :	*Determine bending moment and shear force distribution along the beam*	3	85	75	H	H	-	-	-	-	-	-	-	-	-	-	H	-	H
CLO-3 :	*Determine bending and shear stress distribution across the cross section of rectangular, 'I', 'T' sections.*	3	75	75	H	H	-	H	-	-	-	-	-	-	-	-	H	-	H
CLO-4 :	*Compute slope, deflection of beams (Macaulay's, conjugate beam method) analyze determinate, indeterminate trusses*	3	90	80	H	H	-	-	-	-	-	-	-	-	-	-	H	-	H
CLO-5 :	*Analyze columns using Euler's, Rankine's theories of columns, theories of failure in real time applications*	3	85	75	H	H	-	-	-	-	-	-	-	-	-	-	H	-	H
CLO-6 :	*Apply Macaulay's method, Clapeyron's theorem to solve indeterminate beam problems*	3	80	75	H	H	-	-	-	-	-	-	-	-	-	-	H	-	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	***STRESSES IN COMPOUND SECTIONS*** *Principles of composite sections*	***DETERMINATE BEAMS – BENDING AND SHEAR FORCE DIAGRAMS*** *Determinate structures, Types of beams, load and its types.*	***DETERMINATE BEAMS – SLOPE AND DEFLECTION*** *Definition of slope and deflection:*	***COLUMNS*** *Classifications of columns, failure of column*	***INDETERMINATE BEAMS*** *Introduction to static & kinematic indeterminacy*
	SLO-2	*Analysis of compound sections*	*Shear force and bending moments: definitions, sign conventions*	*Definition of elastic line, differential equation of flexure*	*Euler's column theory limitations, end conditions, effective length, slenderness ratio*	*Static and kinematic indeterminacy of two and three dimensional pin jointed structures*
S-2	SLO-1	*Thermal stresses and strains*	*BM diagrams plotted on tension side, SF diagrams, cantilever beams*	*Slope and deflections of determinate structures - Macaulay's method*	*Solving Problems*	*Static and kinematic Indeterminacy of two and three dimensional rigid jointed structures*
	SLO-2	*Simple and compound bars.*	*SF and BM Diagrams for simply supported beams*	*Solving Problems*	*Solving Problems*	*Analysis of indeterminate beams, propped cantilever beams - Macaulay's Method*
S-3	SLO-1 SLO-2	*Tutorials*	*Tutorials*	*Tutorials*	*Tutorials*	*Tutorials*
S-4	SLO-1	***STRESSES AT A POINT*** *Introduction to principal stresses and strains*	*SF and BM Diagrams for over-hanging beams*	*Slope and deflections of determinate structures - Conjugate beam method.*	*Rankine's formula, factor of safety*	*Analysis of fixed beam by Macaulay's method*
	SLO-2	*Two dimensional stresses without shear stress*	*beams with internal hinges, point of contra flexure*	*Solving Problems*	*Column with eccentricity, core / kernel section.*	*Introduction to Clapeyron's theorem of three moments*
S-5	SLO-1	*Two dimensional stressesLike and unlike stresses, with shear stress*	*Relationship between load, shear force and bending moment.*	***PIN JOINTED TRUSSES*** *Analysis of determinate trusses.*	***THEORIES OF FAILURES*** *Introduction to theories of failures*	*Analysis - Continuous beams*
	SLO-2	*Introduction to three dimensional stresses*	***BENDING / SHEAR STRESSES**: Pure bending, bending equation – Bending / Shear stress distribution*	*Determination of deflection at the tip of the cantilever determinate truss*	*Application of maximum principal stress theory*	*Analysis of Continuous beams with settlement of supports*
S-6	SLO-1 SLO-2	*Tutorials*	*Tutorials*	*Tutorials*	*Tutorials*	*Tutorials*

S-7	SLO-1	*Three dimensional stresses, stress invariants.*	*Neutral axis, moment of resistance, section modulus*	*Indeterminate Trusses - Energy method - Analysis of indeterminate pin jointed - Plane trusses of degree of indeterminacy equal to 1*	*Application of maximum principal strain theory*	*Solving problems on two span continuous beam with simple supports*
	SLO-2	*Stresses in thin cylinder and spherical shells*	*Bending stresses, symmetrical sections.*	*Analysis of Trusses due to lack of fit*	*Application of stress difference theory*	*Solving problems on two span continuous beam end support (s) fixed*
S-8	SLO-1	*Concept of product of inertia, parallel axes theorem*	*Shear stresses: Shear stress at a section, shear flow*	*Analysis of Trusses subjected to temperature effects.*	*Application of strain energy theory*	*Solving three span continuous beams with simple end supports and fixed end supports.*
	SLO-2	*Principal moment of inertia*	*shear stress distribution for different sections.*	*Concept of solving indeterminate trusses with degree of indeterminacy greater than one*	*Application of shear strain energy theory*	*Principle of forming deflection equation - Macaulay's method.*
S-9	SLO-1 SLO-2	*Tutorials*	*Tutorials*	*Tutorials*	*Tutorials*	*Tutorials*

Learning Resources	1. *Devdas Menon, Structural Analysis, 1st ed., Narosa, 2013* 2. *R.C.Hibbeler,Structural Analysis, 9th ed., Pearson India, 2017* 3. *R.C.Hibbeler, Mechanics of Materials, 9th ed.,Pearson India, 2018* 4. *Ramamamrutham.S, Narayan.R, Strength of Materials, 18th ed., Dhanpat Rai Publishing Company, 2014*	5. *Rajput.R. K, Strength of Materials: Mechanics of Solids,5th ed., S. Chand Limited, 2010* 6. *Punmia.B.C, Ashok.K.Jain, Arun.K.Jain, Theory of Structures, 12th ed., Laxmi Publicaitions, 2014* 7. *NPTEL Course: Mechanics of Solids. https://onlinecourses.nptel.ac.in/noc17_ce17/preview* 8. *NPTEL Course: Strength of Materials https://onlinecourses.nptel.ac.in/noc18_ce17/preview*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Er. G.Hariharanath, GA Consultants, Chennai, gac1996@hotmail.com	*1. Dr. G. Appa Rao, Professsor, IIT Madras, garao@iitm.ac.in*	*1. Dr. K. Gunasekaran, SRMIST*
2. Er. AGV. Desigan, Design Group Engineering Consultancy Pvt Ltd. Chennai, desigan.agv@gmail.com	*2. Dr. C. Uma Rani, Professor, Anna University, umarani@annauniv.edu*	*2. Dr. P. R. Kannan Rajkumar, SRMIST*

Course Code	18CEC203L	Course Name	STRENGTH OF MATERIALS LABORATORY	Course Category	C	*Professional Core*	L	T	P	C
							0	0	2	1

Pre-requisite Courses	*Nil*	Co-requisite Courses	*18CEC203T*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Utilize the testing procedure to determine modulus of elasticity of steel, double shear test and hardness test*
CLR-2 :	*Utilize the testing procedure of torsional, impact strength of steel and also compressive strength of bricks and concrete*
CLR-3 :	*Utilize non-destructive testing technique of rebound hammer and UPV tests*
CLR-4 :	*Determine the stiffness and deflection of helical springs*
CLR-5 :	*Determine modulus of elasticity of concrete, split tensile strength and flexural strength of concrete*
CLR-6 :	*Utilize the testing procedure to determine bond strength between steel bar and concrete (pull-out test)*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO - 3
CLO-1 :	*Determine modulus of elasticity of steel, double shear test and hardness test*	3	90	85	H	M		-	M	-	-	-	H	-	-	-	H	-	H
CLO-2 :	*Identify torsional, impact strength of steel, identify compressive strength of bricks and concrete*	3	85	80	H	M	-	-	M	-	-	-	H	-	-	-	H	-	H
CLO-3 :	*Apply the knowledge of non-destructive testing technique of rebound hammer and UPV tests*	3	90	85	H	H	-	-	M	-	-	-	H	-	-	-	H	-	H
CLO-4 :	*Compute stiffness and deflection of helical springs*	3	85	80	H	M	-	-	M	-	-	-	H	-	-	-	H	-	H
CLO-5 :	*Determine modulus of elasticity of concrete, split tensile strength and flexural strength of concrete*	3	85	80	H	M	-	-	M	-	-	-	H	-	-	-	H	-	H
CLO-6 :	*Find bond strength between steel bar and concrete (pull-out test)*	3	85	80	H	M	-	-	M	-	-	-	H	-	-	-	H	-	H

Duration (hour)		6	6	6	6	6
S 1-2	SLO-1, SLO-2	*Determination of strength of steel specimen under impact test -Izod Test*	*Determination of strength of steel specimen under double shear test.*	*Determination of stiffness and deflection of helical springs.*	*Determination of split tensile strength of concrete cylinder.*	*Non Destructive Test using rebound hammer and UPV.*
S 3-4	SLO-1, SLO-2	*Determination of strength of steel specimen under torsion test*	*Determination of strength of concrete cube and bricks under compression tests.*	*Determination of strength of steel specimen under impact test - Charpy Test*	*Determination of flexural strength of concrete beam (two point load test).*	*To study the behavior of Castellated Steel Beam*
S 5-6	SLO-1, SLO-2	*Determination of hardness strength test on specimen using Rockwell & Brinell*	*Deflection Test on steel, aluminum specimens under central and non-central point load.*	*Determination of modulus of elasticity of steel from stress-strain graph by conducting tension test on steel.*	*Determination of bond strength between steel bar and concrete (pull-out test).*	*To study the stress patterns on different models using photo elasticity test-Demo*

Learning Resources

1. *IS 5816:1999 (Reaffirm – 2004), Splitting Tensile Strength of Concrete-Method of Test, Bureau of Indian Standards, New Delhi.*
2. *Strength of Materials Laboratory - Laboratory Manual, SRMIST*
3. *IS 516:1959 (Reaffirm – 2004), Method of Tests for Strength of Concrete, Bureau of Indian Standards, New Delhi.*
4. *IS 1500:2005, Method for Brinell Hardness Test for Metallic Materials -Method of Test, Bureau of Indian Standards, New Delhi.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember / Understand	-	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*
Level 2	Apply / Analyze	-	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*
Level 3	Evaluate / Create	-	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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2. Er. AGV. Desigan, Design Group Engineering Consultancy Pvt Ltd. Chennai, desigan.agv@gmail.com	*2. Dr. C. Uma Rani, Professor, Anna University, umarani@annauniv.edu*	*2. Dr. P. R. Kannan Rajkumar, SRMIST*

Course Code	18CEC204T	Course Name	ENGINEERING SURVEYING	Course Category	C	Professional Core	L	T	P	C
							2	1	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*18CEC204L*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Utilize chain, compass & Plane table surveying*
CLR-2 :	*Utilize concepts of Levelling*
CLR-3 :	*Utilize working procedures of theodolite surveying*
CLR-4 :	*Utilize operations of tachometric surveying*
CLR-5 :	*Utilize the knowledge of surveying in carrying out Civil Engineering works*
CLR-6 :	*Estimate the capacity of reservoirs, areas of embankments & setting out foundation trenches and curves*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO - 3
CLO-1 :	*Apply the principles and making of linear, direction measurements and creation of Plan/Map*	2	90	80	H	H	-	-	L	-	-	-	-	M	-	-	H	-	-
CLO-2 :	*Determine or set the altitude of the point/or set of points w.r.t the given datum*	3	85	75	H	H	-	-	M	-	-	-	-	M	-	-	H	-	-
CLO-3 :	*Measure the horizontal and vertical angle and derive the measurements at times of obstacle and inaccessible points*	3	80	75	H	H	-	-	M	-	-	-	-	M	-	-	H	-	-
CLO-4 :	*Apply knowledge of optics to make the angular measurements in rolling/hilly terrain*	3	85	80	H	H	-	-	M	-	-	-	-	M	-	-	H	-	-
CLO-5 :	*Set horizontal, vertical control and setting out works*	2	85	80	H	H	-	-	H	-	M	-	-	M	-	M	H	-	-
CLO-6 :	*Calculate areas, volumes and setting out curves*	3	80	75	H	H	-	-	H	-	M	-	-	M	-	M	H	-	-

Duration (hour)		9	9	9	9	9
S-1	SLO-1	***Surveying*** *Definition, Principles of Surveying*	*Methods: Radiation, Intersection*	***Theodolite*** *Vernier & microptic, description and uses Temporary Adjustments of Vernier transit*	*Horizontal & Vertical for staff held Inclined Elevation & Depression on Fixed Hair Systems, with and without Analytic Lens*	*Layout, setting out works for foundation trenches*
	SLO-2	*Classification of Surveying, Chain: Description, types of Chain & Accessories*	*Resection: two point &three-point Problem*	*Permanent Adjustments of the Vernier transit*	*Horizontal & Vertical for Normal staff Elevation & Depression. On Fixed Hair Systems, with &without Analytic Lens*	*Curves: Description & Components, Horizontal and Vertical curves, types*
S-2	SLO-1	*Conventional signs, Field & office work chaining*	*Levelling: Level Line, Horizontal Line, horizontal plane*	*Horizontal angles measurements: Radiation & Repetition Method*	*Movable Hair methods: Principle, Stadia constants, Analytic Lens*	*Simple curves: Terms & Components*
	SLO-2	*Ranging: Direct &Reciprocal ranging Procedures*	*Vertical Plane, datum, vertical line, elevation. Levels and Staves & types*	*Traversing, Closing error & distribution, Trigonometrical levelling: Heights & Distances*	*Tangential Systems: Both Angles are Angles of Elevation*	*Methods of Simple curves: setting with chain and tapes, Setting out procedure*
S-3	SLO-1 SLO-2	*Tutorial: Solving Problems*	*Tutorial: Solving Problems*	*Tutorial: Solving Problems*	*Tutorial: Solving Problems*	*Tutorial: Solving Problems*
S-4	SLO-1	*Setting perpendiculars, Well- conditioned triangles*	*Spirit level, sensitiveness, Bench marks & important Terminology in Levelling*	*Base of the Object accessible, Base of the object Inaccessible: Instrument station in the same vertical Plane as Elevated Object. (Single Plane Method)*	*Tangential Systems: Both Angles are angles of Depression*	*Methods of Simple curves Rankies method: Tangential angles by theodolite(Single Theodolite Method)*
	SLO-2	*Compass: Prismatic compass, Surveyor's compass*	*Temporary Adjustments of Vernier Transit*	*Base of the object Inaccessible: Instrument station in the same vertical Plane as Elevated Object*	*Tangential Systems: One Angle of Elevation and Other of Depression*	*Methods of Simple curves Rankies method: tangential angles by theodolite(Double Theodolite Method)*
S-5	SLO-1	*Meridians, Bearings & Types, Bearing systems &Types*	*Permanent adjustments of Vernier transit*	*Base of the object Inaccessible: Instrument station in the same vertical Plane as Elevated Object: Axis at different Levels*	*Substence Bar Method*	*Setting out procedure by rankies method, compound and reverse curves, Transition curves*

	SLO-2	*Conversions, Bearings to angles, Local Attraction: Definition & Corrections applied for Local Attraction*	*Longitudinal & cross-sectional Levelling & plotting*	*Base of the object Inaccessible: Instrumental Station not in the same vertical plane as the elevated object. (Double Plane Method)*	*Self-Reducing Tachometers*	*Contours: Definition, Contour Interval & Consideration Factors*
S-6	SLO-1 SLO-2	*Tutorial: Solving Problems*	*Tutorial: Solving Problems*	*Tutorial: Solving Problems*	*Tutorial: Solving Problems*	*Tutorial: Solving Problems*
S-7	SLO-1	*Adjustment of error, Graphical Method*	*Fly & Check Levelling, Height of collimation, rise & fall Method Booking & Reduction Types*	***Tacheometric Systems**: Merits of tacheometric Systems, Types Tangential, Stadia & Substense methods*	***Engineering Surveys**: Reconnaissance, Preliminary surveys for Engineering Projects*	*Contours, Contouring Methods*
	SLO-2	*Magnetic declination, dip, Traversing, Types & Plotting*	*Gradient & Missing Values on booking & Reduction*	*Stadia Systems: types, Principle of stadia systems*	*Location surveys for Engineering Projects*	*Characteristics of contours*
S-8	SLO-1	*Plane Table Surveying: Plane table instruments and accessories*	*booking & Reduction on levelling for inverted staff*	*Fixed Hair systems: stadia constants, analytic lens*	*Setting out Works, Aims Horizontal Control, Vertical control*	*Uses of contours*
	SLO-2	*Merits and demerits of Plane Table, & Operations of Plane Table*	*Curvature, Refraction & combined correction, Reciprocal Levelling*	*Horizontal & Vertical for staff held Inclined Elevation & Depression on Fixed Hair Systems*	*Base Lines & Types of Grids for carrying setting out works*	*Plotting – Calculation of areas and volumes*
S-9	SLO-1 SLO-2	*Tutorial: Solving Problems*	*Tutorial: Solving Problems*	*Tutorial: Solving Problems*	*Tutorial: Solving Problems*	*Tutorial: Solving Problems*

Learning Resources	1. *Kanetkar T., Surveying and Levelling, Vols. I &II, United Book Corporation, Pune, 2007* 2. *Punmia B.C, Surveying, Vols. I, 17th ed., Laxmi Publications, 2016* 3. *Chandra A.M, Plane Surveying and Higher Surveying, 3rd ed., New Age International (P) Limited, 2015* 4. *Clark.D, Plane and Geodetic Surveying, Vols. I & II, 17th ed., C.B.S. Publishers and Distributors, 2002*	5. *Punmia B.C, Surveying, Vols. II, 16th ed., Laxmi Publications, 2016* 6. *James M. Anderson, Edward M. Mikhail, Introduction to Surveying, 3rd ed., McGraw Hill, 2001* 7. *N N Basak, Surveying & Levelling, 1st ed., Tata Mc Graw Hill, 2015* 8. *Arora K.P, Surveying, Vol. 3,11th ed., Standard Book House, 2013* 9. *NPTEL course: Surveying (Web). https://nptel.ac.in/courses/105107122/1*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

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1. Er. Hariharanath, GA Consultants, Chennai, gac1996@hotmail.com	*1. Dr. K. Srinivasa Raju, Anna University, raju_irs@yahoo.com*	*1. Mr. K Prasanna, SRMIST*	*2. Ms. S Durga Devagi, SRMIST*
2. Er. AGV. Desigan, Design Group Engineering Consultancy Pvt Ltd. Chennai, designan.agv@gmail.com	*2. Dr. E.S.M. Suresh, NITTTR, Chennai, esmsuresh@gmail.com*	*3. Mr V Satya Ramesh Potti, SRMIST*	

Course Code	18CEC204L	Course Name	ENGINEERING SURVEYING LABORATORY	Course Category	C	*Professional Core*	L	T	P	C
							0	0	2	1

Pre-requisite Courses	*Nil*	Co-requisite Courses	*18CEC204T*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Utilize the principles of chain Surveying*
CLR-2 :	*Utilize the principles of Compass surveying*
CLR-3 :	*Utilize the application of principles of Plane table surveying*
CLR-4 :	*Utilize the principles of Levelling*
CLR-5 :	*Utilize the principles of operation of theodolite*
CLR-6 :	*Apply theodolite principle for measuring height and distance*

		Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*traverse and prepare the site layout*	*3*	*90*	*85*	*H*	*H*	*L*	-	*L*	-	-	-	*H*	*H*	-	-	*H*	-	*H*
CLO-2 :	*traverse, resulting in precise location of points using prismatic compass*	*3*	*85*	*80*	*H*	*H*	*L*	-	*L*	-	-	-	*H*	*H*	-	-	*H*	-	*H*
CLO-3 :	*Prepare site layouts*	*3*	*80*	*75*	*H*	*H*	*M*	-	*M*	-	-	-	*H*	*H*	-	-	*H*	-	*H*
CLO-4 :	*Profile land levels and contouring*	*3*	*85*	*80*	*H*	*H*	*M*	-	*M*	-	-	-	*H*	*H*	-	-	*H*	-	*H*
CLO-5 :	*Determine horizontal distance of the inaccessible target*	*3*	*85*	*80*	*H*	*H*	*H*	-	*M*	-	-	-	*H*	*H*	-	*L*	*H*	-	*H*
CLO-6 :	*Estimate the height of inaccessible target*	*3*	*80*	*75*	*H*	*H*	*H*	-	*M*	-	-	-	*H*	*H*	-	*L*	*H*	-	*H*

Duration (hour)		6	6	6	6	6
S 1-2	SLO-1 / SLO-2	*Chain surveying, Calculation of area using cross staff by Perpendicular offset*	*Traversing, Prismatic compass, Running closed and open compass traverse, plotting and adjustments of traverse*	*Resection, Field solution of two point problems*	*Reduction of levels by Rise and Fall method*	*Theodolite, Measure vertical angles and Height of the object*
S 3-4	SLO-1 / SLO-2	*Chain surveying, Calculation of area using cross staff by oblique offset*	*Plane table Surveying by Intersection Method*	*Resection, Field solution of Three point problems (Trial and Error method)*	*Theodolite, Measure horizontal angles by repetition method*	*Height and distance by Single Plane Method*
S 5-6	SLO-1 / SLO-2	*Traversing, measurement of bearing of survey lines by prismatic compass and correction of Local Attraction*	*Plane table Surveying by Radiation Method*	*Reduction of levels by Height of Collimation method*	*Theodolite, Measure horizontal angles by reiteration method*	*Height and distance by Double Plane Method*

Learning Resources	1. *Punmia B.C, Surveying, Vols. I, 17th ed., Laxmi Publications, 2016* 2. *Bhavikatti, S.S, Surveying and Leveling, Vol. I and II, I.K. International, 2010*	3. *Surveying Manual - SRMIST*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	-	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*
Level 2	Apply Analyze	-	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*
Level 3	Evaluate Create	-	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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Course Code	18CEC205T	Course Name	STRUCTURAL ANALYSIS	Course Category	C	*Professional Core*	L	T	P	C
							2	1	0	3

Pre-requisite Courses	*18CE203T*	Co-requisite Courses	*18CEC205L*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes/Standards**	*IS 9282: 2002 Indian Standard Wire Ropes and Strands for Suspension Bridges – Specifications*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Understand the behavior of indeterminate structures using slope deflection method*
CLR-2 :	*Apply moment distribution method in the analysis of indeterminate structures*
CLR-3 :	*Get exposed to stiffness matrix method*
CLR-4 :	*Analyze indeterminate structures using flexibility matrix method*
CLR-5 :	*Understand the behavior of determinate and indeterminate structures under moving loads*
CLR-6 :	*Get an insight into the behavior of arches and suspension bridges*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO - 3
CLO-1 :	*Apply slope deflection method to analyze indeterminate beams and plane rigid jointed frames*	3	90	75	H	H	-	M	-	-	-	-	-	-	-	-	H	-	-
CLO-2 :	*Use moment distribution method to analyze indeterminate beams and plane rigid jointed frames*	3	95	75	H	H	-	M	-	-	-	-	-	-	-	-	H	-	-
CLO-3 :	*Make use of computer based matrix stiffness method and direct stiffness method to analyze indeterminate beams and plane rigid jointed frames*	3	90	75	H	H	-	M	M	-	-	-	-	-	-	-	H	M	-
CLO-4 :	*Apply energy concepts and matrix flexibility method to analyze indeterminate beams and plane rigid jointed frames*	3	80	75	H	H	-	M	-	-	-	-	-	-	-	-	H	-	-
CLO-5 :	*Draw influence line diagrams for determinate and indeterminate structures and apply the same for determinate and indeterminate structures for finding stress resultants due to moving loads*	3	95	75	H	H	-	M	-	-	-	-	-	-	-	-	H	-	-
CLO-6 :	*Analyze three hinged parabolic, circular archesand two hinged parabolic arches and study concepts behind the analysis of fixed arches* *Analyze suspension cables and get an insight into to suspension bridges with two and three hinged girders*	3	85	75	H	H	-	M	-	-	-	-	-	-	-	-	H	-	-

		Influence Lines Diagrams (ILD) and Moving Loads	Arches and Suspension Bridges	Flexibility Matrix Method	Slope Deflection and Moment Distribution Methods	Direct and Element Stiffness Matrix Methods
Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Introduction to influence line diagram (ILD) and Muller Breslau's principle*	*Introduction to arches: three hinged, two hinged, fixed. Eddy's theorem*	*Revisiting Castigliano's energy theorems*	*Fixed end moments, effect of rotations and settlement on support moments*	*Relation between SDM, matrix stiffness method, derive direct stiffness method*
	SLO-2	*ILD for BM and SF for cantilever*	*theoretical arch, analyze three hinged parabolic arches with supports at same level*	*Form basic determinate structure of an indeterminate structure by releasing the redundant reactions or inserting hinges*	*Principle of superposition and joint equilibrium, derivation of slope deflection method (SDM)*	*Advantages of Stiffness method over flexibility method, Analysis of propped cantilever using direct stiffness method*
S-2	SLO-1	*ILD for BM and SF for simply supported, overhanging beam. Introduction to IRC trailer load*	*Analyze three hinged parabolic arches with supports at different levels*	*Derive flexibility coefficients using unit load method.*	*Apply SDM for drawing bending moment diagram (BMD) and shear force diagram (SFD) for propped cantilevers with and without overhang*	*Analyze continuous beams using direct stiffness method*
	SLO-2	*Find max. BM, SF using ILD for cantilever, simply supported, overhanging beam subject to moving point loads and udl*	*Analyze three hinged circular arches with supports at the same level*	*Determine deflection of basic determinate beams using flexibility coefficients*	*Apply SDM for the analysis of beams up to a degree of static indeterminacy of 2 including the effect of support settlements*	*Apply direct stiffness method for single storey portal frame*
S-3	SLO-1 SLO-2	*Tutorial class*	*Tutorial class*	*Tutorial class*	*Tutorial class*	*Tutorial class*
S-4	SLO-1	*Concept of absolute maximum BM in simply supported beams*	*Derive horizontal reaction for two hinged parabolic arches including support movement, temperature change and rib shortening*	*Derive direct flexibility matrix equation. Solving propped cantilever using flexibility method*	*Solve rigid jointed plane frame with degree of static indeterminacy 2 using SDM*	*Introduction to element stiffness method- coordinate systems – element and global*
	SLO-2	*Find absolute maximum BM and SF in a simply supported beam subjected to series of moving loads*	*Analyze two hinged parabolic arches with a single point load*	*Formulate flexibility matrix for a two-span continuous beam with one of the end supports fixed*	*Moment Distribution Method (MDM), definition of stiffness, carry over factors*	*Derive element stiffness matrix for truss, beam, frame elements in local coordinates*

					with demonstrative analysis of propped cantilever	
S-5	SLO-1	*Find absolute maximum BM /SF in a simply supported beam subjected to udl – shorter and longer than the span*	*Analyze two hinged parabolic arches with udl occupying the entire span*	*Analyze two span continuous beam with one of the end supports fixed using direct flexibility method*	*Analyze 2 span- continuous beams using MDM*	*Rotation matrix for truss element and transformation of element stiffness matrix in local coordinates to global coordinates*
	SLO-2	*ILD of propped cantilevers*	*Analyze two hinged parabolic arches with part udl occupying anywhere in the span*	*Form flexibility matrix for single storey portal frame with static indeterminacy of 2 with supports at same level and analyzing*	*Analyze 3 span- continuous beams using MDM includingeffect of support settlements*	*Rotation matrix for frame element and transformation of element stiffness matrix in local coordinates to global coordinates*
S-6	SLO-1 SLO-2	*Tutorial class*	*Tutorial class*	*Tutorial class*	*Tutorial class*	*Tutorial class*
S-7	SLO-1	*ILD for two span continuous beam for end support reaction*	*Introduction to suspension cables*	*Form flexibility matrix for single storey portal frame with static indeterminacy of 2 with supports at different levels and analyzing*	*Analyze non-sway frames using MDM*	*Compute load vector in global coordinates for truss problems. Assemble global stiffness matrix for truss problem*
	SLO-2	*ILD for two span continuous beam for mid support reaction*	*Analyze suspension cables with udl – maximum and minimum cable tension and support reactions – resultant (Supports at same level)*	*Find support reactions for a single storey portal frame with static indeterminacy of 3 with supports at same level and subjected to a lateral point load at beam level*	*Introduction to sway in portal frames*	*Compute joint load vector in beam/frame problems with uniformly distributed and point loads*
S-8	SLO-1	*ILD for two span continuous beam for mid support moment*	*Analyze suspension cables with udl – maximum and minimum cable tension and support reactions – resultant (Supports at different levels)*	*Form flexibility matrix for a single storey portal frame with a static indeterminacy of 3 with supports at same level and subjected to udl over the beam*	*Fixed end moments due to sway in single storey frames and analysis of single storey portal frames with sway using MDM*	*Assemble global stiffness matrix for two span continuous beams. Partition global stiffness matrix and find unknown displacements and reactions*
	SLO-2	*ILD for two span continuous beam for span BM and span shear*	*Find forces at anchor towers – saddle support with rollers and hinged supports. Introduction to two hinged and three hinged stiffening girders*	*Find support reactions for a single storey portal frame with static indeterminacy of 3 with supports at same and different levels and subjected to either udl over the beam or lateral load at beam level*	*KANI'S METHOD* *Introduction to Kani's method for multistory frames and definition of rotation factors and sway corrections*	*Assemble global stiffness matrix for single storey portal frame, partitioning, solve for unknown displacements and find element forces from known displacements upto a static indeterminacy of 3*
S-9	SLO-1 SLO-2	*Tutorial class*	*Tutorial class*	*Tutorial class*	*Tutorial class*	*Tutorial class*

Learning Resources

1. *Menon D, Structural Analysis, Alpha Science International Limited, 2009*
2. *Pandit G.S., Gupta S.P., Structural Analysis- A Matrix Approach, 2nd ed., Tata McGraw-Hill, 2010*
3. *Punmia B.C., Ashok Kumar Jain, Arun Kumar Jain, Theory of Structures, 12th ed., Laxmi Publications, 2004*
4. *Vaidyanathan R, Perumal. P, Comprehensive Structural Analysis-Volume I & II, Laxmi Publications, 2004*
5. *Bhavikatti S. S, Structural Analysis, Vol-1 &2, E-2, Vikas Publishing House Pvt Limited, 2009*
6. *Hibbeler R.C., Structural Analysis, 8th ed., Prentice Hall, 2012*
7. *NPTEL Course: Structural Analysis – I. https://onlinecourses.nptel.ac.in/noc17_ce25/preview*
8. *NPTEL Course: Structural Analysis – II https://nptel.ac.in/downloads/105105109/*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Er. G.Hariharanath, GA Consultants, Chennai, gac1996@hotmail.com	*1. Dr. G. Appa Rao, Professsor, IIT Madras, garao@iitm.ac.in*	*1. Dr. K. Sathyanarayanan, SRMIST*
2. Er. AGV. Desigan, Design Group Engineering Consultancy Pvt Ltd. Chennai, desigan.agv@gmail.com	*2. Dr. C. Uma Rani, Professor, Anna University, umarani@annauniv.edu*	*2. Prof. G. Augustine Maniraj Pandian, SRMIST*

Course Code	18CEC205L	Course Name	COMPUTER AIDED STRUCTURAL ANALYSIS LABORATORY	Course Category	C	Professional Core	L	T	P	C
							0	0	2	1

Pre-requisite Courses	Nil	Co-requisite Courses	18CEC205T	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Utilize the Calculate the Area of Steel of beams using MS Excel program
CLR-2 :	Utilize the method of solving Matrix Equation using Stiffness Matrix
CLR-3 :	Analyze behavior of 2D and 3D Moment Resistant Steel Frames using STAAD Pro or ETABS
CLR-4 :	Analyze behavior of Plane Steel Frames using STAAD Pro or ETABS
CLR-5 :	Utilize the flexural and shear behavior of RCC beam
CLR-6 :	Acquire knowledge on the torsional behavior of RCC beam

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO - 3
CLO-1 :	Calculate the Area of Steel of beams using MS Excel program	3	90	85	H	M	H	-	H	-	-	-	H	-	-	-	H	H	H
CLO-2 :	Solve matrix equation using stiffness matrix	3	85	80	H	M	-	-	H	-	-	-	H	-	-	-	H	H	H
CLO-3 :	Report on the behavior of 2D and 3D Moment Resistant Steel Frames	3	90	85	H	M	-	-	H	-	-	-	H	-	-	-	H	H	H
CLO-4 :	Analyze the behavior of Plane Steel Frames	3	85	80	H	M	-	-	H	-	-	-	H	-	-	-	H	H	H
CLO-5 :	Analyze the Flexural and shear resistance of RCC beams	3	85	80	H	M	-	-	H	-	-	-	H	-	-	-	H	-	H
CLO-6 :	Design the beam for torsion	3	85	80	H	M	M	-	H	-	-	-	H	-	-	-	H	-	H

Duration (hour)		6	6	6	6	6
S 1-2	SLO-1 / SLO-2	Programming in MS Excel for calculating Ast	Solving Matrix Problems in MS Excel	Exercise the solution in STAAD Pro or ETABS	Analysis in STAAD Pro or ETABS for moving IRC loads and verification	Study the behavior of RCC beam test under flexure
S 3-4	SLO-1 / SLO-2	Solving Problems in MS Excel	2D and 3D Moment Resistant Steel Frames Using STAAD Pro or ETABS for real building model	Exercise the solution in STAAD Pro or ETABS	Plane Pin Jointed Steel Frames using STAAD Pro or ETABS	Study the behavior of RCC beam test under shear
S 5-6	SLO-1 / SLO-2	Solving Matrix Equation using Stiffness Matrix	Exercise the solution in STAAD Pro or ETABS	Exercise the solution in STAAD Pro or ETABS and verification using text book problems	Exercise the solution in STAAD Pro or ETABS and verification using text book problems	Study the behavior of RCC beam test under torsion

Learning Resources	1. IS 456 :2000, Plain and Reinforced Concrete: Code of Practice, Bureau of Indian Standards, New Delhi.	2. Laboratory Manual - SRMIST

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember / Understand	-	40 %	-	30 %	-	30 %	-	30 %	-	30%
Level 2	Apply / Analyze	-	40 %	-	40 %	-	40 %	-	40 %	-	40%
Level 3	Evaluate / Create	-	20 %	-	30 %	-	30 %	-	30 %	-	30%
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Er. G.Hariharanath, GA Consultants, Chennai, gac1996@hotmail.com	1. Dr. G. Appa Rao, Professsor, IIT Madras, garao@iitm.ac.in	1. Dr. K. Sathyanarayanan, SRMIST
2. Er. AGV. Desigan, Design Group Engineering Consultancy Pvt Ltd. Chennai, desigan.agv@gmail.com	2. Dr. C. Uma Rani, Professor, Anna University, umarani@annauniv.edu	2. Prof. G. Augustine Maniraj Pandian, SRMIST

Course Code	18CEC206T	Course Name	HYDRAULIC ENGINEERING AND DESIGN	Course Category	C	Professional Core	L	T	P	C
							2	1	0	3

Pre-requisite Courses	*18CEC202T*	Co-requisite Courses	*18CEC206L*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	**Learning**			**Program Learning Outcomes (PLO)**														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-1 :	*Utilize dimensional and model analysis*																		
CLR-2 :	*Address concepts related to open channel flow*																		
CLR-3 :	*Utilize basic hydraulic concepts in measuring discharge and velocity in open channel*																		
CLR-4 :	*Create insights into the components and functions of roto-dynamic pump*																		
CLR-5 :	*Address concepts related to the components and functions of positive displacement pump*																		
CLR-6 :	*Utilize the components, functions and uses of Pelton wheel, Kaplan and Francis turbines*																		
Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Identify and solve various fluid problems involving dimensional and model analysis*	*3*	*80*	*70*	*H*	*H*	-	*M*	-	-	-	-	-	-	-	-	*H*	-	-
CLO-2 :	*Analyze problems related to open channel flow*	*3*	*85*	*75*	*H*	*H*	*H*	*L*	-	-	-	-	-	-	-	-	*H*	-	-
CLO-3 :	*Identify various devices to measure and estimate discharge and velocity in open channel*	*3*	*85*	*75*	*H*	*M*	-	-	-	-	-	-	-	-	-	-	*H*	-	-
CLO-4 :	*Analyze the components and functions of rotodynamic pump*	*3*	*85*	*75*	*H*	*H*	-	-	-	-	-	-	-	-	-	-	*H*	-	-
CLO-5 :	*Identify the components and functions of positive displacement pump*	*3*	*85*	*75*	*H*	*H*	-	-	-	-	-	-	-	-	-	-	*H*	-	-
CLO-6 :	*Identify the components, functions and uses of various hydraulic turbines*	*3*	*80*	*70*	*H*	*H*	*H*	*L*	-	-	-	-	-	-	-	-	*H*	-	-

Duration (hour)		**9**	**9**	**9**	**9**	**9**
S-1	SLO-1	*Dimensional and Model analysis*	*Open channel flow*	*Backwater computation by direct step method*	*Gauging flumes, non-modular/venturiflume*	*Air vessel and its functions*
	SLO-2	*Use of dimensional analysis, fundamental quantities and derived quantities*	*Comparison between open channel and pipe flows; Types of channels and types of flow in channels*	*Rapidly varied flow, hydraulic jump and its types*	*Standing wave / Modular flume*	*Working principle of hydraulic ram, jet pump and gear pump*
S-2	SLO-1	*M-L-T system for various quantities*	*Chezy's formula and Manning's formula*	*Expression for loss of energy due to jump, length of hydraulic jump, height of jump*	*Measurement of velocity, current meter*	*Turbines*
	SLO-2	*Dimensional homogeneity*	*Solving problems using tutorial sheet 4*	*Energy dissipaters and stilling basins*	*Floats, Hot-wire Anemometer*	*Components of hydroelectric power plant, classification of hydraulic turbines*
S-3	SLO-1	*Solving problems using tutorial sheet 1*	*Solving problems using tutorial sheet 4*	*Solving problems using tutorial sheet 7*	*Solving problems using tutorial sheet 10*	*Solving problems using tutorial sheet 13*
	SLO-2	*Solving problems using tutorial sheet 1*	*Design of most economical section of a channel*	*Solving problems using tutorial sheet 7*	*Solving problems using tutorial sheet 10*	*Solving problems using tutorial sheet 13*
S-4	SLO-1	*Rayleigh's method*	*Rectangular channel and trapezoidal channel*	*Measurement of discharge and velocity in open channel*	*Pumps*	*Pelton wheel, velocity triangles and work done*
	SLO-2	*Buckingham's π method*	*Non uniform flow through open channels*	*Flow over notches; Rectangular, triangular*	*Centrifugal pump, components and working*	*Design aspects of Pelton wheel*
S-5	SLO-1	*Selection of repeating variables; Application of dimensional analysis*	*Specific energy and specific energy curve*	*Trapezoidal and stepped notch*	*Velocity triangle, work done, losses and efficiencies*	*Francis turbine, velocity triangles and work done*
	SLO-2	*Model analysis*	*Critical depth, critical velocity*	*Types of Weirs*	*Specific speed, multistage centrifugal pump – pumps in parallel and series*	*Design aspects of Francis turbine*
S-6	SLO-1	*Solving problems using tutorial sheet 2*	*Solving problems using tutorial sheet 5*	*Solving problems using tutorial sheet 8*	*Solving problems using tutorial sheet 11*	*Solving problems using tutorial sheet 14*
	SLO-2	*Solving problems using tutorial sheet 2*	*Solving problems using tutorial sheet 5*	*Solving problems using tutorial sheet 8*	*Solving problems using tutorial sheet 11*	*Solving problems using tutorial sheet 14*

S-7	SLO-1	*Similitude – Geometric similarity*	*Minimum specific energy, critical flow; Subcritical flow and supercritical flow*	*Effect on discharge over a notch or weir due to error in the measurement of head*	*Characteristic curves, NPSH*	*Kaplan turbine, design aspects of Kaplan turbine*
	SLO-2	*Kinematic and dynamic similarity*	*Gradually varied flow*	*Velocity of approach and end contraction*	*Reciprocating pump, components and working*	*Draft tube, types*
S-8	SLO-1	*Dimensionless numbers and their significance*	*Characteristics of surface profiles*	*Cippoletti weir, broad crested weir*	*Coefficient of discharge, slip, indicator diagram*	*Specific speed and its significance*
	SLO-2	*Model (or similarity) laws; Model studies in fluid flow problems*	*Length of back water curve and afflux*	*Narrow crested weir, Ogee weir and drowned/submerged weir*	*Effect of acceleration and friction, Maximum speed of reciprocating pump*	*Characteristic curves of hydraulic turbines*
S-9	SLO-1	*Solving problems using tutorial sheet 3*	*Solving problems using tutorial sheet 6*	*Solving problems using tutorial sheet 9*	*Solving problems using tutorial sheet 12*	*Solving problems using tutorial sheet 15*
	SLO-2	*Solving problems using tutorial sheet 3*	*Solving problems using tutorial sheet 6*	*Solving problems using tutorial sheet 9*	*Solving problems using tutorial sheet 12*	*Solving problems using tutorial sheet 15*

Learning Resources	1. *Modi, P.N., Seth S.M., Hydraulics and Fluid Machines, Standard book house, 2005* 2. *Subramanya, K., Theory and application of fluid mechanics, Tata McGraw Hill, 2002* 3. *R.K., Fluid Mechanics and Hydraulic Machines, S.Chand, 2014*	4. *Chandramouli P.N., Applied Hydraulic Engineering, Yesdee, 2017* 5. *NPTEL Course-Hydraulics. https://nptel.ac.in/courses/105106114/#* 6. *NPTEL Course-Fluid Machinery. https://nptel.ac.in/courses/112104117/*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Abdul Hakeem, National Remote Sensing Center, Hyderabad, abdulhakeem_k@nrsc.gov.in	*1. Dr. R. Saravanan, Anna University, rsaran@annauniv.edu*	*1. Dr. R. Sathyanathan, SRMIST*
2. Dr. Sat Kumar Tomer, Satyukt Analytics Pvt Ltd., Bengaluru, sat@satyukt.com	*2. Dr. S. Saravanan, NIT, Tiruchy, ssaravanan@nitt.edu*	*2. Dr. DeepthaThattai, SRMIST*

Course Code	18CEC206L	Course Name	HYDRAULIC ENGINEERING LABORATORY	Course Category	C	*Professional Core*	L	T	P	C
							0	0	2	1

Pre-requisite Courses	*Nil*	Co-requisite Courses	*18CEC206T*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-1 :	*Utilize the Chezy's and Manning's equations*																		
CLR-2 :	*Analyze the concept of hydraulic jump*																		
CLR-3 :	*Utilize knowledge on notches and flumes*																		
CLR-4 :	*Utilize knowledge in operating the current meter*																		
CLR-5 :	*Utilize centrifugal pump, reciprocating pump, submersible pump and gear oil pump for suitable applications*																		
CLR-6 :	*Utilize Pelton wheel turbine and Francis turbine for suitable applications*																		
Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Apply the concept of Chezy's and Manning's equations*	*3*	*90*	*85*	*H*	*M*	-	-	-	-	-	-	*H*	-	-	-	*H*	-	*H*
CLO-2 :	*Analyze hydraulic jump*	*3*	*90*	*85*	*H*	*M*	-	-	-	-	-	-	*H*	-	-	-	*H*	-	*H*
CLO-3 :	*Evaluate discharge using notches and flumes*	*3*	*90*	*85*	*H*	*M*	-	-	-	-	-	-	*H*	-	-	-	*H*	-	*H*
CLO-4 :	*Evaluate velocity using current meter*	*3*	*90*	*85*	*H*	*M*	-	-	-	-	-	-	*H*	-	-	-	*H*	-	*H*
CLO-5 :	*Analyze the working of centrifugal pump, reciprocating pump, submersible pump and gear oil pump*	*3*	*90*	*85*	*H*	*M*	-	-	-	-	-	-	*H*	-	-	-	*H*	-	*H*
CLO-6 :	*Analyze the working of Pelton wheel turbine and Francis turbine*	*3*	*90*	*85*	*H*	*M*	-	-	-	-	-	-	*H*	-	-	-	*H*	-	*H*

Duration (hour)		6	6	6	6	6
S 1-2	SLO-1 SLO-2	*Determine Chezy's constant for an open channel*	*Measure hydraulic jump*	*Determine coefficient of discharge for triangular notch*	*Test Performance of centrifugal pump*	*Test Performance of gear oil pump*
S 3-4	SLO-1 SLO-2	*Determine Manning's roughness coefficient for an open channel*	*Determine coefficient of discharge for rectangular notch*	*Measure velocity using current meter*	*Test Performance of reciprocating pump*	*Test Performance of Pelton wheel turbine*
S 5-6	SLO-1 SLO-2	*Determine specific energy curve*	*Measure flow using rectangular and triangular notches*	*Measure discharge using venturiflume*	*Test Performance of submersible pump*	*Test Performance of Francis turbine*

Learning Resources		
	1. Modi, P.N., Seth S.M., Hydraulics and Fluid Machines, Standard book house, 2005 *2. Subramanya, K., Theory and application of fluid mechanics, Tata McGraw Hill, 2002*	*3. Rajput R.K, Fluid Mechanics and Hydraulic Machines, S.Chand and Company Ltd.,2013* *4. Laboratory Manual for Hydraulic Engineering Laboratory, SRMIST*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	-	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*
Level 2	Apply Analyze	-	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*
Level 3	Evaluate Create	-	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Abdul Hakeem, National Remote Sensing Center, Hyderabad, abdulhakeem_k@nrsc.gov.in	*1. Dr. R. Saravanan, Anna University, rsaran@annauniv.edu*	*1. Dr. R. Sathyanathan, SRMIST*
2. Dr. Sat Kumar Tomer, Satyukt Analytics Pvt Ltd., Bengaluru, sat@satyukt.com	*2. Dr. S. Saravanan, NIT, Tiruchy, ssaravanan@nitt.edu*	*2. Mr. Shaik NiyazuddinGuntakal, SRMIST*

Course Code	18CEC207T	Course Name	DESIGN OF RC AND STEEL STRUCTURES	Course Category	C	Professional Core	L	T	P	C
							4	0	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes/Standards	IS 456 :2000, SP 16-Column Design Charts, IS 800: 2007, Steel Tables		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Utilize the behavior of RC sections under flexure and shear and to get introduced to the relevant IS codes*
CLR-2 :	*Design RC using Limit state method*
CLR-3 :	*Utilize the concepts in performing design of RC beams, slabs, columns and foundations*
CLR-4 :	*Analyze behavior of Steel sections under tension, compression and flexure, identify relevant IS codes*
CLR-5 :	*Design streel sections using Limit state method*
CLR-6 :	*Utilize the concepts in performing design of steel tension, compression and flexural members and their connections*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1 Level of Thinking (Bloom)	2 Expected Proficiency (%)	3 Expected Attainment (%)	PLO 1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	13 PSO - 1	14 PSO - 2	15 PSO - 3
CLO-1 :	*Identify effect of external loads on RC members, factors influencing their behavior, identify relevant IS codes*	3	85	80	H	-	-	M	-	-	-	-	-	-	-	H	H	M	-
CLO-2 :	*Analyze behavior of RC sections under flexure and shear*	2	80	75	H	H	-	M	-	-	-	-	-	-	-	H	H	M	-
CLO-3 :	*Apply Limit state method of design to RC beams, slabs, columns and foundations*	2	85	80	H	H	H	H	-	-	-	-	-	-	-	H	H	M	-
CLO-4 :	*Identify effect of external loads on Steel members, factors influencing their behavior, identify relevant IS codes*	3	85	80	H	-	-	M	-	-	-	-	-	-	-	H	H	M	-
CLO-5 :	*Analyze the behavior of Steel sections under tension, compression and flexure*	2	80	75	H	H	-	M	-	-	-	-	-	-	-	H	H	M	-
CLO-6 :	*Apply Limit state method of design to steel tension, compression and flexural members and their connections*	2	85	80	H	H	H	H	-	-	-	-	-	-	-	H	H	M	-

Duration (hour)		12	12	12	12	12
S-1	SLO-1	***INTRODUCTION TO RC DESIGN*** *Grade of concrete - concrete mix design-IS code provisions-Design of nominal and design mix*	***RC SLABS*** *Reinforcement detailing of one way slabs*	***RC BEAMS*** *Concept of load transfer from slab to beam-Introduction to singly and doubly reinforced and flanged beams* ***-****Design recommendations as per IS 456:2000*	***RC STAIR-CASES*** *Design of dog-legged stair-case-Procedure*	***RC FOUNDATIONS*** *Introduction-Types of foundation-Transfer of forces at junction of column-foundation*
	SLO-2	*Basic design concepts- Design Philosophy- Working stress and Limit state method of design*	*Design of continuous slabs-Procedure*	*Design of singly reinforced beams-Procedure*	*Design of stair-cases-Example 1*	*Design recommendations as per IS 456:2000*
S-2	SLO-1	*RC DESIGN: Partial safety factors -Limit state method-advantages*	*RC SLABS Design of continuous slabs-Example 1*	*RC BEAMS Design of singly reinforced beams-Example 1*	*RC STAIR-CASES Design of stair-cases-Example 2*	*RC FOUNDATIONS Design of isolated foundation-axially loaded-sloped*
	SLO-2	*General design recommendations as per IS 456:2000*	*Design of continuous slabs-Example 2*	*Design of singly reinforced beams-Example 2*	*Reinforcement detailing-Use of SP 34*	*Design of isolated foundation-axially loaded-stepped*
S-3	SLO-1	***INTRODUCTION TO STEEL DESIGN AND PLASTIC ANALYSIS****: Types of steel structures - Properties of structural steel, Indian Standard Specifications and sections- Design criteria as per IS 800:2007-Analysis methods*	***STEEL TENSION MEMBERS*** *Design provisions of tension members*	***STEEL COMPRESSION MEMBERS*** *Design of simple columns-Procedure*	***STEEL CONNECTIONS*** *Design of pin connections*	*STEEL BEAMS Design provisions of beams*
	SLO-2	*Calculation of Loads as per IS codes-Design Philosophy-Introduction to Limit State Method of design – Partial safety factors- General design requirements as per IS800:2007*	*Design of simple tension members - Effective net area-Types of failures*	*Design of simple columns-Example 1*	*Design of lap joints-Procedure*	*Design of simple beams-restrained-Procedure*
S-4	SLO-1	*PLASTIC ANALYSIS :Plastic analysis, Plastic hinge mechanism, Plastic moment of resistance, Plastic modulus*	*STEEL TENSION MEMBERS Design of plates with holes subjected to tension-Procedure*	*STEEL COMPRESSION MEMBERS Design of simple columns-Example 2*	*STEEL CONNECTIONS Design of lap joints-Example 1*	***STEEL BEAMS*** *Design of simple beams-restrained-Example*
	SLO-2	*Shape Factor for rectangular, circular and triangular sections*	*Design of plates with holes subjected to tension-Example*	*Types of built up columns*	*Design of lap joints-Example 2*	*Lateral torsional buckling behaviour of unrestrained beams*

S-5	SLO-1	***RC DESIGN** :Behaviour of RC sections under flexure, stress blocks – IS, AC and BS*	***RC SLABS** Reinforcement detailing of continuous slabs*	***RC BEAMS** Design of doubly reinforced beams-Procedure*	***RC COLUMNS** Short and long columns, Effective length slenderness ratio, un braced and braced columns -Design recommendations as per IS 456:2000*	***RC FOUNDATIONS** Design of isolated foundation-eccentrically loaded-Procedure*
	SLO-2	*Behaviour of RC sections under shear*	*Design of two way slabs-Procedure*	*Design of doubly reinforced beams-Example 1*	*Design of axially loaded short columns*	*Design of isolated foundation-eccentrically loaded-Example*
S-6	SLO-1	*RC DESIGN :Design recommendations as per IS 456:2000-flexure*	*RC SLABS Design of two way slabs-Simply supported on the edges with corners not held down*	*RC BEAMS Design of doubly reinforced beams-Example 2*	*RC COLUMNS Uniaxial and biaxial bending of columns*	*RC FOUNDATIONS Design of combined rectangular foundation-Procedure*
	SLO-2	*Design recommendations as per IS 456:2000-shear*	*Design of two way slab- Simply supported on the edges with corners held down*	*Ductile detailing of beams as per IS 13920*	*Use of interaction curves from SP16*	*Design of combined rectangular foundation-Example*
S-7	SLO-1	***PLASTIC ANALYSIS**: Shape Factor for I section*	***STEEL TENSION MEMBERS** Design of angles subjected to tension-Procedure*	***STEEL COMPRESSION MEMBERS** Design of lacing-Procedure*	***STEEL CONNECTIONS** Design of butt joints-Procedure*	***STEEL BEAMS** Check for lateral torsional buckling of unrestrained beams-Steps*
	SLO-2	*Shape Factor for T and C sections*	*Design of angles subjected to tension-Example*	*Design of lacing-Example*	*Design of butt joints-Example 1*	*Check for lateral torsional buckling of unrestrained beams-Example*
S-8	SLO-1	*PLASTIC ANALYSIS: Load factor, Static method of plastic analysis*	*STEEL TENSION MEMBERS Design of built-up tension members-various cross-sections*	*STEEL COMPRESSION MEMBERS Design of batten-Procedure*	*STEEL CONNECTIONS Design of butt joints-Example 2*	*STEEL BEAMS Design of beams subjected to biaxial bending-Procedure*
	SLO-2	*Mechanism method of plastic analysis*	*Design of built-up tension members-Procedure*	*Design of batten-Example*	*Design of Truss joint-Procedure*	*Design of beams subjected to biaxial bending-Example 1*
S-9	SLO-1	***RC SLABS** Introduction-Types of slab -Introduction on moment co-efficient and design recommendations as per IS 456:2000*	***RC SLABS** Design of two way slabs-with edges fixed*	***RC BEAMS** Design of flanged beams-Procedure*	***RC COLUMNS** Design of long columns*	***RC FOUNDATIONS** Introduction to Strip Footing*
	SLO-2	*Design of one way slabs-Procedure*	*Design of two way slabs-Example*	*Design of flanged beams-design for torsion*	*Ductile detailing of columns as per IS 13920*	*Introduction to Raft Footing*
S-10	SLO-1	*RC SLABS Design of one way slabs-Example 1*	*RC SLABS Reinforcement detailing of two way slabs*	*RC BEAMS Design of flanged beams-Example 1*	*RC COLUMNS Reinforcement detailing at beam-column joints using SP34*	*RC FOUNDATIONS Design of pile foundation, pile cap*
	SLO-2	*Design of one way slabs-Example 2*	*Use of design handbooks*	*Design of flanged beams-Example 2*	*Extension of design of columns to piles*	*Reinforcement detailing*
S-11	SLO-1	***PLASTIC ANALYSIS** :Analysis of indeterminate beams with uniform M_p*	***STEEL TENSION MEMBERS** Design of built-up tension members-Example*	***STEEL CONNECTIONS** Types of connections-Bolted and welded*	***STEEL CONNECTIONS** Design of Truss joint-Example 1*	***STEEL BEAMS** Design of beams subjected to biaxial bending-Example 2*
	SLO-2	*Analysis of indeterminate beams with varying M_p*	*Tension splices*	*Types of bolts and welds-Permissible stresses*	*Design of Truss joint-Example 2*	*Design of built-up beams-Procedure*
S-12	SLO-1	*PLASTIC ANALYSIS :Analysis of single bay single storey rectangular portal frames-with same column heights*	***STEEL COMPRESSION MEMBERS** Design provisions of compression members*	*STEEL CONNECTIONS Load transfer mechanism*	***STEEL BEAMS** Behaviour of steel members in flexure*	*STEEL BEAMS Design of built-up beams-Example 1*
	SLO-2	*Analysis of single bay single storey rectangular portal frames with varying column heights*	*Effective length-Slenderness ratio-Types of buckling-Classification of cross-sections*	*Types of failure of connections*	*Phenomenon of web buckling and web crippling*	*Design of built-up beams-Example 2*

Learning Resources	*1. Varghese.P.C, Limit State Design of Reinforced Concrete, 2nd ed.,PHI Learning Pvt. Ltd., 2004* *2. Unnikrishna Pillai.S, Devdoss Menon, Reinforced Concrete Design, 5th ed., Tata McGraw, 2003* *3. Subramanian.N, Design of Reinforced Concrete Structures, Oxford University Press, 2013* *4. Punmia.B.C, Ashok Kumar Jain,A run Kumar Jain, Limit State Design of Reinforced Concrete,1st edition, Laxmi Publications Pvt. Ltd., 2007* *5. Duggal S.K, Limit state design of steel structures, Tata McGraw Hill, 2010*	*6. Subramanian.N, Design of Steel structures-Limit state method, Oxford University Press, 2016* *7. Shah.V.L,, Veena Gore, Limit State Design of. Steel Structures, 1st ed.,Structures Publications, 2009* *8. Punmia.B.C, Ashok Kumar Jain, Arun Kumar Jain,Comprehensive Design of Steel structures, Laxmi Publications Pvt. Ltd., 2007* *9. NPTELCourse: Design of Reinforced Concrete Structures: https://onlinecourses.nptel.ac.in/noc18_ce24/preview* *10. NPTELCourse: Design of Steel Structures https://onlinecourses.nptel.ac.in/noc17_ce21/preview*

Learning Assessment												
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Er. G.Hariharanath, GA Consultants, Chennai, gac1996@hotmail.com	*1. Dr. G. Appa Rao, Professsor, IIT Madras, garao@iitm.ac.in*	*1. Dr. K. Sathyanarayanan, SRMIST*
2. Er. AGV. Desigan, Design Group Engineering Consultancy Pvt Ltd. Chennai, designan.agv@gmail.com	*2. Dr. C. Uma Rani, Professor, Anna University, umarani@annauniv.edu*	*2. Prof. G. Augustine Maniraj Pandian, SRMIST*

Course Code	18CEC208T	Course Name	ENVIRONMENTAL ENGINEERING AND DESIGN	Course Category	C	*Professional Core*	L	T	P	C
							2	1	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*18CEC208L*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Utilize the sources of water supply and its quality*
CLR-2 :	*Design and Construct water treatment for domestic supplies*
CLR-3 :	*Utilize sanitary engineering concepts for implementation*
CLR-4 :	*Design sewage treatment plants for towns and cities*
CLR-5 :	*Utilize solid waste management mechanisms*
CLR-6 :	*Analyze the role of Government and NGO's in sustaining the environment*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO - 3
CLO-1 :	*Identify the various sources of water and its quality*	2	85	80	H	H	M	L	-	L	H	-	-	-	-	L	H	-	-
CLO-2 :	*Design water treatment units for domestic purposes*	3	85	75	H	H	H	H	-	-	H	-	-	-	-	-	H	-	-
CLO-3 :	*Identify the collection and conveyance of domestic sewage*	2	80	75	H	H	M	M	-	L	H	-	-	-	-	L	H	-	-
CLO-4 :	*Design of sewage treatment units for sanitary sewage*	3	85	75	H	H	H	H	-	-	H	-	-	-	-	-	H	-	-
CLO-5 :	*Apply the concept of reducing, reuse, recycling in solid waste management*	2	85	80	H	H	M	M	L	L	M	-	-	-	-	L	H	-	-
CLO-6 :	*Analyze the environmental legislations*	2	80	75	H	H	M	-	-	L	M	M	-	-	-	-	H	-	-

		Water Supply	**Water Treatment**	**Sanitary Engineering**	**Disposal of Sewage**	**Solid Waste Management & Air Pollution**
Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Water quality requirement for different beneficial uses*	*Concept and objectives of water treatment*	*Domestic and storm water quantity of sewage and flow variations*	*Concept of sewage disposal*	*Concept and generation of solid waste*
	SLO-2	*Importance of water supply scheme and Need for protected water supply*	*Principles of Aeration and Sedimentation. Types of sedimentation & design*	*Conveyance of sewage and types of sewers. Design of sewers*	*Pollution due to improper disposal of sewage*	*Municipal Solid Waste(MSW), composition and other parameters*
S-2	SLO-1	*Various sources of water available for supply*	*Principles of Coagulation and Flocculation*	*Pumping of sewage and sewer appurtenances*	*Zones of pollution and Self-purification of rivers*	*Quantification and Collection of MSW*
	SLO-2	*Per capita consumption-Demand*	*Types of coagulants used in water treatment*	*Laying and jointing of sewer lines*	*Oxygen sag curve. National river cleaning plans Dissolved Oxygen and BOD*	*Treatment and disposal of MSW*
S-3	SLO-1	*Solving problems using Tutorial Sheet 1*	*Solving problems using Tutorial Sheet 4*	*Solving problems using Tutorial Sheet 7*	*Solving problems using Tutorial Sheet 10*	*Solving problems using Tutorial Sheet 13*
	SLO-2	*Solving problems using Tutorial Sheet 1*	*Solving problems using Tutorial Sheet 4*	*Solving problems using Tutorial Sheet 7*	*Solving problems using Tutorial Sheet 10*	*Solving problems using Tutorial Sheet 13*
S-4	SLO-1	*Quality issues in various sources of water*	*Concept and theory of Filtration*	*Different plumbing systems adopted in buildings*	*Disposal of treated sewage in irrigation land*	*Waste from commercial establishments and other urban areas*
	SLO-2	*Water Pollution, sources, causes and effects. Water quality characteristics*	*Working principles of slow sand filters and design*	*Sanitary fittings used in buildings. Quantification of storm water*	*Sewage sickness and remedial measures*	*Effect of solid waste on environment*
S-5	SLO-1	*WHO and BIS standards and Water Borne Diseases*	*Working principles of rapid sand filters and design*	*Concept of Primary, Secondary and Tertiary treatments*	*Concept of sludge management*	*Segregation and disposal methods of sloid waste*
	SLO-2	*Population forecast using different methods*	*Disinfection of water and Chlorination*	*Screening and Grit Chambers*	*Thickening, Conditioning and Dewatering of sludge*	*Reduction at source, recovery and recycle*
S-6	SLO-1	*Solving problems using Tutorial Sheet 2*	*Solving problems using Tutorial Sheet 5*	*Solving problems using Tutorial Sheet 8*	*Solving problems using Tutorial Sheet 11*	*Solving problems using Tutorial Sheet 14*
	SLO-2	*Solving problems using Tutorial Sheet 2*	*Solving problems using Tutorial Sheet 5*	*Solving problems using Tutorial Sheet 8*	*Solving problems using Tutorial Sheet 11*	*Solving problems using Tutorial Sheet 14*

S-7	SLO-1	*Water requirements for industrial need and agriculture*	*Advanced treatment like adsorption, ion exchange*	*Concept of aerobic and anaerobic treatment systems*	*Various disposal methods of sludge*	*Concept of Air Pollution: Properties and monitoring of Air pollutants*
	SLO-2	*Components of water supply system*	*Advanced treatment like membrane processes and UV methods.*	*Primary settling tanks and secondary settling tanks*	*Energy recovered from sludge*	*Air quality standards and control measures for Air Pollution*
S-8	SLO-1	*Transmission of water and distribution system*	*Effective water management Rain water harvesting methods*	*Principles of septic tanks and design.*	*Revenue from end product of sludge management*	*Basic concept of Noise Pollution and measurements*
	SLO-2	*Service reservoirs used in water supply*	*Measures taken for protecting the existing water bodies*	*Activated Sludge Process and Trickling Filters*	*Design of Sludge digestion tanks*	*Various control methods of noise pollution Acceptable standards for Noise levels*
S-9	SLO-1	*Solving problems using Tutorial Sheet 3*	*Solving problems using Tutorial Sheet 6*	*Solving problems using Tutorial Sheet 9*	*Solving problems using Tutorial Sheet 12*	*Solving problems using Tutorial Sheet 15*
	SLO-2	*Solving problems using Tutorial Sheet 3*	*Solving problems using Tutorial Sheet 6*	*Solving problems using Tutorial Sheet 9*	*Solving problems using Tutorial Sheet 12*	*Solving problems using Tutorial Sheet 15*

Learning Resources	1. *Metcalf, Eddy, Wastewater Engineering, Treatment and Reuse, Tata McGraw Hill, 2005* 2. *S. K. Garg, Water Supply Engineering, Khanna Publishers, 2017* 3. *S. K. Garg, Sewage Disposal and Air Pollution Engineering, Khanna Publishers, 2017* 4. *CPHEEO Manual on Water Supply and Treatment, Ministry of Drinking water and Sanitation, New Delhi, 2015*	5. *GeorgeTchobanoglous, Hilary Theisen, Samuel Vigil, Integrated Solid Waste Management, McGraw Hill,1993* 6. *CPHEEO Manual on Sewerage and Sewage Treatment, Ministry of Urban Development, New Delhi, 2010* 7. *NPTEL Course-Water, Society & Sustainability. https://onlinecourses.nptel.ac.in/noc18_hs36/* 8. *NPTEL Course-Wastewater Treatment & Recycling https://onlinecourses.nptel.ac.in/noc18_ce26*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Rajkumar Samuel, Hubert Enviro-Care Systems, Chennai, rajkumar@hecs.in	*1. Dr. S. Madhava Kumar, IIT Madras, mathav@iitm.ac.in*	*1. Mr. K. Prasanna, SRMSIT*
2. Mr. A. Abdul Rasheed, CMWSS Board, juruterarasheed@gmail.com	*2. Dr. G. Dhinagaran, Anna University, Chennai, dhinagaran@annauniv.edu*	*2. Mr. D. Justus Reymond, SRMIST*

Course Code	18CEC208L	Course Name	ENVIRONMENTAL ENGINEERING LABORATORY	Course Category	C	*Professional Core*	L	T	P	C
							0	0	2	1

Pre-requisite Courses	*Nil*	Co-requisite Courses	*18CEC208T*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Evaluate characteristics of water*
CLR-2 :	*Evaluate the characteristics of waste water*
CLR-3 :	*Conduct tests on water and wastewater*
CLR-4 :	*Utilize turbidity meter, pH meter, electrical conductivity meter*
CLR-5 :	*Utilize spectrophotometer, high volume sampler, noise level meter*
CLR-6 :	*Conduct titration experiments*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1	2	3	Program Learning Outcomes (PLO) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Evaluate the characteristics of water*	3	90	85	H	M	-	-	-	-	H	-	-	-	-	-	H	-	H
CLO-2 :	*Analyze the characteristics of waste water*	3	85	80	H	M	-	-	-	-	H	-	-	-	-	-	H	-	H
CLO-3 :	*Test water and wastewater sample*	3	90	85	H	M	-	-	-	-	-	-	-	-	-	-	H	-	H
CLO-4 :	*Identify the working of turbidity meter, pHmeter, electrical conductivity meter*	3	85	80	H	M	-	-	-	-	-	-	-	-	-	-	H	-	H
CLO-5 :	*Identify the working of spectrophotometer, high volume sampler, noise level meter*	3	85	80	H	M	-	-	-	-	H	-	-	-	-	-	H	-	H
CLO-6 :	*Conduct titration based experiments*	3	85	80	H	M	-	-	-	-	H	-	-	-	-	-	H	-	H

Duration (hour)		6	6	6	6	6
S 1-2	SLO-1 / SLO-2	*Determine turbidity, electrical conductivity, pH*	*Determine solids contents in water: Total, volatile, fixed, suspended, dissolved, settle able and inorganic solids*	*Determine alkalinity and Acidity*	*Determine total hardness, calcium and magnesium hardness*	*Determine chloride and sulphate*
S 3-4	SLO-1 / SLO-2	*Determine optimum coagulant dose*	*Determine Chemical Oxygen Demand (COD)*	*Determine Dissolved Oxygen(DO) and Biological Oxygen Demand(BOD)*	*Determine break point chlorination*	*Determine copper*
S 5-6	SLO-1 / SLO-2	*Determine bacteriological quality measurement: MPN*	*Monitor Ambient air quality (TSP,RSPM)*	*Monitor Ambient air quality (SO_x)*	*Monitor Ambient air quality (NO_x)*	*Measure Ambient noise*

Learning Resources	
	1. *S. K. Garg, Water Supply Engineering, Khanna Publishers, 2017*
	2. *S. K. Garg, Sewage Disposal and Air Pollution Engineering, Khanna Publishers, 2017*
	3. *IS:10500-2012, Indian Standards for Drinking Water, Bureau of Indian Standards, New Delhi.*
	4. *Environmental Engineering lab manual, SRMIST*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage) CLA – 1 (10%) Theory	Practice	CLA – 2 (15%) Theory	Practice	CLA – 3 (15%) Theory	Practice	CLA – 4 (10%)# Theory	Practice	Final Examination (50% weightage) Theory	Practice
Level 1	Remember / Understand	-	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*
Level 2	Apply / Analyze	-	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*
Level 3	Evaluate / Create	-	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Rajkumar Samuel, Hubert Enviro-Care Systems, Chennai, rajkumar@hecs.in	*1. Dr. S. Madhava Kumar, IIT Madras, mathav@iitm.ac.in*	*1. Mrs. Sija Arun, SRMIST*
2. Mr. A. Abdul Rasheed, CMWSS Board, juruterarasheed@gmail.com	*2. Dr .G. Dhinagaran, Anna University, Chennai, dhinagaran@annauniv.edu*	*2. Mr. S. Ramesh, SRMIST*

ACADEMIC CURRICULA

Professional Core Courses

COMPUTER SCIENCE AND ENGINEERING

Regulations - 2018

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Kancheepuram, Tamil Nadu, India

Course Code	18CSC201J	Course Name	DATA STRUCTURES AND ALGORITHMS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	18CSC204J
Course Offering Department	Computer Science and Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Utilize the different data types; Utilize searching and sorting algorithms for data search
CLR-2 :	Utilize linked list in developing applications
CLR-3 :	Utilize stack and queues in processing data for real-time applications
CLR-4 :	Utilize tree data storage structure for real-time applications
CLR-5 :	Utilize algorithms to find shortest data search in graphs for real-time application development
CLR-6 :	Utilize the different types of data structures and its operations for real-time programming applications

Course Learning Outcomes (CLO): At the end of this course, learners will be able to:		Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	Identify linear and non-linear data structures. Create algorithms for searching and sorting	3	80	70	L	H	-	H	L	-	-	-	L	L	-	H	-	-	-
CLO-2 :	Create the different types of linked lists and evaluate its operations	3	85	75	M	H	L	M	L	-	-	-	M	L	-	H	-	-	-
CLO-3 :	Construct stack and queue data structures and evaluate its operations	3	75	70	M	H	M	H	L	-	-	-	M	L	-	H	-	-	-
CLO-4 :	Create tree data structures and evaluate its types and operations	3	85	80	M	H	M	H	L	-	-	-	M	L	-	H	-	-	-
CLO-5 :	Create graph data structure, evaluate its operations, implement algorithms to identify shortest path	3	85	75	H	H	M	H	L	-	-	-	M	L	-	H	-	-	-
CLO-6 :	Construct the different data structures and evaluate their types and operations	3	80	70	L	H	-	H	L	-	-	-	L	L	-	H	-	-	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Introduction-Basic Terminology	Array	Stack ADT	General Trees	Graph Terminology
	SLO-2	Data Structures	Operations on Arrays – Insertion and Deletion	Stack Array Implementation	Tree Terminologies	Graph Traversal
S-2	SLO-1	Data Structure Operations	Applications on Arrays	Stack Linked List Implementation	Tree Representation	Topological sorting
	SLO-2	ADT	Multidimensional Arrays- Sparse Matrix	Applications of Stack- Infix to Postfix Conversion	Tree Traversal	Minimum spanning tree – Prims Algorithm
S-3	SLO-1	Algorithms – Searching techniques	Linked List Implementation - Insertion	Applications of Stack- Postfix Evaluation	Binary Tree Representation	Minimum Spanning Tree - Kruskal's Algorithm
	SLO-2	Complexity – Time , Space Trade off	Linked List- Deletion and Search	Applications of Stack- Balancing symbols	Expression Trees	Network flow problem
S 4-5	SLO-1 SLO-2	Lab 1: Implementation of Searching - Linear and Binary Search Techniques	Lab 4 : Implementation of Array – Insertion, Deletion.	Lab 7 :Implementation of stack using array and Linked List	Lab 10: Implementation of Tree using array	Lab 13: Implementation of Graph using Array
S-6	SLO-1	Algorithms - Sorting	Applications of Linked List	Applications of Stack- Nested Function Calls	Binary Tree Traversal	Shortest Path Algorithm- Introduction
	SLO-2	Complexity – Time , Space Trade off	Polynomial Arithmetic	Recursion concept using stack	Threaded Binary Tree	Shortest Path Algorithm: Dijkstra's Algorithm
S-7	SLO-1	Mathematical notations	Cursor Based Implementation – Methodology	Applications of Recursion: Tower of Hanoi	Binary Search Tree :Construction, Searching	Hashing: Hash functions - Introduction
	SLO-2	Asymptotic notations-Big O, Omega	Cursor Based Implementation	Queue ADT	Binary Search Tree : Insertion and Deletion	Hashing: Hash functions
S-8	SLO-1	Asymptotic notations - Theta	Circular Linked List	Queue Implementation using array	AVL Trees: Rotations	Hashing : Collision avoidance

	SLO-2	*Mathematical functions*	*Circular Linked List - Implementation*	*Queue Implementation using Linked List*	*AVL Tree: Insertions*	*Hashing : Separate chaining*
S 9-10	SLO-1	*Lab 2: Implementation of sorting Techniques – Insertion sort and Bubble Sort Techniques*	*Lab 5: Implementation of Linked List - Cursor Based Implementation*	*Lab 8: Implementation of Queue using Array and linked list*	*Lab 11: Implementation of BST using linked list*	*Lab 14 :Implementation of Shortest path Algorithm*
	SLO-2					
S-11	SLO-1	*Data Structures and its Types*	*Applications of Circular List -Joseph Problem*	*Circular Queue*	*B-Trees Constructions*	*Open Addressing*
	SLO-2	*Linear and Non-Linear Data Structures*	*Doubly Linked List*	*Implementation of Circular Queue*	*B-Trees Search*	*Linear Probing*
S-12	SLO-1	*1D, 2D Array Initialization using Pointers*	*Doubly Linked List Insertion*	*Applications of Queue*	*B-Trees Deletions*	*Quadratic probing*
	SLO-2	*1D, 2D Array Accessing using Pointers*	*Doubly Linked List Insertion variations*	*Double ended queue*	*Splay Trees*	*Double Hashing*
S-13	SLO-1	*Declaring Structure and accessing*	*Doubly Linked List Deletion*	*Priority Queue*	*Red Black Trees*	*Rehashing*
	SLO-2	*Declaring Arrays of Structures and accessing*	*Doubly Linked List Search*	*Priority Queue - Applications*	*Red Black Trees Insertion*	*Extensible Hashing*
S 14-15	SLO-1	*Lab 3: Implement Structures using Pointers*	*Lab 6: Implementation of Doubly linked List*	*Lab 9: Applications of Stack, Queue*	*Lab 12:Implementation of B-Trees*	*Lab 15 :Implementation of Minimal Spanning Tree*
	SLO-2					

Learning Resources	1. *Seymour Lipschutz, Data Structures with C, McGraw Hill, 2014* 2. *R.F.Gilberg, B.A.Forouzan, Data Structures, 2nd ed., Thomson India, 2005* 3. *A.V.Aho, J.E Hopcroft , J.D.Ullman, Data structures and Algorithms, Pearson Education, 2003* 4. *Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2nd ed., Pearson Education, 2015*	5. *Reema Thareja, Data Structures Using C, 1st ed., Oxford Higher Education, 2011* 6. *Thomas H Cormen, Charles E Leiserson, Ronald L Revest, Clifford Stein, Introduction to Algorithms 3rd ed., The MIT Press Cambridge, 2014*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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	3. Dr.Noor Mahammad, IIITDM, Kancheepuram, noor@iiitdm.ac.in	*3. Ms. Ferni Ukrit, SRMIST*

Course Code	18CSC202J	Course Name	OBJECT ORIENTED DESIGN AND PROGRAMMING	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18CSS101J	Co-requisite Courses	Nil	Progressive Courses	18CSC207J
Course Offering Department	Computer Science and Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Utilize class and build domain model for real-time programs
CLR-2 :	Utilize method overloading and operator overloading for real-time application development programs
CLR-3 :	Utilize inline, friend and virtual functions and create application development programs
CLR-4 :	Utilize exceptional handling and collections for real-time object oriented programming applications
CLR-5 :	Construct UML component diagram and deployment diagram for design of applications
CLR-6 :	Create programs using object oriented approach and design methodologies for real-time application development

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO – 3
CLO-1 :	Identify the class and build domain model	3	80	70	H	H	M	-	-	-	-	-	H	H	-	-	M	H	H
CLO-2 :	Construct programs using method overloading and operator overloading	3	85	75	H	H	H	H	H	-	M	-	H	H	-	-	M	H	H
CLO-3 :	Create programs using inline, friend and virtual functions, construct programs using standard templates	3	75	70	H	H	M	H	H	-	M	-	H	H	-	-	M	H	H
CLO-4 :	Construct programs using exceptional handling and collections	3	85	80	H	H	H	-	-	-	-	-	H	M	-	-	M	H	H
CLO-5 :	Create UML component diagram and deployment diagram	3	85	75	H	M	M	M	M	M	M	-	H	H	-	M	M	H	H
CLO-6 :	Create programs using object oriented approach and design methodologies	3	80	70	H	H	M	-	-	-	-	-	H	H	-	-	M	H	H

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Comparison of Procedural and Object Oriented Programming	Types of constructor (Default, Parameter)	Feature Inheritance: Single and Multiple	Generic - Templates : Introduction	STL: Containers: Sequence and Associative Container
	SLO-2	OOPS and its features	Static constructor and copy constructor	Inheritance: Multilevel	Function templates	
S-2	SLO-1	I/O Operations, Data Types, Variables, static	Feature Polymorphism: Constructor overloading	Inheritance: Hierarchical	Example programs Function templates	Sequence Container: Vector, List
	SLO-2	Constants, Pointers, Type Conversions	Method Overloading	Inheritance: Hybrid	Class Templates	Sequence Container: Deque, Array
S-3	SLO-1	Features: Class and Objects	Example for method overloading	Inheritance: Example Programs	Class Templates	STL : Stack
	SLO-2	UML Diagrams Introduction	Method Overloading: Different parameter with different return values		Example programs for Class and Function templates	
S 4-5	SLO-1 SLO-2	Lab 1: I/O operations	Lab 4: Constructor and Method overloading	Lab 7: Inheritance and its types	Lab 10: Templates	Lab 13: STL Containers
S-6	SLO-1	Feature :Class and Objects	Operator Overloading and types	Advanced Functions: Inline, Friend	Exceptional Handling: try and catch	Associative Containers: Map, Multimap
	SLO-2	Examples of Class and Objects	Overloading Assignment Operator	Advanced Functions: Virtual, Overriding	Exceptional Handling: Multilevel exceptional	
S-7	SLO-1	UML Class Diagram and its components	Overloading Unary Operators	Advanced Function: Pure Virtual function	Exceptional Handling: throw and throws	Iterator and Specialized iterator
	SLO-2	Class Diagram relations and Multiplicity	Example for Unary Operator overloading	Example for Virtual and pure virtual function	Exceptional Handling: finally	Functions of iterator
S-8	SLO-1	Feature Abstraction and Encapsulation	Overloading Binary Operators	Abstract class and Interface	Exceptional Handling: User defined exceptional	Algorithms: find(), count(), sort()
	SLO-2	Application of Abstraction and Encapsulation	Example for Binary Operator overloading	Example Program	Example Programs using C++	Algorithms: search(), merge()
S	SLO-1			Lab 8: Virtual Function and Abstract class		

9-10	SLO-2	Lab 2: Classes and Objects, Class Diagram	Lab 5: Polymorphism : Operators Overloading		Lab 11: Exceptional Handling	Lab 15: STL Associative containers and algorithms
S-11	SLO-1	Access specifiers – public, private	UML Interaction Diagrams	UML State Chart Diagram	Dynamic Modeling: Package Diagram	Function Object : for_each(), transform()
	SLO-2	Access specifiers - protected, friend, inline	Sequence Diagram	UML State Chart Diagram	UML Component Diagram	Example for Algorithms
S-12	SLO-1	UML use case Diagram, use case, Scenario	Collaboration Diagram	Example State Chart Diagram	UML Component Diagram	Streams and Files: Introduction
	SLO-2	Use case Diagram objects and relations	Example Diagram	UML Activity Diagram	UML Deployment Diagram	Classes and Errors
S-13	SLO-1	Method, Constructor and Destructor	Feature: Inheritance	UML Activity Diagram	UML Deployment Diagram	Disk File Handling Reading Data and Writing Data
	SLO-2	Example program for constructor	Inheritance and its types	Example Activity Diagram	Example Package, Deployment, Package	
S 14-15	SLO-1 SLO-2	Lab 3: Methods and Constructor, Usecase	Lab 6: UML Interaction Diagram	Lab 9: State Chart and Activity Diagram	Lab12 : UML Component, Deployment, Package diagram	Lab15: Streams and File Handling

Learning Resources	1. Grady Booch, Robert A. Maksimchuk, Michael W. Engle, Object-Oriented Analysis and Design with Applications, 3rd ed., Addison-Wesley, May 2007 2. Reema Thareja, Object Oriented Programming with C++, 1st ed., Oxford University Press, 2015 3. Sourav Sahay, Object Oriented Programming with C++, 2nd ed., Oxford University Press, 2017	4. Robert Lafore, Object-Oriented Programming in C++, 4th ed., SAMS Publishing, 2008 5. Ali Bahrami, Object Oriented Systems Development", McGraw Hill, 2004 6. Craig Larmen, Applying UML and Patterns, 3rd ed., Prentice Hall, 2004

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	20%	20%	15%	15%	15%	15%	15%	15%	15%	15%
Level 2	Apply Analyze	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Level 3	Evaluate Create	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc
For the laboratory component the students are advised to take an application and apply the concepts

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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Ms. Thamilchelvi, Solutions Architect, Wipro Ltd	2. Dr. Ramesh Babu, N, IITM Chennai, nrbabu@iitm.ac.in	2. Mr. C.Arun, SRMIST
		3. Mr. Geogen George, SRMIST
		4. Mr. Muthukumaran, SRMIST

Course Code	18CSC203J	Course Name	COMPUTER ORGANIZATION AND ARCHITECTURE	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*18CSC207J*
Course Offering Department	*Computer Science and Engineering*	Data Book / Codes/Standards	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Utilize the functional units of a computer*
CLR-2 :	*Analyze the functions of arithmetic Units like adders, multipliers etc.*
CLR-3 :	*Understand the concepts of Pipelining and basic processing units*
CLR-4 :	*Study about parallel processing and performance considerations.*
CLR-5 :	*Have a detailed study on Input-Output organization and Memory Systems.*
CLR-6 :	*Simulate simple fundamental units like half adder, full adder etc*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO – 3
CLO-1 :	*Identify the computer hardware and how software interacts with computer hardware*	2	80	70	H	H	-	-	-	-	-	-	M	L	-	M	-	-	-
CLO-2 :	*Apply Boolean algebra as related to designing computer logic, through simple combinational and sequential logic circuits*	3	85	75	H	H	H	-	H	-	-	-	M	L	-	M	-	-	-
CLO-3 :	*Analyze the detailed operation of Basic Processing units and the performance of Pipelining*	2	75	70	H	H	H	H	-	-	-	-	M	L	-	M	-	-	-
CLO-4 :	*Analyze concepts of parallelism and multi-core processors.*	3	85	80	H	-	-	H	-	-	-	-	M	L	-	M	-	-	-
CLO-5 :	*Identify the memory technologies, input-output systems and evaluate the performance of memory system*	3	85	75	H	-	H	H	-	-	-	-	M	L	-	M	-	-	-
CLO-6 :	*Identify the computer hardware, software and its interactions*	3	85	75	H	H	H	H	H	-	-	-	M	L	-	M	-	-	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Functional Units of a computer*	*Addition and subtraction of Signed numbers*	*Fundamental concepts of basic processing unit*	*Parallelism*	*Memory systems -Basic Concepts*
	SLO-2	*Operational concepts*	*Problem solving*	*Performing ALU operation*	*Need, types of Parallelism*	*Memory hierarchy*
S-2	SLO-1	*Bus structures*	*Design of fast adders*	*Execution of complete instruction, Branch instruction*	*applications of Parallelism*	*Memory technologies*
	SLO-2	*Memory locations and addresses*	*Ripple carry adder and Carry look ahead adder*	*Multiple bus organization*	*Parallelism in Software*	*RAM, Semiconductor RAM*
S-3	SLO-1	*Memory operations*	*Multiplication of positive numbers*	*Hardwired control*	*Instruction level parallelism*	*ROM,Types*
	SLO-2	*Memory operations*	*Problem Solving*	*Generation of control signals*	*Data level parallelism*	*Speed,size cost*
S 4-5	SLO-1 SLO-2	*Lab 1: To recognize various components of PC- Input Output systems Processing and Memory units*	*Lab4:Study of TASM* *Addition and Subtraction of 8-bit number*	*Lab-7: Design of Half Adder* *Design of Full Adder*	*Lab-10: Study of Array Multiplier* *Design of Array Multiplier*	*Lab-13: Study of Carry Save Multiplication* *Program to carry out Carry Save Multiplication*
S-6	SLO-1	*Instructions, Instruction sequencing*	*Signed operand multiplication*	*Micro-programmed control-*	*Challenges in parallel processing*	*Cache memory*
	SLO-2	*Addressing modes*	*Problem solving*	*Microinstruction*	*Architectures of Parallel Systems - Flynn's classification*	*Mapping Functions*
S-7	SLO-1	*Problem solving*	*Fast multiplication- Bit pair recoding of Multipliers*	*Micro-program Sequencing*	*SISD,SIMD*	*Replacement Algorithms*

	SLO-2	Introduction to Microprocessor	Problem Solving	Micro instruction with Next address field	MIMD, MISD	Problem Solving
S-8	SLO-1	Introduction to Assembly language	Carry Save Addition of summands	Basic concepts of pipelining	Hardware multithreading	Virtual Memory
	SLO-2	Writing of assembly language programming	Problem Solving	Pipeline Performance	Coarse Grain parallelism, Fine Grain parallelism	Performance considerations of various memories
S 9-10	SLO-1 SLO-2	Lab-2:To understand how different components of PC are connected to work properly Assembling of System Components	Lab 5: Addition of 16-bit number Subtraction of 16-bit number	Lab-8: Study of Ripple Carry Adder Design of Ripple Carry Adder	Lab-11: Study of Booth Algorithm	Lab-14: Understanding Processing unit Design of primitive processing unit
S-11	SLO-1	ARM Processor: The thumb instruction set	Integer division – Restoring Division	Pipeline Hazards-Data hazards	Uni-processor and Multiprocessors	Input Output Organization
	SLO-2	Processor and CPU cores	Solving Problems	Methods to overcome Data hazards	Multi-core processors	Need for Input output devices
S-12	SLO-1	Instruction Encoding format	Non Restoring Division	Instruction Hazards	Multi-core processors	Memory mapped IO
	SLO-2	Memory load and Store instruction in ARM	Solving Problems	Hazards on conditional and Unconditional Branching	Memory in Multiprocessor Systems	Program controlled IO
S-13	SLO-1	Basics of IO operations.	Floating point numbers and operations	Control hazards	Cache Coherency in Multiprocessor Systems	Interrupts-Hardware, Enabling and Disabling Interrupts
	SLO-2	Basics of IO operations.	Solving Problems	Influence of hazards on instruction sets	MESI protocol for Multiprocessor Systems	Handling multiple Devices
S 14-15	SLO-1 SLO-2	Lab -3To understand how different components of PC are connected to work properly Disassembling of System Components	Lab-6: Multiplication of 8-bit number Factorial of a given number	Lab-9: Study of Carry Look-ahead Adder Design of Carry Look-ahead Adder	Lab-12: Program to carry out Booth Algorithm	Lab-15: Understanding Pipeline concepts Design of basic pipeline.

Learning Resources	1. Carl Hamacher, ZvonkoVranesic, SafwatZaky, Computer Organization, 5th ed., McGraw-Hill, 2015 2. Kai Hwang, Faye A. Briggs, Computer Architecture and Parallel Processing", 3rd ed., McGraw Hill, 2016 3. Ghosh T. K., Computer Organization and Architecture, 3rd ed., Tata McGraw-Hill, 2011 4. P. Hayes, Computer Architecture and Organization, 3rd ed., McGraw Hill, 2015.	5. William Stallings, Computer Organization and Architecture – Designing for Performance, 10th ed., Pearson Education, 2015 6. David A. Patterson and John L. Hennessy Computer Organization and Design - A Hardware software interface, 5th ed., Morgan Kaufmann,2014

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	20%	20%	15%	15%	15%	15%	15%	15%	15%	15%
Level 2	Apply Analyze	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Level 3	Evaluate Create	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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		2. Dr. C. Malathy, SRMIST
		3. Mrs M.S.Abirami, SRMIST

Course Code	18CSC204J	Course Name	DESIGN AND ANALYSIS OF ALGORITHMS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18CSC201J, 18CSC202J	Co-requisite Courses	18CSC207J	Progressive Courses	Nil
Course Offering Department	Computer Science and Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Design efficient algorithms in solving complex real time problems
CLR-2 :	Analyze various algorithm design techniques to solve real time problems in polynomial time
CLR-3 :	Utilize various approaches to solve greedy and dynamic algorithms
CLR-4 :	Utilize back tracking and branch and bound paradigms to solve exponential time problems
CLR-5 :	Analyze the need of approximation and randomization algorithms, utilize the importance Non polynomial algorithms
CLR-6 :	Construct algorithms that are efficient in space and time complexities

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO – 3
CLO-1 :	Apply efficient algorithms to reduce space and time complexity of both recurrent and non-recurrent relations	3	80	70	L	H	-	H	L	-	-	-	L	L	-	H	-	-	-
CLO-2 :	Solve problems using divide and conquer approaches	3	85	75	M	H	L	M	L	-	-	-	M	L	-	H	-	-	-
CLO-3 :	Apply greedy and dynamic programming types techniques to solve polynomial time problems.	3	75	70	M	H	M	H	L	-	-	-	M	L	-	H	-	-	-
CLO-4 :	Create exponential problems using backtracking and branch and bound approaches.	3	85	80	M	H	M	H	L	-	-	-	M	L	-	H	-	-	-
CLO-5 :	Interpret various approximation algorithms and interpret solutions to evaluate P type, NP Type, NPC, NP Hard problems	3	85	75	H	H	M	H	L	-	-	-	M	L	-	H	-	-	-
CLO-6 :	Create algorithms that are efficient in space and time complexities by using divide conquer, greedy, backtracking technique	3	80	70	L	H	M	H	L	-	-	-	L	L	-	H	-	-	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Introduction-Algorithm Design	Introduction-Divide and Conquer	Introduction-Greedy and Dynamic Programming	Introduction to backtracking - branch and bound	Introduction to randomization and approximation algorithm
	SLO-2	Fundamentals of Algorithms	Maximum Subarray Problem	Examples of problems that can be solved by using greedy and dynamic approach	N queen's problem - backtracking	Randomized hiring problem
S-2	SLO-1	Correctness of algorithm	Binary Search	Huffman coding using greedy approach	Sum of subsets using backtracking	Randomized quick sort
	SLO-2	Time complexity analysis	Complexity of binary search	Comparison of brute force and Huffman method of encoding	Complexity calculation of sum of subsets	Complexity analysis
S-3	SLO-1	Insertion sort-Line count, Operation count	Merge sort	Knapsack problem using greedy approach	Graph introduction	String matching algorithm
	SLO-2	Algorithm Design paradigms	Time complexity analysis	Complexity derivation of knapsack using greedy	Hamiltonian circuit - backtracking	Examples
S 4-5	SLO-1 SLO-2	Lab 1: Simple Algorithm-Insertion sort	Lab 4: Quicksort, Binary search	Lab 7: Huffman coding, knapsack and using greedy	Lab 10: N queen's problem	Lab 13: Randomized quick sort
S-6	SLO-1	Designing an algorithm	Quick sort and its Time complexity analysis	Tree traversals	Branch and bound - Knapsack problem	Rabin Karp algorithm for string matching
	SLO-2	And its analysis-Best, Worst and Average case	Best case, Worst case, Average case analysis	Minimum spanning tree - greedy Kruskal's algorithm - greedy	Example and complexity calculation. Differentiate with dynamic and greedy	Example discussion
S-7	SLO-1	Asymptotic notations Based on growth functions.	Strassen's Matrix multiplication and its recurrence relation	Minimum spanning tree - Prims algorithm	Travelling salesman problem using branch and bound	Approximation algorithm
	SLO-2	O,O,Θ, ω, Ω	Time complexity analysis of Merge sort	Introduction to dynamic programming	Travelling salesman problem using branch and bound example	Vertex covering

S-8	SLO-1	*Mathematical analysis*	*Largest sub-array sum*	*0/1 knapsack problem*	*Travelling salesman problem using branch and bound example*	*Introduction Complexity classes*
	SLO-2	*Induction, Recurrence relations*	*Time complexity analysis of Largest sub-array sum*	*Complexity calculation of knapsack problem*	*Time complexity calculation with an example*	*P type problems*
S 9-10	SLO-1 SLO-2	*Lab 2: Bubble Sort*	*Lab 5: Strassen Matrix multiplication*	*Lab 8: Various tree traversals, Krukshall's MST*	*Lab 11: Travelling salesman problem*	*Lab 14: String matching algorithms*
S-11	SLO-1	*Solution of recurrence relations*	*Master Theorem Proof*	*Matrix chain multiplication using dynamic programming*	*Graph algorithms*	*Introduction to NP type problems*
	SLO-2	*Substitution method*	*Master theorem examples*	*Complexity of matrix chain multiplication*	*Depth first search and Breadth first search*	*Hamiltonian cycle problem*
S-12	SLO-1	*Solution of recurrence relations*	*Finding Maximum and Minimum in an array*	*Longest common subsequence using dynamic programming*	*Shortest path introduction*	*NP complete problem introduction*
	SLO-2	*Recursion tree*	*Time complexity analysis-Examples*	*Explanation of LCS with an example*	*Floyd-Warshall Introduction*	*Satisfiability problem*
S-13	SLO-1	*Solution of recurrence relations*	*Algorithm for finding closest pair problem*	*Optimal binary search tree (OBST)using dynamic programming*	*Floyd-Warshall with sample graph*	*NP hard problems*
	SLO-2	*Examples*	*Convex Hull problem*	*Explanation of OBST with an example.*	*Floyd-Warshall complexity*	*Examples*
S 14-15	SLO-1 SLO-2	*Lab 3: Recurrence Type-Merge sort, Linear search*	*Lab 6: Finding Maximum and Minimum in an array, Convex Hull problem*	*Lab 9: Longest common subsequence*	*Lab 12: BFS and DFS implementation with array*	*Lab 15: Discussion over analyzing a real time problem*

Learning Resources	1. *Thomas H Cormen, Charles E Leiserson, Ronald L Revest, Clifford Stein, Introduction to Algorithms, 3rd ed., The MIT Press Cambridge, 2014* 2. *Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2nd ed., Pearson Education, 2006*	3. *Ellis Horowitz, Sartajsahni, Sanguthevar, Rajesekaran, Fundamentals of Computer Algorithms, Galgotia Publication, 2010* 4. *S. Sridhar, Design and Analysis of Algorithms, Oxford University Press, 2015*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*\15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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		3. Mr. V. Sivakumar, SRMIST
		4. Ms. R. Vidhya, SRMIST

Course Code	18CSC205J	Course Name	OPERATING SYSTEMS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Science and Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Introduce the key role of an Operating system
CLR-2 :	Insist the Process Management functions of an Operating system
CLR-3 :	Emphasize the importance of Memory Management concepts of an Operating system
CLR-4 :	Realize the significance of Device Management part of an Operating system
CLR-5 :	Comprehend the need of File Management functions of an Operating system
CLR-6 :	Explore the services offered by the Operating system practically

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO – 3
CLO-1 :	Identify the need of an Operating system	1	80	70	H	H	H	H	H	M	L	M	H	M	M	H	H	H	M
CLO-2 :	Know the Process management functions of an Operating system	1	85	75	H	H	H	H	H	M	L	M	H	M	M	H	H	H	M
CLO-3 :	Understand the need of Memory Management functions of an Operating system	1	75	70	H	H	H	H	H	M	L	M	H	M	M	H	H	H	M
CLO-4 :	Find the significance of Device management role of an Operating system	2	85	80	H	H	H	H	H	M	L	M	H	M	M	H	H	H	M
CLO-5 :	Recognize the essentials of File Management part of an Operating system	2	85	75	H	H	H	H	H	M	L	M	H	M	M	H	H	H	M
CLO-6 :	Gain an insight of Importance of an Operating system through practical	3	80	70	H	H	H	H	H	M	L	M	H	M	M	H	H	H	M

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Operating System Objectives and functions	PROCESS SYNCHRONIZATION : Peterson's solution, Synchronization Hardware	MEMORY MANAGEMENT: Memory Management: Logical Vs Physical address space, Swapping	VIRTUAL MEMORY– Background	STORAGE MANAGEMENT : Mass storage structure – Overview of Mass storage structure – Magnetic Disks
	SLO-2	Gaining the role of Operating systems	Understanding the two-process solution and the benefits of the synchronization hardware	Understanding the basics of Memory management	Understanding the need of demand paging	Understanding the Basics in storage management
S-2	SLO-1	The evolution of operating system, Major achievements	Process synchronization: Semaphores, usage, implementation	Contiguous Memory allocation – Fixed and Dynamic partition	VIRTUAL MEMORY – Basic concepts – page fault handling	Disk Scheduling
	SLO-2	Understanding the evolution of Operating systems from early batch processing systems to modern complex systems	Gaining the knowledge of the usage of the semaphores for the Mutual exclusion mechanisms	Getting to know about Partition memory management and issues: Internal fragmentation and external fragmentation problems	Understanding , how an OS handles the page faults	Understanding the various scheduling with respect to the disk
S-3	SLO-1	OS Design considerations for Multiprocessor and Multicore	Classical Problems of synchronization – Readers writers problem, Bounded Buffer problem	Strategies for selecting free holes in Dynamic partition	Performance of Demand paging	FILE SYSTEM INTERFACE: File concept, File access methods
	SLO-2	Understanding the key design issues of Multiprocessor Operating systems and Multicore Operating systems	Good understanding of synchronization mechanisms	Understanding the allocation strategies with examples	Understanding the relationship of effective access time and the page fault rate	Understanding the file basics
S 4-5	SLO-1 SLO-2	LAB 1 : Understanding the booting process of Linux	LAB4 : System admin commands – Basics	LAB7: Shell Programs – Basic level	LAB10 : Overlay concept	LAB13:Process synchronization
S-6	SLO-1	PROCESS CONCEPT– Processes, PCB	Classical Problems of synchronization – Dining Philosophers problem (Monitor)	Paged memory management	Copy-on write	File sharing and Protection

	SLO-2	Understanding the Process concept and Maintanance of PCB by OS	Understanding synchronization of limited resources among multiple processes	Understanding the Paging technique.PMT hardware mechanism	Understanding the need for Copy-on write	Emphasis the need for the file sharing and its protection
S-7	SLO-1	Threads – Overview and its Benefits	CPU SCHEDULING : FCFS,SJF,Priority	Structure of Page Map Table	Page replacement Mechanisms: FIFO, Optimal, LRU and LRU approximation Techniques	FILE SYSTEM IMPLEMENTATION : File system structure
	SLO-2	Understanding the importance of threads	Understanding the scheduling techniques	Understanding the components of PMT	Understanding the Pros and cons of the page replacement techniques	To get the basic file system structure
S-8	SLO-1	Process Scheduling : Scheduling Queues, Schedulers, Context switch	CPU Scheduling: Round robin, Multilevel queue Scheduling, Multilevel feedback Scheduling	Example : Intel 32 bit and 64 –bit Architectures	Counting based page replacement and Page Buffering Algorithms	Directory Implementation
	SLO-2	Understanding basics of Process scheduling	Understanding the scheduling techniques	Understanding the Paging in the Intel architectures	To know on additional Techniques available for page replacement strategies	Understanding the various levels of directory structure
S 9-10	SLO-1 SLO-2	LAB2 : Understanding the Linux file system	LAB5: System admin commands – Simple task automations	LAB 8: Process Creation	LAB11: IPC using Pipes	LAB14 : Study of OS161
S-11	SLO-1	Operations on Process – Process creation, Process termination	Real Time scheduling: Rate Monotonic Scheduling and Deadline Scheduling	Example : ARM Architectures	Allocation of Frames - Global Vs Local Allocation	FILE SYSTEM IMPLEMENTATION :Allocation methods
	SLO-2	Understanding the system calls – fork(),wait(),exit()	Understanding the real time scheduling	Understanding the Paging with respect to ARM	Understanding the root cause of the Thrashing	Understanding the pros and Cons of various disk allocation methods
S-12	SLO-1	Inter Process communication : Shared Memory, Message Passing ,Pipe()	DEADLOCKS: Necessary conditions, Resource allocation graph, Deadlock prevention methods	Segmented memory management	Thrashing, Causes of Thrashing	FILE SYSTEM IMPLEMENTATION :Free space Management
	SLO-2	Understanding the need for IPC	Understanding the deadlock scenario	Understanding the users view of memory with respect to the primary memory	Understanding the Thrashing	Understanding the methods available for maintaining the free spaces in the disk
S-13	SLO-1	PROCESS SYNCHRONIZATION: Background, Critical section Problem	Deadlocks :Deadlock Avoidance, Detection and Recovery	Paged segmentation Technique	Working set Model	Swap space Management
	SLO-2	Understanding the race conditions and the need for the Process synchronization	Understanding the deadlock avoidance, detection and recovery mechanisms	Understanding the combined scheme for efficient management	Understanding the working set model for controlling the Working set Model	Understanding the Low-level task of the OS
S 14-15	SLO-1 SLO-2	LAB3: Understanding the various Phases of Compilation of a 'C' Program	LAB6 : Linux commands	LAB9: Overlay concept	LAB12: IPC using shared memory and Message queues	LAB15 : Understanding the OS161 filesystem and working with test programs

Learning Resources	1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, Operating systems, 9th ed., John Wiley & Sons, 2013 2. William Stallings, Operating Systems-Internals and Design Principles, 7th ed., Prentice Hall, 2012	3. Andrew S. Tanenbaum, Herbert Bos, Modern Operating systems, 4th ed., Pearson, 2015 4. Bryant O'Hallaxn, Computer systems- A Programmer's Perspective, Pearson, 2015

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	20%	20%	15%	15%	15%	15%	15%	15%	15%	15%
Level 2	Apply Analyze	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Level 3	Evaluate Create	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%
	Total	100 %		100 %		100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts	
1. Mr. Balamurugan, Infosys, balams@gmail.com	1. Dr. Latha Parthiban, Pondicherry University, lathaparthiban@yahoo.com	1. Dr.G.Maragatham, SRMIST	3. Ms. Aruna S, SRMIST
		2. Mr. Eliazer M, SRMIST	

Course Code	18CSC206J	Course Name	SOFTWARE ENGINEERING AND PROJECT MANAGEMENT	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Computer Science and Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Familiarize the software life cycle models and software development process*
CLR-2 :	*Understand the various techniques for requirements, planning and managing a technology project*
CLR-3 :	*Examine basic methodologies for software design, development, testing, closure and implementation*
CLR-4 :	*Understand manage users expectations and the software development team*
CLR-5 :	*Acquire the latest industry knowledge, tools and comply to the latest global standards for project management*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO – 3
CLO-1 :	*Identify the process of project life cycle model and process*	1	85	80	H	H	L	-	-	-	L	-	H	H	M	M	-	-	-
CLO-2 :	*Analyze and specify software requirements through a productive working Relationship with project stakeholders*	2	80	75	H	H	H	H	H	-	M	-	H	H	H-	M	-	-	-
CLO-3 :	*Design the system based on Functional Oriented and Object Oriented Approach for Software Design.*	3	85	85	H	H	M	H	H	M	M	L	H	H	M	-	-	-	-
CLO-4 :	*Develop the correct and robust code for the software products*	3	85	85	H	H	H	-	H	-	-	M	H	M	H	-	-	-	-
CLO-5 :	*Perform by applying the test plan and various testing techniques*	2	85	75	H	M	M	M	M	M	M	-	H	H	-	M	-	-	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Introduction to Software Engineering*	*Software Design - Software Design Fundamentals*	*Software Construction*	*Introduction to testing*	*Product Release*
	SLO-2	*Software Project Management - life cycle activities*	*Design Standards - Design Type*	*Coding Standards*	*Verification*	*Product Release*
S-2	SLO-1	*Traditional – Waterfall, V Model*	*Design model – Architectural design, Software architecture*	*Coding Framework*	*Validation*	*Product Release Management*
	SLO-2	*Prototype, Spiral, RAD*	*Software Design Methods*	*Reviews - Desk checks (Peer Reviews)*	*Test Strategy*	*Product Release Management*
S-3	SLO-1	*Conventional – Agile,*	*Top Down , Bottom Up*	*Walkthroughs*	*Planning*	*Implementation*
	SLO-2	*XP, Scrum*	*Module Division (Refactoring)*	*Code Reviews, Inspections*	*Example: Test Strategy and Planning*	*Implementation*
S 4-5	SLO-1 SLO-2	*Lab1:Identify the Software Project, Create Business Case, Arrive at a Problem Statement*	*Lab 4:Prepare Project Plan based on scope, Find Job roles and responsibilities, Calculate Project effort based on resources*	*Lab 7:State and Sequence Diagram, Deployment Diagram, Sample Frontend Design (UI/UX)*	*Lab 10: Module Implementation (Phase 2), Scrum Master to Induce New Issues in Agile Development*	*Lab 13:Manual Testing*
S-6	SLO-1	*Introduction to Requirement Engineering*	*Module Coupling*	*Coding Methods*	*Test Project Monitoring and Control*	*User Training*
	SLO-2	*Requirements Elicitation*	*Component level design*	*Structured Programming*	*Test Project Monitoring and Control*	*Maintenance Introduction*
S-7	SLO-1	*Software Project Effort and cost estimation*	*User Interface Design*	*Object-Oriented Programming*	*Test Project Monitoring and Control*	*Maintenance Types - Corrective*
	SLO-2	*Cost estimation*	*Pattern oriented design*	*Automatic Code Generation*	*Test Project Monitoring and Control*	*Adaptive*
S-8	SLO-1	*Cocomo 1 and 2*	*Web application design*	*Automatic Code Generation*	*Test Project Monitoring and Control*	*Perfective*
	SLO-2	*Cocomo 1 and 2*	*Web application design*	*Automatic Code Generation*	*Test Project Monitoring and Control*	*Preventive*
S 9-10	SLO-1 SLO-2	*Lab 2:Stakeholder and User Description, Identify the appropriate Process Model, Comparative study with Agile Model*	*Lab 5:Prepare the Work, Breakdown Structure based on timelines, Risk Identification and Plan*	*Lab 8:Module Description, Module Implementation (phase 1) Using Agile*	*Lab 11:Module Implementation (Phase 3) Scrum Master to Induce New requirements in Agile Development, Scrum Master to Induce New Issues in Agile Development, Code Documentation*	*Lab 14:User Manual, Analysis of Costing, Effort and Resources*

S-11	SLO-1	*Risk Management*	*Design Reuse*	*Software Code Reuse*	*Design –Master test plan, types*	*Maintenance Cost*
	SLO-2	*Risk Management*	*Design Reuse*	*Software Code Reuse*	*Design –Master test plan, types*	*Maintenance Process*
S-12	SLO-1	*Configuration management*	*Concurrent Engineering in Software Design*	*Pair Programming*	*Test Case Management*	*life cycle*
	SLO-2	*Configuration management*	*Concurrent Engineering in Software Design*	*Test-Driven Development*	*Test Case Management*	*Software Release*
S-13	SLO-1	*Project Planning – WBC, planning,*	*Design Life-Cycle Management*	*Configuration Management*	*Test Case Reporting*	*Software Maintenance*
	SLO-2	*scope, risk*	*Design Life-Cycle Management*	*Software Construction Artifacts*	*Test Case Reporting*	*Software Release, Software Maintenance*
S 14-15	SLO-1 / SLO-2	*Lab 3:Identify the Requirements, System Requirements, Functional Requirements, Non-Functional Requirements*	*Lab 6:Design a System Architecture, Use Case Diagram, ER Diagram (Database), DFD Diagram (process) (Upto Level 1), Class Diagram (Applied For OOPS based Project), Collaboration Diagram (Applied For OOPS based Project) (Software – Rational Rose)*	*Lab 9:Module Implementation, Scrum Master to Induce New requirements in Agile Development*	*Lab 12:Master Test Plan, Test Case Design (Phase 1)*	*Lab 15: Project Demo and Report Submission with the team*

Learning Resources	1. *Roger S. Pressman, Software Engineering – A Practitioner Approach, 6th ed., McGraw Hill, 2005* 2. *Ian Sommerville, Software Engineering, 8th ed., Pearson Education, 2010* 3. *Rajib Mall, Fundamentals of Software Engineering, 4th ed., PHI Learning Private Limited, 2014* 4. *Ramesh, Gopalaswamy, Managing Global Projects, Tata McGraw Hill, 2005*	5. *Ashfaque Ahmed, Software Project Management: a process-driven approach, Boca Raton, Fla: CRC Press, 2012* 6. *Walker Royce, Software Project Management, Pearson Education, 1999* 7. *Jim Smith Agile Project Management: Creating Innovative Products,Pearson 2008*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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		3. Mr.N.Arivazhagan, SRMIST
		4. Mrs K.R.Jansi, SRMIST

Course Code	18CSC207J	Course Name	ADVANCED PROGRAMMING PRACTICE	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*18CSC202J*	Co-requisite Courses	*18CSC204J*	Progressive Courses	*Nil*
Course Offering Department	*Computer Science and Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Create Real-time Application Programs using structured, procedural and object oriented programming paradigms*
CLR-2 :	*Create Real-time Application Programs using event driven, declarative and imperative programming paradigms*
CLR-3 :	*Create Real-time Application Programs using parallel, concurrent and functional programming paradigms*
CLR-4 :	*Create Real-time Application Programs using logic, dependent type and network programming paradigms*
CLR-5 :	*Create Real-time Application Programs using symbolic, automata based and graphical user interface program paradigm*
CLR-6 :	*Create Real-time Application Programs using different programming paradigms using python language*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO – 3
CLO-1 :	*Create Programs using structured, procedural and object oriented programming paradigms*	3	85	80	H	H	H	H	H	-	-	L	M	M	L	M	-	M	-
CLO-2 :	*Create Programs using event driven, declarative and imperative programming paradigms*	3	85	80	H	H	H	H	H	-	-	L	M	M	L	M	-	-	-
CLO-3 :	*Create Programs using parallel, concurrent and functional programming paradigms*	3	85	80	H	H	H	H	H	-	-	L	M	M	L	M	-	-	-
CLO-4 :	*Create Programs using logic, dependent type and network programming paradigms*	3	85	80	H	H	H	H	H	-	-	L	M	M	L	M	-	-	-
CLO-5 :	*Create Programs using symbolic, automata based and graphical user interface programming paradigms*	3	85	80	H	H	H	H	H	-	-	L	M	M	L	M	-	-	-
CLO-6 :	*Create Programs using different programming paradigms using python language*	3	85	80	H	H	H	H	H	-	-	L	M	M	L	M	-	-	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Structured Programming Paradigm*	*Event Driven Programming Paradigm*	*Parallel Programming Paradigm*	*Logic Programming Paradigm*	*Symbolic Programming Paradigm*
	SLO-2	*Programming Language Theory*	*Event Object, handler, bind*	*Multi-threading, Multi-Processing*	*First-class function, Higher-order function, Pure functions, Recursion*	*Symbolic Maths, algebraic manipulations, limits, differentiation, integration, series*
S-2	SLO-1	*Bohm-Jacopini structured program theorem*	*Keypress events, Mouse events*	*Serial Processing, Parallel Processing*	*Packages: Kanren, SymPy*	*SymPy usage for symbolic maths*
	SLO-2	*Sequence, selection, decision, iteration, recursion*	*Automatic events from a timer*	*Multiprocessing module in Python*	*PySWIP, PyDatalog*	*Equation Solving, Matrices*
S-3	SLO-1	*Other languages: C, C++, Java, C#, Ruby*	*Other languages: Algol, Javascript, Elm*	*Process class, Pool class*	*Other languages: Prolog, ROOP, Janus*	*Other languages: Aurora, LISP, Wolfram*
	SLO-2	*Demo: Structured Programing in Python*	*Demo: Event Driven Programming in Python*	*Demo: Parallel Programming in Python*	*Demo: Logic Programming in Python*	*Demo: Symbolic Programming in Python*
S 4-5	SLO-1 SLO-2	*Lab 1: Structured Programming*	*Lab 4: Event Driven Programming*	*Lab 7: Parallel Programming*	*Lab 10: Logic Programming*	*Lab 13: Symbolic Programming*
S-6	SLO-1	*Procedural Programming Paradigm*	*Declarative Programming Paradigm*	*Concurrent Programming Paradigm*	*Dependent Type Programming Paradigm*	*Automata Based Programming Paradigm*
	SLO-2	*Routines, Subroutines, functions*	*Sets of declarative statements*	*Parallel Vs Concurrent Programming*	*Logic Quantifier: for all, there exists*	*Finite State Machine, deterministic finite automation (dfa), nfa*
S-7	SLO-1	*Using Functions in Python*	*Object attribute, Binding behavior*	*threading, multiprocessing*	*Dependent functions, dependent pairs*	*State transitions using python-automaton*
	SLO-2	*logical view, control flow of procedural programming in various aspects*	*Creating Events without describing flow*	*concurrent.futures, gevent, greenlets, celery*	*Relation between data and its computation*	*Initial state, destination state, event (transition)*
S-8	SLO-1	*Other languages: Bliss, ChucK, Matlab*	*Other languages: Prolog, Z3, LINQ, SQL*	*Other languages: ANI, Plaid*	*Other Languages: Idris, Agda, Coq*	*Other languages: Forth, Ragel, SCXML*
	SLO-2	*Demo: creating routines and subroutines using functions in Python*	*Demo: Declarative Programming in Python*	*Demo: Concurrent Programming in Python*	*Demo: Dependent Type Programming in Python*	*Demo: Automata Based Programming in Python*

S 9-10	SLO-1 SLO-2	*Lab 2: Procedural Programming*	*Lab 5: Declarative Programming*	*Lab 8: Concurrent Programming*	*Lab 11: Dependent Type Programming*	*Lab 14: Automata Programming*
S-11	SLO-1	*Object Oriented Programming Paradigm*	*Imperative Programming Paradigm*	*Functional Programming Paradigm*	*Network Programming Paradigm*	*GUI Programming Paradigm*
	SLO-2	*Class, Objects, Instances, Methods*	*Program State, Instructions to change the program state*	*Sequence of Commands*	*Socket Programming: TCP & UDP Connection oriented, connectionless*	*Graphical User Interface (GUI)*
S-12	SLO-1	*Encapsulation, Data Abstraction*	*Combining Algorithms and Data Structures*	*map(), reduce(), filter(), lambda*	*Sock_Stream, Sock_Dgram, socket(), bind(), recvfrom(), sendto(), listen()*	*Tkinter, WxPython, JPython*
	SLO-2	*Polymorphism, Inheritance*	*Imperative Vs Declarative Programming*	*partial, functools*	*Server-Client; send(), recv(), connect(), accept(), read(), write(), close()*	*WxWidgets, PyQT5*
S-13	SLO-1	*Constructor, Destructor*	*Other languages: PHP, Ruby, Perl, Swift*	*Other languages: F#, Clojure, Haskell*	*Other languages: PowerShell, Bash, TCL*	*Other languages: GTK, java-gnome*
	SLO-2	*Example Languages: BETA, Cecil, Lava Demo: OOP in Python*	*Demo: Imperative Programming in Python*	*Demo: Functional Programming in Python*	*Demo: Socket Programming in Python*	*Demo: GUI Programming in Python*
S 14-15	SLO-1 SLO-2	*Lab 3: Object Oriented Programming*	*Lab 6: Imperative Programming*	*Lab 9: Functional Programming*	*Lab 12: Network Programming*	*Lab 15: GUI Programming*

Learning Resources	1. *Elad Shalom, A Review of Programming Paradigms throughout the History: With a suggestion Toward a Future Approach, Kindle Edition, 2018* 2. *John Goerzen, Brandon Rhodes, Foundations of Python Network Programming: The comprehensive guide to building network applications with Python, 2nd ed., Kindle Edition, 2010* 3. *Elliot Forbes, Learning Concurrency in Python: Build highly efficient, robust and concurrent applications, Kindle Edition, 2017*	4. *Amit Saha, Doing Math with Python: Use Programming to Explore Algebra, Statistics, Calculus and More, Kindle Edition, 2015* 5. *Alan D Moore, Python GUI Programming with Tkinter: Develop responsive and powerful GUI applications with Tkinter, Kindle Edition, 2018* 6. *https://www.scipy-lectures.org/*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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		3. Ms. K. Sornalakshmi, SRMIST
		4. Mr. C. Arun, SRMIST

ACADEMIC CURRICULA

Professional Core Courses

ELECTRICAL & ELECTRONICS ENGINEERING

Regulations - 2018

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Kancheepuram, Tamil Nadu, India

Course Code	18EEC201J	Course Name	ANALYSIS OF ELECTRIC CIRCUITS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*18EES101J*	Co-requisite Courses		Progressive Courses	
Course Offering Department	*Electrical and Electronics Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Analyze real-time circuits using mesh and nodal analysis and network reduction*
CLR-2 :	*Utilize solutions of AC circuits including series and parallel resonance*
CLR-3 :	*Utilize network theorems on DC & AC circuits*
CLR-4 :	*Examine circuits at transient condition*
CLR-5 :	*Solve 3 phase circuits, coupled and tuned circuits*
CLR-6 :	*Enrich the concepts of AC and DC circuits using different analysis*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO - 3
CLO-1 :	*Analyze circuit parameters, analyze circuits using mesh and nodal analysis and network reduction*	3	75	75	H	H	-	-	-	-	-	-	M	M	-	-	M	M	-
CLO-2 :	*Evaluate solution methods of AC circuits including series and parallel resonance*	3	75	75	H	H	-	-	M	-	-	-	M	M	-	-	M	M	-
CLO-3 :	*Calculate solutions of network theorems for DC and AC circuits*	3	75	75	H	H	-	-	-	-	-	-	M	M	-	-	M	M	-
CLO-4 :	*Analyze the transients of RLC circuits*	3	75	75	H	H	M	-	M	-	-	-	M	M	-	-	M	M	-
CLO-5 :	*Analyze 3 phase circuits, coupled, tuned circuits and two port networks.*	3	75	75	H	H	M	-	-	-	-	-	M	M	-	-	M	M	-
CLO-6 :	*Evaluate AC and DC circuits under different cases*	3	75	75	H	H	M	-	M	-	-	-	M	M	-	-	M	M	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Introduction to two terminal circuit passive elements*	*Introduction to AC circuits*	*Superposition theorem in DC circuits*	*Introduction: Exponentially increasing functions*	*Analysis of balanced three-phase 3 wire circuits*
	SLO-2	*Characteristics of two terminal circuit passive elements*	*Phasors*	*Problems in Superposition theorem in DC circuits*	*Exponentially Decreasing functions*	*Problems in balanced three-phase 3 wire circuits*
S-2	SLO-1	*Circuit Reduction Techniques*	*Impedance*	*Superposition theorem in AC circuits*	*RL free circuits*	*Analysis of unbalanced three-phase circuits*
	SLO-2	*Problems in Circuit Reduction Techniques*	*Admittance*	*Problems in Superposition theorem in AC circuits*	*RL Driven circuits*	*Problems in unbalanced three-phase circuits*
S-3	SLO-1	*Combination of Sources*	*Calculation of Power and Power Factor*	*Reciprocity theorems in AC circuits*	*Transients in RL circuit with DC excitation*	*Two-wattmeter method of measuring three-phase power*
	SLO-2	*Source Transformation*	*Problems in Power and Power Factor*	*Problems in Reciprocity theorems in AC circuits*	*Transients in RL circuit with AC excitation*	*Problems in Two-wattmeter method of measuring three-phase power*
S 4-5	SLO-1 SLO-2	*Lab 1: Circuit reduction and basic laws*	*Lab 4: Determine Power and Power Factor*	*Lab 7: Verify Superposition and Reciprocity Theorems*	*Lab 10: Analyze Time domain of RL transient circuit*	*Lab 13: Measure power in 3 phase circuits using two wattmeter method*
S-6	SLO-1	*Mesh current analysis of DC circuits with dependent sources*	*Steady state analysis of RL circuits*	*Thevenin's theorem in DC circuits*	*RC free circuits*	*Analysis of coupled circuits*
	SLO-2	*Problems in Mesh current analysis of DC circuits with dependent sources*	*Steady state analysis of RC circuits*	*Norton theorem in DC circuits*	*RC driven circuits*	*Problems in coupled circuits*
S-7	SLO-1	*Mesh analysis in DC circuits with current sources*	*Steady state analysis of RLC circuits*	*Thevenin's theorem in AC circuits*	*Transients in RC circuit with DC excitation*	*Analysis of tuned circuits*
	SLO-2	*Problems in Mesh analysis in DC circuits with current sources*	*Phasor diagram of RLC circuits*	*Problems in Thevenin's theorem in AC circuits*	*Transients in RC circuit with AC excitation*	*Problems in tuned circuits*
S-8	SLO-1	*Nodal Voltage analysis of DC circuits with dependent sources*	*Series resonance circuits*	*Norton's theorem in AC circuits*	*Laplace transforms*	*Introduction to Two port networks*

	SLO-2	*Problems in Nodal Voltage analysis of DC circuits with dependent sources*	*Problems in Series resonance circuits*	*Problems in Norton's theorem in AC circuits*	*Transform impedance*	*Analysis of Two port networks*
S 9-10	SLO-1	*Lab 2: Mesh analysis in DC circuits*	*Lab 5: Real time Data Acquisition*	*Lab 8: Verify Thevenin's and Norton's theorems*	*Lab 11: Analyze Time domain of RC transient circuit*	*Lab 14: Analysis in tuned circuits*
	SLO-2					
S-11	SLO-1	*Supermesh method for mesh analysis*	*Parallel resonance circuits*	*Millman's theorem in AC circuits*	*Transients in RLC circuit with DC excitation*	*Impedance parameters*
	SLO-2	*Problems in Supermesh method for mesh analysis*	*Problems in Parallel resonance circuits*	*Problems in Millman's theorem in AC circuits*	*Problems in Transients in RLC circuit with DC excitation*	*Problems in impedance parameters*
S-12	SLO-1	*Nodal analysis in DC circuits with voltage sources*	*Mesh analysis in AC circuits*	*Maximum Power Transfer Theorem in DC circuits*	*Transients in RLC circuit with AC excitation*	*Admittance parameters*
	SLO-2	*Problems in Nodal analysis in DC circuits with voltage sources*	*Problems in Mesh analysis in AC circuits*	*Problems in Maximum Power Transfer Theorem in DC circuits*	*Problems in Transients in RLC circuit with AC excitation*	*Problems in admittance parameters*
S-13	SLO-1	*Supernodal method for nodal analysis*	*Nodal analysis in AC circuits*	*Maximum Power Transfer Theorem in AC circuits*	*Circuit transients using Laplace transform*	*Hybrid parameters*
	SLO-2	*Problems in Supernodal analysis*	*Problems in Nodal analysis in AC circuits*	*Problems in Maximum Power Transfer Theorem in AC circuits*	*Problems in Circuit transients using Laplace transform*	*Inverse Hybrid parameters*
S 14-15	SLO-1	*Lab 3: Nodal analysis in DC circuits*	*Lab 6: Study of series and parallel resonance circuits*	*Lab 9: Verify maximum power transfer theorem*	*Lab 12: Analyze Time domain of RLC transient circuits*	*Lab 15: Determine hybrid parameters*
	SLO-2					

Learning Resources	1. *Sudhakar A, Shyam Mohan S.P, Circuits and Networks Analysis and Synthesis, 4th ed., Tata McGraw Hill, 2010* 2. *William H. Hayt, Jack E. Kemmerly, Steven M. Durbin, Engineering circuit analysis, 8th ed., McGraw Hill, 2012* 3. *Jegatheesan R, Analysis of Electric Circuits, McGraw Hill, 2014*	4. *John Bird, Electric circuit theory and technology, 5th ed., Taylor and Francis, 2013* 5. *https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-071j-introduction-to-electronics-signals-and-measurement-spring-2006/lecture-notes/*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr . Roosefart Mohan, Nelcast Limited, chennai,roosefart@gmail.com	*1. Dr. D. Devaraj, Kalasalingam Academy of Research and Education, deva230@yahoo.com*	*1. Dr. R. Jegatheesan, SRMIST*
2.Mr. Muralikrishna, National Instruments, emkkrishnan@gmail.com	*2. Dr. B. ChittiBabu, IIITD, Kanchipuram, chittibabu@gmail.com*	*2. Dr. J. Preetha Roselyn, SRMIST*

Course Code	18EEC202T	Course Name	ELECTROMAGNETIC THEORY	Course Category	C	Professional Core	L	T	P	C
							3	1	0	4

Pre-requisite Courses		Co-requisite Courses		Progressive Courses	
Course Offering Department	*Electrical and Electronics Engineering*	Data Book / Codes/Standards	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Utilize the concepts of Electromagnetic theory for practical applications*
CLR-2 :	*Utilize knowledge about the static electric field and its applications.*
CLR-3 :	*Utilize knowledge on static magnetic field*
CLR-4 :	*Utilize parameters involved in time varying field and Maxwell's equations*
CLR-5 :	*Enrich in the field of Electromagnetic waves*
CLR-6 :	*Create a mindset to solve various engineering problems in the field of electromagnetism*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1 Level of Thinking (Bloom)	2 Expected Proficiency (%)	3 Expected Attainment (%)	PLO 1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	13 PSO - 1	14 PSO - 2	15 PSO - 3
CLO-1 :	*Identify the basic laws of electromagnetics and coordinate systems*	2	80	75	M	M	-	-	-	-	-	-	M	M	-	-	M	M	-
CLO-2 :	*Solve the Electric field parameters for simple configuration under static condition*	3	80	75	H	H	M	L	-	-	-	-	M	M	-	-	M	M	-
CLO-3 :	*Examine the Magnetic field for simple configuration under static condition*	3	80	75	H	H	M	L	-	-	-	-	M	M	-	-	M	M	-
CLO-4 :	*Extend the basics of electromagnetic theory on time varying electric and magnetic field*	3	80	75	H	H	M	L	M	-	-	-	M	M	-	-	M	M	-
CLO-5 :	*Analyze propagation of electromagnetic waves*	3	80	75	H	H	M	L	-	-	-	-	M	M	-	-	M	M	-
CLO-6 :	*Apply electromagnetic concepts to solve real time problems*	3	75	75	H	H	M	L	M	-	-	-	M	M	-	-	M	M	-

Duration (hour)		12	12	12	12	12
S-1	SLO-1	*Vector analysis for three-dimensional Euclidean space*	*Current density, Ohms Law in point form*	*Fundamentals of Magnetostatics (B, H)*	*Faraday's law of Electromagnetic induction*	*Wave parameters- velocity, intrinsic impedance- propagation constants*
	SLO-2	*Stokes and Divergence theorem*	*Continuity of current equation*	*Magnetic field due to straight conductor*	*Motional and transformer EMF*	*Uniform plane waves*
S-2	SLO-1	*Three orthogonal coordinate systems –Cartesian system*	*Boundary conditions of perfect dielectric materials*	*B and H for a circular loop*	*Displacement current and conduction current*	*Electromagnetic Wave equation for free space,*
	SLO-2	*Cylindrical and spherical coordinate system*	*Boundary condition between conductor and dielectric, conductor and free space.*	*Magnetic field due to infinite sheet of current.*	*Point form of Maxwell's equation, Integral form of Maxwell's equations*	*Equation for lossy dielectric medium*
S-3	SLO-1	*Conversion from one coordinate to another coordinate system*	*Permittivity of dielectric materials*	*Magnetic materials, permeability*	*Phasor representation of time harmonic field*	*Wave equation for lossless dielectrics and conductors*
	SLO-2	*Solutions of Coulomb's law*	*Dielectric strength and dielectric polarization*	*Magnetic dipole*	*Energy in quasi-stationary Electromagnetic Fields*	*Skin effect and skin depth calculations*
S-4	SLO-1 SLO-2	*Tutorial: Quantitative analysis of coordinate system*	*Tutorial: Quantitative analysis of boundary condition problem*	*Tutorial: Quantitative analysis of B and H calculations*	*Tutorial: Quantitative analysis of Maxwell's Equation*	*Tutorial: Quantitative analysis of Electromagnetic Wave Equation*
S-5	SLO-1	*Fundamentals of electrostatics*	*Capacitance of a two-wire line.*	*Magnetization and Magnetic susceptibility*	*Magnetic Potential*	*Standing wave*
	SLO-2	*Electric field intensity (E) andflux density (D) due to point, line and surface charge*	*Solution of Laplace and Poisson's equation*	*Magnetic field in multiple media – Boundary conditions*	*Potential for time varying fields*	*Plane wave reflection and refraction*
S-6	SLO-1	*D and E for volume charge distribution*	*Applications of Laplace and Poisson's equation*	*Magnetic potential – Scalar and Vector potential. Magnetic diffusion*	*MagNet software*	*The incidence of plane wave at the boundary between two regions*
	SLO-2	*Electric field due to dipole*	*Uniqueness theorem*	*Magnetic force and stress tensor*	*MagNet software for 3D electromagnetic field simulations*	*Fresenel's coefficient*
S-7	SLO-1	*Applications of Gauss law's*	*Duality theorem*	*Inductance calculation for a solenoid and toroid*	*Case study on real time applications of Maxwell's equations*	*Goos-Hanchen's effect*

	SLO-2	Electric Potential and its calculation for different configurations	Method of images	Inductance of a coaxial cable	Problems on time varying field	Snell's law
S-8	SLO-1	Tutorial: Quantitative analysis forD, E and potential calculation	Tutorial: Quantitative analysis of capacitance calculations and Laplace equations	Tutorial: Quantitative analysis of magnetic boundary conditions	Tutorial: Quantitative analysis of Poynting vectors and magnetic potential	Tutorial: Quantitative analysis of Electromagnetic boundary conditions
	SLO-2					
S-9	SLO-1	Force on a moving charge and differential current element	Sketches of fields and field plotting.	Inductance derivation for two wire transmission line	Case study of Parallel Particle Tracing for Steady-State and Time-Varying Flow Fields	Reflection coefficient
	SLO-2	Magnetic field and induced emf in rotating machines	Finite difference method (FDM)	Problems on Inductance calculations	Applications of Poynting theorem	Transmission coefficient
S-10	SLO-1	Mutipole concept	FDM to a solution of region and boundary conditions	Energy density in magnetic field	Electromagnetic Wave Equations	Quantitative analysis of wave parameters
	SLO-2	Multipole of electrostatic expansion	Quantitative analysis of FDM	The finite element analysis- an introduction	Solutions of Helmholtz's equation	Brewster angle
S-11	SLO-1	Quadrupole and octupole	Method of moment for Electrostatic field	Finite element method (FEM) for magnetostatic field	Prototype using the concept of EM theory	Critical angle
	SLO-2	Example for multipole expansion	Case study on dust cloud ignition caused by static electricity	Case study on super conducting disk in an external magnetic field.	Minor Project presentation	Case study on fault calculations using EM wave equations
S-12	SLO-1	Tutorial: quantitative analysis of force, current and torque	Tutorial: Quantitative analysis of Electrostatic field calculations	Tutorial: quantitative analysis of magnetostatic field	Tutorial: quantitative analysis of electromagnetic field	Tutorial: Quantitative analysis of EM wave coefficients
	SLO-2					

Learning Resources	1. William Hayt, Engineering Electromagnetics, 7th ed., McGraw Hill, 2014 2. Matthew. N.O. Sadiku, Elements of Electromagnetics, 4th ed., Oxford University Press, 2010 3. David J. Griffths, Introduction to Electrodynamics, 4th ed., Pearson publication, 2013	4. Joseph A Edminister, Theory and Problem of Electromagnetics, Schaum's outline series McGraw Hill, 2006 5. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-632-electromagnetic-wave-theory-spring-2003/index.htm

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
Level 2	Apply Analyze	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
Level 3	Evaluate Create	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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2. Mr.J. Sasikumar,Philips India Limited, Chennai	2. Dr. A. Venkadesan, NIT, Pondicherry, venkadesan@nitpy.ac.in	2. Mrs. D. Anitha, SRMIST

Course Code	18EEC203J	Course Name	DIGITAL SYSTEM DESIGN	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*18EES101J*	Co-requisite Courses		Progressive Courses	
Course Offering Department	*Electrical and Electronics Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Utilize digital systems*
CLR-2 :	*Utilize combinational logic circuits*
CLR-3 :	*Design and implement sequential logic circuits*
CLR-4 :	*Implement different logic functions using transistor and MOSFET*
CLR-5 :	*Analyze the types of PLD's and VHDL programming*
CLR-6 :	*Analyze and design digital logic circuits*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO - 3
CLO-1 :	*Simplify Boolean expression*	2	75	75	H	M	M	M	-	-	-	-	M	M	-	-	L	M	-
CLO-2 :	*Solve problems in combinational logic circuits*	3	75	75	H	M	M	M	-	-	-	-	M	M	-	-	L	M	-
CLO-3 :	*Construct sequential circuits for given requirement and verify them in laboratory*	3	75	75	H	M	M	M	-	-	-	-	M	M	-	-	L	M	-
CLO-4 :	*Analyze IC characteristics operation of logic gates and their families*	2	75	75	H	M	L	L	-	-	-	-	M	M	-	-	L	M	-
CLO-5 :	*Implement digital circuit using PLA, PAL, PROM. Write programs using VHDL*	3	75	75	H	L	L	L	L	-	-	-	M	M	-	-	M	M	-
CLO-6 :	*Apply the concepts of digital systems and experimentally validate them*	3	75	75	H	M	M	M	L	-	-	-	M	M	-	-	L	M	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Minterms, Canonical SOP form*	*Binary multiplier*	*Introduction to latches/Flip flop*	*Introduction to asynchronous sequential circuit*	*Memory organization and operation*
	SLO-2	*Simplification of switching function using K maps-SOP method*	*Binary divider*	*Flip flop: SR flip flop*	*Steps involved in design of asynchronous sequential circuit*	*Classification of memories ROM, PROM, EPROM, RAM*
S-2	SLO-1	*Simplification of Incompletely specified function using K maps- SOP method*	*Arithmetic logic unit (ALU)*	*Flip flops: D flip flop*	*Merger graph*	*Content addressable memory, Charge decoupled device memory*
	SLO-2	*Simplification of switching function with Don't care using K maps-SOP method*	*Elementary ALU design*	*Flip flops: JK & T flip flops*	*Problems in design of asynchronous sequential circuit*	*Commonly used memory chips*
S-3	SLO-1	*Maxterms, Canonical POS form*	*Multiplexer*	*Realization of D, JK, T flip flops using SR flip flops*	*Cycles*	*Programmable Logic Array(PLA)*
	SLO-2	*Simplification of switching function using K maps-POS method*	*Implementation of Boolean expression using multiplexer*	*Realization of D flip flop using T flip flop, Realization of T flip flop using D flip flop, Realization of JK flip flops using D flip flop*	*Critical and non-critical Races, Hazards*	*Implementation of Boolean function using PLA*
S 4-5	SLO-1 SLO-2	*Lab 1: Simplification of switching function using K maps and implementation using logic gates*	*Lab 4: Realization of MUX, Realization of Boolean expression using MUX*	*Lab 7: Realization of one flip flop using another flip flop*	*Lab 10: Design and implementation of Hazard free circuit*	*Lab 13: Realize Boolean algebra using PLA*
S-6	SLO-1	*Quine-McCluskey method for 4 variable problem*	*Demultiplexer*	*Design of synchronous sequential circuits- Moore Model using D flip flop*	*Problems in design of asynchronous sequential circuit including races*	*Programmable Array Logic (PAL)*
	SLO-2	*Quine-McCluskey method for4 variable problem with Don't care*	*Implementation of Boolean expression using demultiplexer*	*Design of synchronous sequential circuits- Moore Model using JK flip flop*	*Analysis of asynchronous sequential circuits*	*Implementation of Boolean function using PAL*
S-7	SLO-1	*Quine-McCluskey method for5 variable problem*	*Decoders,*	*Design of synchronous sequential circuits- Moore Model using T flip flop*	*Analysis of asynchronous sequential machines with latches*	*Complex programmable logic device (CPLD), FPGA*
	SLO-2	*Quine-McCluskey method for5 variable problem with Don't care*	*BCD to 7 segment decoders, drivers for display devices*	*Design of synchronous sequential circuits- Mealy Model using D flip flop*	*Asynchronous up Counters, Asynchronous down Counters design*	*Introduction to VHDL programming*

S-8	SLO-1	Adder: Half adder, Full adder	Encoder	Design of synchronous sequential circuits- Mealy Model using JK flip flop	Design of asynchronous up/down counter	VHDL design flow
	SLO-2	Subtractor: Half subtractor, Full subtractor	Priority encoder	Design of synchronous sequential circuits- Mealy Model using T flip flop	Design of asynchronous MOD-n Counter	VHDL types and operators
S 9-10	SLO-1 SLO-2	Lab 2: Realization of combinational circuits: Half adder, Full adder, Half subtractor, Full subtractor	Lab 5: Design of BCD to 7 segment decoders	Lab 8: Design and implementation of synchronous sequential circuits	Lab 11: Design of asynchronous Counters	Lab 14: Verification of gates using FPGA
S-11	SLO-1	Parallel binary adder and parallel binary subtractor	Parity generator	Analysis of synchronous sequential circuits using D,T flip flops	Digital logic families: Characteristics of Digital logic families	Structural and Behavioral Modelling
	SLO-2	Parallel adder/subtractor	Parity checker	Analysis of synchronous sequential circuits using JK flip flop	TTL Logic, Schottky TTL Logic, CMOS Logic	Data flow Modelling
S-12	SLO-1	Carry look ahead adder	Code Converter: Binary to Grey	Synchronous counters: up, down, up-down counters	ECL logic	Packages, subroutines
	SLO-2	BCD adder	Code Converter: Grey to Binary	MOD-n, Random counters	Interfacing CMOS with TTL	Test bench
S-13	SLO-1	Magnitude Comparator for 1,2-bit Comparator	Code Converter: BCD to Excess 3	Shift registers, Serial to parallel converter, Parallel to serial converter, Universal shift register	Tristate logic	Simple VHDL program: Combinational logic circuits
	SLO-2	Magnitude Comparator for 4-bit Comparator	Code Converter: Excess 3 to BCD	Ring counter, Johnson counter	Comparison between various logic circuits	Simple VHDL program: counters
S 14-15	SLO-1 SLO-2	Lab 3: Realization of BCD adder and 2-bit Magnitude Comparator	Lab 6: Realization of Code Converters	Lab 9: Design of Synchronous Counters, Design of shift registers and ring counters	Lab 12: Mini Project Presentation: Realization of digital control circuits	Lab 15: Verification of Combinational logic circuits using FPGA

Learning Resources	1. M. Morris Mano, Michael D. Ciletti, Digital Design: With an Introduction to Verilog HDL, VHDL and System Verilog, 6th ed., Pearson, 2018 2. Thomas L.Floyd, Digital Fundamentals, 11th ed., Pearson India, 2014	3. Charles H. Roth, Lizy K. John, Digital System Design Using VHDL, 2nd ed., Cengage learning, 2012 4. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (100% weightage)								Final Examination	
		CLA – 1 (20%)		CLA – 2 (30%)		CLA – 3 (30%)		CLA – 4 (20%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	20%	20%	15%	15%	15%	15%	15%	15%	15%	15%
Level 2	Apply Analyze	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Level 3	Evaluate Create	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Roosefart Mohan, Nelcast Limited, Chennai, roosefart@gmail.com	1. Dr. D. Devaraj, Kalasalingam Academy of Research and Education, deva230@yahoo.com	1. Dr. C. S. Boopathi, SRMIST
2. Mr. Muralikrishna, National Instruments, emkkrishnan@gmail.com	2. Dr. B. ChittiBabu, IIITD, Kanchipuram, chittibabu@gmail.com	2. Ms. D. Anitha, SRMIST

Course Code	18EEC204J	Course Name	ELECTRICAL MACHINES I	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18EES101J	Co-requisite Courses		Progressive Courses	
Course Offering Department	Electrical and Electronics Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Analyze the characteristics of different types of DC generators
CLR-2 :	Identify the working, starting and speed control of DC motors
CLR-3 :	Analyze transformers and derive its equivalent circuit
CLR-4 :	Test DC machines and transformers as per standard practice
CLR-5 :	Model DC machines
CLR-6 :	Analyze the performance of the DC machine and transformer

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO - 3
CLO-1 :	Analyze the principle and fundamentals of DC generator	2	75	75	H	L	-	-	-	-	-	-	M	M	-	-	M	M	-
CLO-2 :	Analyze the principle and fundamentals of DC motor	2	75	75	H	L	-	-	-	-	-	-	M	M	-	-	M	M	-
CLO-3 :	Identify the different types of transformers and analyze its performance using equivalent circuit	2	75	75	H	M	-	-	-	-	-	-	M	M	-	-	M	M	-
CLO-4 :	Investigate and interpret the performance of DC machines and transformers performing suitable tests	3	75	75	H	M	-	-	-	-	-	M	M	M	-	-	M	M	M
CLO-5 :	Analyze DC machines by mathematical modeling	3	75	75	H	M	L	L	L	-	-	-	M	M	-	-	M	M	-
CLO-6 :	Evaluate characteristics of transformers, DC Machines and evaluate their performance by applying various testing methods	3	75	75	H	M	L	L	L	-	-	L	M	M	-	-	M	M	L

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Energy in magnetic system	Torque equation of DC motor	Transformers: Types and Construction	Testing of DC machines: Brake test	Modeling of dc machines: Basic two pole DC machine
	SLO-2	Field energy and mechanical force	Emf equation of DC motor	Principle of operation, emf equation	Swinburne's test	Analysis of DC machine using Primitive two axis machine equation
S-2	SLO-1	Single excited systems	Voltage equation of various types of DC motor	Ideal transformer and Practical transformer on no load	Problems in Swinburne's test	Modelling of voltage equation
	SLO-2	Multiple excited systems	Current equation of various types of DC motor	Practical transformer on load	Retardation test	Modelling of torque equation
S-3	SLO-1	Torque and Force equations	Speed equation and regulation of DC motor	Equivalent circuit of transformer	Hopkinson's test	Mathematical model of separately excited DC machine
	SLO-2	Energy conversion via electric fields	Power flow in DC motor, Losses & efficiency	Transformer regulation, losses, efficiency	Problems in Hopkinson's test	Problems in mathematical model of separately excited DC machine
S 4-5	SLO-1 SLO-2	Lab 1: Demo on Single & Multiple excited systems	Lab 4: Load test on DC motors	Lab 7: Load test on single-phase transformer	Lab 10: Swinburne's test and Hopkinson's test on DC machine	Lab 13: Study of impulse test in transformer
S-6	SLO-1	Dynamic equation of electromechanical systems	Review of mechanical starter- 3-point starter	Phasor diagram of transformer	Open circuit test on single phase transformer	Mathematical model of shunt connected DC machine
	SLO-2	DC generator- lap and wave winding, Major considerations in design of windings	4-point starter, 2-point starter	EMF in power transformers	Short circuit test on single phase transformer	Problems in mathematical model of shunt connected DC machine
S-7	SLO-1	DC generator-EMF equation-circuit model	Electronic soft starters for DC motor with energy saving	All day efficiency, Per unit representation of transformer	Sumpner's test	Mathematical model of series connected DC machine
	SLO-2	Methods of excitation	Speed control: Field control, Armature control	Three phase transformers connections, Scott connection	Equivalent circuit, efficiency and regulation from OC & SC test	Problems in mathematical model of series connected DC machine
S-8	SLO-1	Losses in DC generator	Speed control: voltage control	Phasing of transformer	Equivalent circuit, efficiency and regulation from Sumpner's test	Mathematical model of compound connected DC machine

	SLO-2	*Power flow in DC generator, efficiency*	*Problems in DC motors*	*Parallel operation of single phase and three phase transformers*	*Problems in OC & SC test*	*Problems in Mathematical model of compound connected DC machine*
S 9-10	SLO-1	*Lab 2: Open circuit and load characteristics of Separately Excited DC generator*	*Lab 5: Speed Control of DC Motor: Field control, Armature control*	*Lab 8: Load test on three phase transformer*	*Lab 11: Open circuit and short circuit test and Sumpner's test on single phase transformer*	*Lab 14: Study of zero sequence impedance and noise level test in transformer*
	SLO-2					
S-11	SLO-1	*Effect of armature flux on field flux in DC generator*	*Speed control: Thyristor control*	*Auto transformer*	*Routine test on transformer*	*Time domain model of shunt connected DC machine*
	SLO-2	*Use of compensating windings, Ampere-Turns calculations*	*Speed control: Converters control*	*Tap changing transformers- tertiary winding*	*Dielectric and parametric test on transformer*	*State equations of shunt connected DC machine*
S-12	SLO-1	*Commutation in DC generator, construction of commutator,*	*Speed control: choppers control*	*Variable frequency transformer, audio frequency transformer*	*Type test on transformer*	*Problems in state equations of shunt connected DC machine*
	SLO-2	*Methods to improve commutation*	*Braking of DC motors*	*Phase shifting transformer, dry type transformer*	*Temperature rise and impulse test on transformer*	*Time domain model of permanent magnet DC machine*
S-13	SLO-1	*Voltage and current equation, Residual voltage, Critical Resistance*	*Permanent magnet DC motor*	*Grounding transformer, traction transformer*	*Unbalance current, magnetic balance test on transformer*	*State equations of permanent magnet DC machine*
	SLO-2	*Problems in DC generator*	*Problems in speed control*	*Welding transformer, rectifier transformer*	*Zero sequence impedance and noise level test on transformer*	*Problemsin state equations of permanent magnet DC machine*
S 14-15	SLO-1	*Lab 3: Open circuit and load characteristics of Self Excited DC generator*	*Lab 6: Speed Control of DC Motor: Thyristor, converter and chopper control*	*Lab 9: Parallel operation of single phase and three phase transformers*	*Lab 12: IEC/IEEE standard practice on transformer testing*	*Lab 15: Simulation of separately and self-excited DC machine*
	SLO-2					

Learning Resources	1. *D. P. Kothari, I. J. Nagrath, Electrical Machines, 5th ed.,Tata-McGraw Hill, 2017* 2. *A. E. Fitzgerald, C. Kingsley, Electric Machinery, 6th ed., McGraw Hill Education, 2013*	3. *Paul C. Krause, Oleg Wasynezuk, Scott D. Sudhoff, Analysis of electric machinery and Drive systems 3rd ed., IEEE Series, John Wiley & Sons, 2013* 4. *https://ocw.mit.edu/courses/electrical-engineering-and-computer-science*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (100% weightage)								Final Examination	
		CLA – 1 (20%)		CLA – 2 (30%)		CLA – 3 (30%)		CLA – 4 (20%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. S. Paramasivam, Danfoss Industries Pvt Ltd, paramsathya@yahoo.com	*1. Dr. D. Devaraj, Kalasalingam Academy of Research and Education, deva230@yahoo.com*	*1. Dr. C. S. Boopathi, SRMIST*
2.Mr. Muralikrishna, National Instruments, emkkrishnan@gmail.com	*2. Dr. B. ChittiBabu, IIITD, Kanchipuram, chittibabu@gmail.com*	*2. Dr. K. Vijayakumar, SRMIST*

Course Code	18EEC205J	Course Name	ELECTRICAL MACHINES II	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18EES101J	Co-requisite Courses		Progressive Courses	
Course Offering Department	Electrical and Electronics Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Identify the need of rotating magnetic field in three phase induction motor and draw its equivalent circuit
CLR-2 :	Evaluate performance of three phase induction motor using circle diagram, identify its starting, speed control methods
CLR-3 :	Develop an equivalent circuit of single phase induction motor and explain the operation of single phase AC machines
CLR-4 :	Construct an equivalent circuit and phasor diagram of an alternator and obtain its voltage regulation
CLR-5 :	Analyze the working and characteristics of salient pole alternator and synchronous motor
CLR-6 :	Utilize the construction, operation and performance of AC machines

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO – 1	PLO 14: PSO - 2	PLO 15: PSO - 3
CLO-1 :	Analyze the working of three phase induction motor, its torque slip characteristics and hence obtain its equivalent circuit	2	75	75	H	H	M	-	-	-	-	-	M	M	-	-	L	M	-
CLO-2 :	Identify the starting and speed control methods of three phase induction motor and evaluate its performance	3	75	75	H	H	M	-	-	-	-	-	M	M	-	-	M	M	-
CLO-3 :	Analyze the different single phase AC machines and model a single-phase induction motor	3	75	75	H	M	L	-	-	-	-	-	M	M	-	-	L	M	-
CLO-4 :	Model alternators and compute its voltage regulation	3	75	75	H	H	M	-	-	-	-	-	M	M	-	-	L	M	-
CLO-5 :	Identify the operation and control of salient pole alternator and synchronous motor	2	75	75	H	L	L	-	-	-	-	-	M	M	-	-	M	M	-
CLO-6 :	Analyze the performance of an AC machine by modeling and by carrying out laboratory experiments	3	75	75	H	M	M	-	-	-	-	-	M	M	-	-	L	M	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Review of poly phase distributed AC winding, Production of EMF	Construction of circle diagram for 3-phase induction motor	Constant magnetic field, Pulsating magnetic field	Alternators- Constructional features and types, Short pitch and full-pitch coils	Salient pole synchronous machine
	SLO-2	Flux and mmf waves in induction motor	Performance calculation from circle diagram	Alternating current in winding with spatial displacement	Concentrated and distributed winding, Coil span factor, Winding distribution factor	Blondel's two reaction theory
S-2	SLO-1	Constructional details of three-phase induction motor	Problems in circle diagram	Magnetic field produced by single winding- fixed current and alternating current	Air gap MMF distribution with fixed current	Phasor diagram using Xd, Xq
	SLO-2	Principle of operation of three-phase induction motor	Determination of maximum quantities from circle diagram	Pulsating fields produced by spatially displaced windings	Air gap MMF distribution with sinusoidal current	Slip test, Voltage regulation using slip test
S-3	SLO-1	Slip, Effect of slip on rotor parameters	Need for speed control	Windings spatially shifted by 90 degrees	EMF equation of alternator	Power output of Salient pole synchronous machine
	SLO-2	Torque equation, Starting torque equation, Maximum torque	Speed control of three-phase induction motor: Stator side	Addition of pulsating magnetic fields	Armature reaction, Alternator on load, phasor diagram	Problems in voltage regulation
S 4-5	SLO-1 SLO-2	Lab 1: Load test on 3 phase induction motor	Lab 4: Speed control of three-phase induction motor: stator side	Lab 7: Demo of spatially displaced windings	Lab 10: Load test on 3 phase alternators	Lab 13: Determination of Xd and Xq of salient pole machine
S-6	SLO-1	Torque-slip characteristics, Generation and breaking region in Torque-slip characteristics	Speed control of three-phase induction motor: rotor side	Constructional detail of single phase induction motor	Equivalent circuit and phasor diagram	Synchronous motor: Principle of operation, Methods of starting
	SLO-2	Starting characteristics of 3 phase induction motor, Effect of Rotor resistance on Torque-slip characteristics	Speed control by solid state devices	Double revolving field theory	Synchronous Impedance, voltage regulation	Torque and power equations
S-7	SLO-1	Power Stages	Necessity of Starters	Torque equation	Pre-determination of voltage regulation using EMF method	Synchronous motor on load, Synchronous motor on constant excitation variable load
	SLO-2	Relation between rotor input, rotor copper losses and rotor output	Types of starters	Torque- speed characteristics	Problems in EMF method	Synchronous motor on constant load variable excitation, 'V', inverted 'V' curves

S-8	SLO-1	*Problems in power stages*	*Induction generator, Self-excited Induction generator*	*No load blocked rotor tests*	*Pre-determination of voltage regulation using MMF method*	*Synchronous condenser, Hunting and its suppression*
	SLO-2	*No load and blocked rotor tests*	*Doubly-Fed Induction generator*	*Equivalent circuit*	*Problems in MMF method*	*Short circuit transient in synchronous machine*
S 9-10	SLO-1 SLO-2	*Lab 2: No load and blocked rotor test on 3-phase squirrel cage induction motor*	*Lab 5: Speed control of three-phase induction motor on rotor side*	*Lab 8: No load and blocked rotor test on 1-phase induction: To draw equivalent circuit*	*Lab 11: Voltage regulation of alternators by EMF and MMF methods*	*Lab 14: Determination of 'V' and inverted 'V' curves in synchronous motor*
S-11	SLO-1	*Steady state analysis-Equivalent circuit*	*Harmonics in induction motor*	*Making single phase induction self-starting*	*Pre-determination of voltage regulation using ZPF method*	*Capability curves in synchronous machine*
	SLO-2	*Motor efficiency, rotor efficiency*	*Crawling, Cogging*	*Shaded pole induction motor*	*Problems in ZPF method*	*Positive, Negative and Zero sequence reactance of synchronous machines*
S-12	SLO-1	*Equivalent circuit from No load and blocked rotor tests*	*Electric Braking: Regenerative braking, Plugging Braking*	*Linear Induction motor, Universal motor*	*Pre-determination of voltage regulation using ASA method*	*Synchronous induction motor*
	SLO-2	*Problems in no load and blocked rotor test*	*Electric Braking: AC, DC dynamic braking*	*Reluctance motor*	*Problems in ASA method*	*Brushless DC motor*
S-13	SLO-1	*Double cage rotor*	*Slip power recovery scheme*	*AC series motor, Repulsion motor*	*Parallel operation of alternators, Load sharing*	*Permanent Magnet Synchronous Motor*
	SLO-2	*Equivalent circuit of double cage rotor, Performance calculation*	*Difference in starting and blocked rotor characteristics*	*Stepper motor*	*Voltage and frequency control, Synchronization to infinite bus-bar*	*Tacho generator*
S 14-15	SLO-1 SLO-2	*Lab 3: No load and blocked rotor test on 3-phase slip ring induction motor*	*Lab 6: Characteristics of 3 phase Induction generator*	*Lab 9: Load test on single phase induction motor*	*Lab 12: Voltage regulation of alternators by ZPF method, Synchronization and parallel operation of alternators*	*Lab 15: Determination of Positive, Negative and Zero sequence reactance of synchronous machines*

Learning Resources	1. *H.Wayne Beaty&Jame. L.Kirtley.Jr, Electric Motor Handbook, McGraw-Hill, USA, 1st Edition, 1998* 2. *M.G.Say, The Performance and Design of Alternating Current machines, Tata-McGraw Hill, 1st Edition, 2004*	3. *J. B. Gupta, Theory & Performance of Electrical Machines, 15th ed., S. K. Kataria & Sons, 2015* 4. *https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-685-electric-machines-fall-2013/index.htm*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (100% weightage)								Final Examination	
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		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. S. Paramasivam, Danfoss Industries Pvt Ltd, paramsathya@yahoo.com	*1. Dr. D. Devaraj, Kalasalingam Academy of Research and Education, deva230@yahoo.com*	*1. Dr. C. S. Boopathi, SRMIST*
2. Mr. Muralikrishna, National Instruments, emkkrishnan@gmail.com	*2. Dr. R. Ramesh, CEG, rramesh@annauniv.edu*	*2. Dr. K. Vijayakumar, SRMIST*

Course Code	18EEC206J	Course Name	ANALOG ELECTRONICS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*18EES101J*	Co-requisite Courses		Progressive Courses	
Course Offering Department	*Electrical and Electronics Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Know the basic amplifier circuits.*
CLR-2 :	*Acquire knowledge on different power amplifiers.*
CLR-3 :	*Construct different waveform generating circuits.*
CLR-4 :	*Discuss the basics of operational amplifiers.*
CLR-5 :	*Understand different analog to digital and digital to analog converters*
CLR-6 :	*Design amplifier circuits using transistor and operational amplifiers.*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	**Learning** 1 Level of Thinking (Bloom)	2 Expected Proficiency (%)	3 Expected Attainment (%)	**Program Learning Outcomes (PLO)** 1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	13 PSO - 1	14 PSO - 2	15 PSO - 3
CLO-1 :	*Analyze the amplifier circuits using small signal model and hybrid model*	2	75	75	H	H	H	H	-	-	L	-	M	M	-	-	M	H	-
CLO-2 :	*Recognize the different power amplifiers*	2	75	75	H	H	H	H	-	-	-	-	M	M	-	-	M	H	-
CLO-3 :	*Design oscillators and multivibrators.*	3	75	75	H	H	H	M	-	-	-	-	M	M	-	-	M	M	-
CLO-4 :	*Apply different operational amplifiers.*	2	75	75	H	M	M	-	-	-	-	-	M	M	-	-	M	M	-
CLO-5 :	*Evaluate filters and converter circuits*	3	75	75	H	H	H	M	H	-	-	-	M	M	-	-	M	M	-
CLO-6 :	*Demonstrate electronic modern tools in various electronic fields.*	2	75	75	H	H	H	M	M	-	L	-	M	M	-	-	M	M	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	*BJT -Biasing methods -Base bias, base bias with emitter feedback*	*Power amplifiers: Types. Determine efficiency for class A, B power amplifier*	*Oscillators and classification of oscillators*	*Introduction to Linear Integrated Technology*	*Filters basics and types*
	SLO-2	*Base bias with collector feedback and voltage divider bias*	*Frequency response of RC coupled class A amplifier*	*Design and Analysis of RC Phase shift oscillator*	*Fabrication process for Integrated Circuits*	*Design of I and II Order LPF*
S-2	SLO-1	*Emitter bias using BJT in CE configuration*	*Frequency response of Transformer coupled class A amplifier.*	*Operation of Hartley's oscillator*	*Dc characteristics of op amp and input bias current.*	*Design of I Order HPF*
	SLO-2	*Transistor biasing stability using BJT in CE configuration*	*Operation of Class B push pull power amplifier*	*Analysis of Hartley's oscillator*	*Input offset voltage, Thermal Drift*	*Design of II Order HPF*
S-3	SLO-1	*Operation of BJT as an amplifier*	*Operation of Differential amplifier*	*Operation of Armstrong oscillator*	*AC characteristics of op-amp and Frequency Compensation*	*Design of BPF and BRF*
	SLO-2	*CE, CB, CC Amplifier –Evaluation of h-parameters*	*Analysis of Differential amplifier*	*Operation of UJT Relaxation oscillator*	*Slew rate*	*Switched variable filters and state variable filters.*
S 4-5	SLO-1 SLO-2	*Lab 1: Determination of hybrid parameters of a CE amplifier.*	*Lab 4: Determination of gain of an amplifier.*	*Lab 7: RC Phase shift oscillator*	*Lab 10: and AC characteristics of IC 741 Op-amp*	*Lab 13: Design of Low pass and High Pass Filters.*
S-6	SLO-1	*Small signal analysis of CE Amplifier*	*Self–biased active load differential amplifier*	*Operation of Cross Coupled oscillator*	*Inverting amplifier and Non-inverting amplifier*	*Oscillators- Wein bridge Oscillator using IC 741.*
	SLO-2	*Small signal analysis of CB and CC amplifier*	*Source degenerated common source amplifier*	*Integrators*	*Summer and Subtractor.*	*Amplitude control and Quadrature Control Oscillator*
S-7	SLO-1	*Large signal analysis of CE Amplifier*	*Classification of class C power amplifiers (Tuned amplifiers)*	*Differentiators*	*Voltage follower and ac amplifiers*	*Introduction to simple MOSFET based op-amp circuits.*
	SLO-2	*Large signal analysis of CB and CC amplifier.*	*Frequency response of Single,Double and Staggered Tuned Class C power amplifier*	*Schmitt trigger*	*V to I and I to V converters*	*Analog to Digital converters, classification. Counter and Sigma Delta type ADC.*
S-8	SLO-1	*JFET –Common source (CS) amplifier - operation*	*Cascode and Cascade circuits*	*Multivibrator, Classification Operation of Astable Multivibrator*	*Instrumentation amplifier*	*Successive approximation type ADC*

	SLO-2	*CS Amplifier – small signal analysis*	*Feedback amplifiers –Barkhausen criterion and Types of feedback amplifier*	*Analysis of Astable Multivibrator*	*Log and Antilog amplifiers*	*Digital to Analog converters and Pulse width modulator DAC*
S 9-10	SLO-1 SLO-2	*Lab 2: Analysis of JFET amplifier*	*Lab 5: Frequency response of RC coupled amplifier*	*Lab 8: AstableMultivibrator*	*Lab 11: Applications of op-amp*	*Lab 14: Wein bridge oscillator using IC 741.*
S-11	SLO-1	*JFET – Common Drain (CD) Amplifier – operation*	*Analysis of voltage series feedback amplifier*	*Operation of Monostable Multivibrator.*	*Comparators and classification of comparators*	*R -2R Ladder DAC*
	SLO-2	*Small signal analysis of MOSFET*	*Analysis of voltage shunt feedback amplifier*	*Analysis of Monostable Multivibrator.*	*Applications of Comparators : Summer, Subtractor, Voltage follower*	*Binary coded DAC*
S-12	SLO-1	*Biasing of MOSFET*	*Analysis of current series amplifier*	*Operation of Bistable Multivibrator.*	*Basics of IC 555 Timer and Pin Details*	*Case study: Minor project on any advanced application based circuit using IC 741 or IC 555 Timer or IC 723.*
	SLO-2	*CD Amplifier – small signal analysis*	*Analysis of current shunt feedback amplifier*	*Analysis of Bistable Multivibrator.*	*Astable operation using IC 555 Timer with applications*	
S-13	SLO-1	*Problems on biasing of circuits.*	*Problems on power amplifiers.*	*Voltage and time-based circuits.*	*Monostable operation using IC 555 Timer with applications*	*Case study: Minor project on any advanced application based circuit using IC 741 or IC 555 Timer or IC 723.*
	SLO-2	*Problems on hybrid parameters*	*Problems on feedback amplifiers*	*Series and shunt voltage regulator*	*Voltage regulator using IC 723*	
S 14-15	SLO-1 SLO-2	*Lab 3: Analysis of MOSFET amplifier*	*Lab 6: Frequency response of Class C Power amplifier*	*Lab 9: Transistor series voltage regulator*	*Lab 12: Voltage Regulator Using IC 723*	*Lab 15: R -2R Ladder DAC*

Learning Resources	1. *Jacob Millman, Christos C.Halkias, SatyabrataJit, Millman's Electronic Devices and Circuits, 4th ed., Tata McGraw Hill, 2015* 2. *Boylestead, Nashelsky, Electronic Devices and Circuit Theory, 11th ed., Pearson, 2015* 3. *David A. Bell, Electronic Devices and Circuits, 5th ed., Prentice Hall, 2004*	4. *Sergio Franco, Design with operational amplifiers and Analog Integrated circuits, 5th ed., McGraw-Hill, 2014* 5. *Roy Choudhary and Shail Jain, Linear Integrated Circuits, 4th ed., New Age International Publishers, 2014* 6. *https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-002-circuits-and-electronics-spring-2007/syllabus/*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (100% weightage)								Final Examination	
		CLA – 1 (20%)		CLA – 2 (30%)		CLA – 3 (30%)		CLA – 4 (20%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. S. Paramasivam, Danfoss Industries Pvt Ltd, paramsathya@yahoo.com	*1. Dr. P. Satheeshkumar, Anna University, silkart@gmail.com*	*1. Ms. R. C. Ilambirai, SRMIST*
2. Mr. B. Nliranjithkumar, BEL, Chennai., niranjithkumarb@bel.co.in	*2. Dr. S. Kamalakannan, Anna University, kamalakannan1612@gmail.com*	*2. Dr. K. Mohanraj, SRMIST*

Course Code	18EEC207J	Course Name	ELECTRICAL AND ELECTRONICS MEASUREMENTS AND INSTRUMENTATION	Course Category	C	*Professional Core*	L	T	P	C
							3	0	2	4

Pre-requisite Courses		Co-requisite Courses		Progressive Courses	
Course Offering Department	Electrical and Electronics Engineering	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Utilize the knowledge of various types of measuring instruments, DC and AC bridge.*
CLR-2 :	*Utilize the working of analog meters for power, energy and harmonic measurements*
CLR-3 :	*Utilize different measuring and display devices*
CLR-4 :	*Compare the measurement of non- electrical quantities.*
CLR-5 :	*Analyze the functions of biomedical instruments and data acquisition system*
CLR-6 :	*Utilize the knowledge about measurements, measuring instruments for practical applications*

		Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Solve the problems in measuring instruments and bridges*	3	75	75	H	L	-	-	L	-	-	-	M	M	-	-	L	M	-
CLO-2 :	*Apply the different analog meters for power, energy and harmonic measurements.*	2	75	75	H	L	-	-	-	-	-	-	M	M	-	-	L	M	-
CLO-3 :	*Design the operation of different measuring and display devices*	2	75	75	H	L	-	-	-	-	-	-	M	M	-	-	L	L	-
CLO-4 :	*Identify the measurement of non- electrical quantities.*	2	75	75	H	-	-	-	L	-	-	-	M	M	-	-	L	L	-
CLO-5 :	*Describe the working of biomedical instruments and data acquisition system*	2	75	75	H	-	-	-	-	-	-	-	M	M	-	-	L	M	-
CLO-6 :	*Interpret the acquired knowledge of measuring instruments*	2	75	75	H	L	-	-	L	-	-	-	M	M	-	-	L	M	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Functional elements of instrument*	*Special type of transformers -Current Transformer*	*Construction and working of synchro scope – Western type*	*Methods of pressure measurements- Dead-weight gauges and Manometers*	*Over view of biomedical measurements*
	SLO-2	*Static characteristics of measurement*	*Potential Transformer- Measurement of voltage*	*Nalder-Lipman type*	*Pressure measuring system*	*Sources of bio electric potentials, Electrodes*
S-2	SLO-1	*Dynamic characteristics of measurement*	*Principle of operation, construction, Torque equation of induction type single phase energy meter*	*General principle and performance equations of Ballistic Galvanometer*	*Elastic transducer, Vibrating cylinder*	*Measurement of blood pressure-direct methods*
	SLO-2	*Errors in measurement*	*Three phase energy meter*	*D'Arsonval Galvanometer*	*Resonant transducer.*	*Working of X- ray Instrumentation*
S-3	SLO-1	*Kelvin's Double Bridge, measurement of Low value of Resistances*	*Creeping adjustments, testing of energy meters*	*General principle and working of Hall effect sensors*	*Measurement of Flow: Flow visualization from Pitot-static tube, Yaw tube.*	*Applications of X- ray Instrumentation*
	SLO-2	*Wheat -stone Bridge, measurement of Medium value of Resistances.*	*Calibration of energy meter using direct loading.*	*Encoder-Laser based methods.*	*Positive displacement method, Obstruction methods.*	*Working and applications of Electrocardiograph (ECG)*
S 4-5	SLO-1 SLO-2	*Lab 1: Measurement of R, L and C using bridge circuit*	*Lab 4: Measurement of power and energy*	*Lab 7: Measurement of liquid flow rate*	*Lab 10: Measurement of water level using capacitive Transducer*	*Lab 13: Real time monitoring of ECG wave analysis using simulator*
S-6	SLO-1	*Maxwell's Inductance Bridge, Measuring Unknown value of Inductance*	*Digital energy meter*	*Graphical methods of measurement: Cathode ray oscilloscope*	*Drag effect methods, hot-wire anemometers.*	*Block diagram of data acquisition system*
	SLO-2	*Anderson's Bridge, measurement of Un known value of Inductance.*	*Net metering*	*Digital storage oscilloscope*	*Measuring Devices: Vacuum and sound*	*Block diagram of Signal conditioning*
S-7	SLO-1	*Schering's Bridge measurement of Un known value of Capacitance.*	*Measurement of reactive power using wattmeter in single phase circuit.*	*Storage devices: Strip chart recorder*	*McLeod gauge, Knudsen gauge*	*Telemetry and working.*
	SLO-2	*Principle of operation of Thermal type instruments*	*Measurement of reactive power using wattmeter in Poly phase circuits*	*X-Y recorder*	*Diaphragm and ionization gauges*	*Respiratory instrumentation – Mechanism of respiration, spirometry*
S-8	SLO-1	*Principle of operation, construction, working of single phase power factor meter*	*Measurement of Volt Ampere reactive power using VAR meter*	*Principle of operation and applications of Phase sequence indicator*	*Motion measurement-Fundamentals standards.*	*Working of different types of Pacemakers*

	SLO-2	*Three phase power factor meter*	*Principle of operation, and construction of Maximum demand indicator*	*Principle of operation and applications of Display devices: LED, LCD, Dot matrix display*	*Temperature measurement using Liquid in glass thermometers*	*Applications of Pacemakers*
S 9-10	SLO-1	*Lab 2: Power factor measurement*	*Lab 5: Measurement of power and energy*	*Lab 8: Measurement of harmonics using Power quality analyser.*	*Lab 11: Measurement of temperature to estimate the response time using temperature measuring instruments*	*Lab 14: Study of Pacemaker Module*
	SLO-2					
S-11	SLO-1	*Solving Problems in error measurements*	*Solving Problems in single phase energy meter*	*Solving Problems in Phase sequence indicator.*	*Solving Problems in transducers*	*Interfacing instruments –General purpose interfacing bus (GPIB)*
	SLO-2	*Solving Problems in bridge circuits*	*Solving Problems in three phase energy meter*	*Solving Problems in Galvanometer*	*Solving Problems in Pressure measurement.*	*Working of GPIB Hardware Components*
S-12	SLO-1	*Principle of operation, construction, Torque equation of Dynamometer type instruments*	*Frequency meters, Electrical resonance type*	*Measurement of LCD screen size*	*Measurement of Pressure thermometers*	*GPIB / SCPI Programming Elements and specifications*
	SLO-2	*Principle of operation of Rectifier type instruments*	*Frequency meters - Mechanical Resonance Type.*	*Operation of an analogue actuator: the DC Servo motor*	*Properties of analogue sensors for temperature*	*Interfacing instruments –USB*
S-13	SLO-1	*Principle of operation and applications of Digital voltmeter.*	*Principle of operation of spectrum analyser*	*Radio frequency identification (RFID) reader*	*Properties of analogue sensors for pressure*	*Instrumentation for medical imaging*
	SLO-2	*Principle of operation and applications of Digital Multimeter.*	*Principle of operation of Harmonic analyser*	*Data loggers*	*Laser based measurement of liquid temperature*	*Instrumentation for Therapeutic Devices*
S 14-15	SLO-1	*Lab 3: Demo on Universal bridge*	*Lab 6: Demo on Frequency meter*	*Lab 9: Identification of phase sequence using Synchroscope*	*Lab 12: Study of temperature and pressure sensor*	*Lab 15: Analysis of Instrumentation for medical imaging*
	SLO-2					

Learning Resources	1. *Ernest O Doebelin, Dhanesh N Manik, Measurements Systems Application and Design, 5th ed., McGraw Hill, 2006* 2. *Sawhney A. K, A Course in Electrical and electronic Measurement and Instrumentation, Dhanpat Rai & Sons, 2015* 3. *Rajendra Prasad, Electrical Measurements & Measuring instruments, 10th ed., Khanna Publishers, 1989*	4. *Albert D Halfride & William D Cooper, Modern Electronic Instrumentation and Measurement Techniques, Pearson, 2015* 5. *John G Webster, Medical instrumentation: Application and design ,4th ed., Wiley, 2010* 6. *https://ocw.mit.edu/courses/electrical-engineering-and-computer-science*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (100% weightage)								Final Examination	
		CLA – 1 (20%)		CLA – 2 (30%)		CLA – 3 (30%)		CLA – 4 (20%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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2. Mr. Muralikrishna, National Instruments, emkkrishnan@gmail.com	*2. Dr. Bindu, Govt. College of Engineering, Vayanadu, Kerala, bgr100@gmail.com*	*2. Ms. S. Vijayalakshmi, SRMIST*

Course Code	18EEC208T	Course Name	GENERATION, TRANSMISSION AND DISTRIBUTION	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses		Co-requisite Courses		Progressive Courses	
Course Offering Department	Electrical and Electronics Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Utilize the basics of electric power generation, transmission and distribution
CLR-2 :	Solve the various transmission line parameters for single and three phase transmission system
CLR-3 :	Analyze the performance of transmission line and to learn the different voltage compensation techniques
CLR-4 :	Utilize insulators, cables and estimate the string efficiency
CLR-5 :	Analyze the basics of substation components and DC distribution systems
CLR-6 :	Create overall structure of power system starting from generation to power transmission and distribution

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)
CLO-1 :	Identify the layout of various energy sources and its economics of power generation	2	80	75
CLO-2 :	Calculate the line parameter for single and multi-phase power transmission system	3	80	75
CLO-3 :	Compute the performance of various types of transmission lines	3	80	75
CLO-4 :	Acquire knowledge on insulators, cables and evaluate stress and sag	3	80	75
CLO-5 :	Identify the substation components and compute the DC distribution systems	3	80	75
CLO-6 :	Design a power system using components like generators, transmission lines and distributors	3	80	75

Program Learning Outcomes (PLO)

	1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	13 PSO - 1	14 PSO - 2	15 PSO - 3
CLO-1	H	M	M	-	-	-	M	-	-	-	-	-	H	M	H
CLO-2	H	H	M	M	M	-	M	-	-	-	-	-	M	M	M
CLO-3	H	H	H	M	-	-	-	-	M	M	-	-	H	M	M
CLO-4	H	M	H	M	-	-	-	-	-	-	-	-	H	H	M
CLO-5	H	H	M	M	-	-	-	-	-	-	-	-	H	M	M
CLO-6	H	H	M	M	M	-	M	-	M	M	-	-	H	M	M

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Sources of energy	Calculate Resistance in a single-phase transmission line	Analyze performance of short line	Classify insulators for transmission and distribution purpose	Classification, major components of substations, Bus-bar arrangements
	SLO-2	Structure of power system	Calculate Inductance in a single-phase transmission line	Analyze performance of medium transmission line (end condenser method)	Voltage distribution in insulator string	Substation bus schemes- single bus, double bus with double breaker
S-2	SLO-1	Basic layout of PV power generation	Calculate Capacitance in a single-phase transmission line	Calculate efficiency,regulation of voltage for medium line by end condenser method	Improvement of string efficiency	Double bus with single breaker
	SLO-2	Basic layout of wind power generation	Calculate Inductance and capacitance of three phase transmission lines	Analyze Performance of medium line using T method	Calculation of voltage distribution and string efficiency	Main and transfer bus schemes
S-3	SLO-1	Basic layout of Ocean Thermal Energy Conversion (OTEC)	Calculate Inductance and capacitance in a Symmetrically spaced conductor	Calculation of efficiency and regulation of voltage for medium line by T method	Testing of insulators	Double bus-bar scheme with bypass isolators
	SLO-2	Types of OTEC	Calculate inductance and capacitance in an Unsymmetrical spaced conductor (transposed)	Analyze Performance of medium line using πmethod	Construction features of LT and HT cables, Insulation resistance	Introduction to substation earthing
S-4	SLO-1	Basic layout of Biomass power plant	Calculate inductance of Single circuit lines	Calculation of efficiency and regulation of voltage for medium line by π method	Calculate Capacitance, dielectric stress	Substation safety
	SLO-2	Load curve & Load duration curve	Calculate capacitance of Single circuit lines	Analyze Performance of long line using Rigorous method	Grading cables	Qualitative treatment to neutral grounding
S-5	SLO-1	Calculation of total power generation	Calculate inductance in double circuit lines	Ferranti effect – surge impedance	Fault in underground cables	Feeders, service mains and distributors
	SLO-2	Load, demand and diversity factors	Calculate capacitance in double circuit lines	Attenuation constant and phase constant	Location of fault in underground cables	DC Distribution
S-6	SLO-1	Plant capacity and plant use factors	Calculate inductance in Stranded and bundled conductors	Real power flow in transmission lines	Tan δ and power loss	Types of DC distributors

	SLO-2	*Calculation of Plant capacity and plant use factors*	*Calculate capacitance in Stranded and bundled conductors*	*Reactive power flow in transmission lines*	*Thermal characteristics of cables*	*Quantitative analysis of radial distribution fed at one end*
S-7	SLO-1	*Choice of type of generation, choice of size and number of units*	*Application of self GMD*	*Power circle diagrams*	*Calculate Stress of towers with equal heights*	*Quantitative analysis of radial distribution fed at both the ends*
	SLO-2	*Cost of energy generated*	*Application of mutual GMD*	*Receiving end power circle diagrams for finding the maximum power transfer*	*Calculate Sag of towers with equal heights*	*Quantitative analysis of Ring main distribution*
S-8	SLO-1	*Tariffs*	*Skin and Proximity effect*	*Series compensation*	*Calculate Stress of towers with unequal heights*	*Design of rural distribution, planning and design of town electrification schemes*
	SLO-2	*Types of tariffs*	*Inductive interference, Corona*	*Shunt compensation*	*Calculate Sag of towers with unequal heights*	*Kelvin's law for the design of feeders and limitations*
S-9	SLO-1	*Transmission systems*	*Implementation of distribution system using software*	*Seminar Presentations on ABCD constants*	*Effect of wind on overhead transmission line*	*Smart grid*
	SLO-2	*Distribution systems*	*Implementation of distribution system using software*	*Seminar Presentation on surge impedance loading*	*Effect of ice loading on overhead transmission line*	*Power system restructuring*

Learning Resources	1. *D.P. Kothari, I.J. Nagrath Power System Engineering Mc Graw-Hill Publishing company limited, New Delhi, 2nd ed., 2008* 2. *C. L. Wadwa, Electric Power Systems, 7th ed., New Age International Publishers,2016*	3. *Luces M. Fualkar berry, Walter Coffer Electrical Power Distribution and Transmission, Pearson Education, 2007* 4. *S.N.Singh, Electric power generation, transmission and distribution, 2nd ed., PHI, 2011* 5. *https://ocw.mit.edu/courses/electrical-engineering-and-computer-science*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Bhaskarsahu, Schneider Electric Ltd, bhaskar.sahu@schneider-electric.com	*1. Dr. K. S. Swarup, IITM, ksswarup@iitm.ac.isn*	*1. Mr. P. Suresh, SRMIST*
2. Dr. P. Dharmalingam, Ensave Pvt Ltd, pdlingam@gmail.com	*2.Dr. R. Ramesh, Anna University, rramesh@annauniv.edu*	*2. Dr. D. Sattianadan, SRMIST*

ACADEMIC CURRICULA

Professional Core Courses

ELECTRONICS AND COMMUNICATION ENGINEERING

Regulations - 2018

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Kancheepuram, Tamil Nadu, India

Course Code	18ECC102J	Course Name	ELECTRONIC DEVICES	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18EES101J	Co-requisite Courses	Nil	Progressive Courses	18ECC201J
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Provide a basis for understanding semiconductor material, how a pn junction is formed and its principle of operation*
CLR-2 :	*Explain the importance of diode in electronic circuits by presenting appropriate diode applications*
CLR-3 :	*Discuss the basic characteristics of several other types of diodes that are designed for specific applications*
CLR-4 :	*Describe the basic structure, operation and characteristics of BJT, and discuss its use as a switch and an amplifier.*
CLR-5 :	*Describe the basic structure, operation and characteristics of MOSFET, and discuss its use as a switch and an amplifier.*
CLR-6 :	*Use modern engineering tools such as PSPICE to carry out design experiments and gain experience with instruments and methods used by technicians and electronic engineers*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO–1: Professional Achievement	14: PSO – 2: Project Management Techniques	15: PSO – 3: Analyze & Research
CLO-1 :	*Understand the operation, characteristics, parameters and specifications of semiconductor diodes and special diodes*	1	90	80	H	-	-	-	-	-	-	-	-	-	-	M	-	-	-
CLO-2 :	*Demonstrate important applications of semiconductor diodes and special diodes.*	2	80	75	-	-	-	-	-	-	-	-	-	-	-	M	-	-	-
CLO-3 :	*Review bipolar transistor construction, operation, characteristics and parameters, as well as its application in amplification and switching.*	1	90	80	H	-	-	-	-	-	-	-	-	-	-	M	-	-	-
CLO-4 :	*Review field-effect transistor construction, operation, characteristics and parameters, as well as its application in amplification and switching.*	1	80	75	H	-	-	-	-	-	-	-	-	-	-	M	-	L	-
CLO-5 :	*Build a circuit, then make functional measurements to understand the operating characteristics of the device / circuit.*	3	80	75	-	-	-	-	H	-	-	-	-	-	-	-	L	L	-
CLO-6 :	*Solve specific design problem, which after completion will be verified using modern engineering tools such as PSPICE.*	3	90	75	-	-	-	-	H	-	-	L	H	M	-	M	-	-	-

Duration (hour)		Semiconductor Diodes	Diode Circuits	Special Diodes	Bipolar Junction Transistors	MOS Field-Effect Transistors
		15	15	15	15	15
S-1	SLO-1	*Basic semiconductor theory: Intrinsic & extrinsic semiconductors*	*HWR operation, Efficiency and ripple factor*	*Backward diode*	*Physical structure*	*Physical structure*
	SLO-2	*Current flow in semiconductors*	*Problem solving*	*Varactor diode*	*Device operation of BJT*	*Device operation of E-MOSFET & D-MOSFET*
S-2	SLO-1	*PN junction theory: Equilibrium PN junction*	*Center-Tapped Transformer FWR operation, Efficiency and ripple factor*	*Step recovery diode*	*Current-Voltage characteristics of CE BJT configuration*	*I-V characteristics of E-MOSFET*
	SLO-2	*Forward biased PN junction*	*Problem solving*	*Point-contact diode*	*Current-Voltage characteristics of CE BJT configuration*	*Problem solving*
S-3	SLO-1	*Reverse biased PN junction*	*Bridge FWR operation, Efficiency and ripple factor*	*Metal-semiconductor junction: Structure, Energy band diagram*	*Current-Voltage characteristics of CB BJT configuration*	*Derive drain current*
	SLO-2	*Relation between Current and Voltage*	*Problem solving*	*Forward & Reverse Characteristics of Schottky Diode*	*Current-Voltage characteristics of CB BJT configuration*	*Problem solving*
S 4-5	SLO-1 SLO-2	*Lab 1: PN Junction Diode Characteristics*	*Lab 4: Diode clipping and clamping circuits*	*Lab 7: Series and Shunt Regulators*	*Lab 10: BJT and MOSFET Switching Circuits*	*Lab 13: Repeat Experiments*
S-6	SLO-1	*Calculate depletion width*	*Filters: Inductor & Capacitor Filters*	*Tunnel Diode*	*Current-Voltage characteristics of CC BJT configuration*	*Derive transconductance*
	SLO-2	*Calculate barrier potential*	*Problem solving*	*Tunnel Diode*	*Current-Voltage characteristics of CC BJT configuration*	*Problem solving*
S-7	SLO-1	*Derive diode current equation*	*Filters: LC & CLC Filters*	*Gunn Diode*	*BJT as an amplifier*	*CMOS FET*

	SLO-2	Derive diode current equation	Problem solving	Gunn Diode	BJT as a switch	MOSFET as an amplifier
S-8	SLO-1	Effect of Capacitance in PN junction: Transition Capacitance	Diode Clippers	IMPATT Diode	BJT circuit models - h-parameter	MOSFET as a switch
	SLO-2	Diffusion Capacitance	Problem solving	IMPATT Diode	BJT circuit models - hybrid-π parameter	Problem solving
S 9-10	SLO-1 SLO-2	Lab 2: Zener diode characteristics	Lab 5: BJT Characteristics	Lab 8: MOSFET Characteristics	Lab 11: Photoconductive Cell, LED, and Solar Cell Characteristics	Lab-14: Model Examination
S-11	SLO-1	Energy band structure of PN Junction Diode	Diode Clampers	PIN Diode	BJT biasing circuits and stability analysis: Base bias and emitter bias	Biasing Circuits for MOSFET: Gate Bias
	SLO-2	Ideal diode and its current-voltage characteristics	Problem solving	PIN Photodiode	Problem solving	Problem Solving
S-12	SLO-1	Terminal characteristics & parameters	Voltage Multipliers	Avalanche photodiode	Voltage-divider bias	Self-bias
	SLO-2	Diode modeling	Zener diode: Characteristics, breakdown mechanisms	Laser diode	Problem solving	Problem Solving
S-13	SLO-1	DC load line and analysis	Zener resistances and temperature effects Zener diode as voltage regulator	Problem solving	Collector-feedback bias	Voltage-divider bias
	SLO-2	Problem solving	Problem solving	Problem solving	Problem solving	Problem Solving
S 14-15	SLO-1 SLO-2	Lab 3: Diode rectifier circuits	Lab 6: BJT Biasing Circuits	Lab 9: MOSFET Biasing Circuits	Lab 12: Simulation experiments using PSPICE	Lab 15: End-Semester Practical Examination

Learning Resources	1. David A. Bell, Electronic Devices and Circuits, 5th ed., Oxford University Press, 2015 2. Donald Neamen, Electronic Circuits: Analysis and Design, 3rd ed., McGraw-Hill Education, 2011 3. Adel S. Sedra, Kenneth C. Smith, Microelectronic Circuits: Theory and Applications, OUP, 2014 4. Thomas L. Floyd, Electronic Devices", 9th ed., Pearson Education, 2013	5. Robert L. Boylestad, Louis Nashelsky, Electronic Devices and Circuit Theory, 11th ed., Pearson Education, 2013 6. Muhammad Rashid, Microelectronic Circuits: Analysis & Design, 2nd ed., Cengage Learning, 2010 7. Muhammed H Rashid, Introduction to PSpice using OrCAD for circuits and electronics, 3rd ed., Pearson, 2004 8. Laboratory Manual, Department of ECE, SRM University

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	20%	20%	15%	15%	15%	15%	15%	15%	15%	15%
Level 2	Apply Analyze	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Level 3	Evaluate Create	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu	1. Mr. Manikandan AVM, SRMIST
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	2. Dr. Diwakar R Marur, SRMIST

Course Code	18ECC103J	Course Name	DIGITAL ELECTRONIC PRINCIPLES	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18EES101J	Co-requisite Courses	Nil	Progressive Courses	18ECC203J
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Understand binary codes, digital arithmetic operations and able to simplify Boolean logic expressions
CLR-2 :	Describe how basic TTL and CMOS gates operate at the component level
CLR-3 :	Able to design simple combinational logics using basic gates and MSI circuits
CLR-4 :	Familiarize with basic sequential logic components: flip-flops, registers, counters and their usage, and able to design and analyze sequential logic circuits and Finite State Machines.
CLR-5 :	Know how to implement logic circuits using PLDs.
CLR-6 :	Use modern engineering tools such as PSPICE / Logisim to carry out design experiments and gain experience with instruments and methods used by technicians and electronic engineers

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO–1: Professional Achievement	PLO 14: PSO – 2: Project Management Techniques	PLO 15: PSO – 3: Analyze & Research
CLO-1 :	Have a thorough understanding of the fundamental concepts and techniques used in digital electronics.	1	90	75	H	-	-	-	-	-	-	-	-	-	-	M	-	-	-
CLO-2 :	Understand the basic electronics of various logic families and able to use Integrated Circuits.	1	80	70	H	-	-	-	-	-	-	-	-	-	-	M	-	-	-
CLO-3 :	Understand, analyze, design and troubleshoot various combinational logic circuits.	2,3	90	75		M	H	-	H	-	-	-	-	-	-	M	-	-	-
CLO-4 :	Understand, analyze, design and troubleshoot various clocked sequential logic circuits.	2,3	90	75		M	H	-	H	-	-	-	-	-	-	M	-	-	-
CLO-5 :	Analyze, design and implement various digital logic circuits using PLDs	2,3	80	75	-	M	H	-	H	-	-	-	-	-	-	-	-	-	-
CLO-6 :	Solve specific design problem, which after completion will be verified using modern engineering tools such as PSPICE / Logisim	3	90	75	-	M	H	-	H	-	-	L	H	M	L	M	M	-	L

Duration (hour)		Binary Codes, Digital Arithmetic and Simplification of Boolean Functions	Logic Families	Combinational Systems	Sequential Systems	Memory and Programmable Logic
		15	15	15	15	15
S-1	SLO-1	Binary Codes, Digital Arithmetic and Simplification of Boolean Functions	Introduction	Binary arithmetic units	Flip-flop and Latch: SR latch,	RAM Memory decoding
	SLO-2	Error detecting codes	TTL Logic Family	Adder	JK flip-flop, T flip-flop, D flip-flop	ROM
S-2	SLO-1	Error correcting code	Totem-pole TTL	Design of Half adder	Master-slave RS flip-flop	Programmable Logic Devices (PLDs): Basic concepts
	SLO-2	Hamming Code	open-collector and tristate TTL	Design of Full adder	Master-slave JK flip-flop	PROM
S-3	SLO-1	Arithmetic number representation	Schottkey TTL, standard TTL characteristics	Subtractor	Registers & Counters	PROM as PLD
	SLO-2	Binary arithmetic	Metal Oxide Semiconductor logic families	Design subtractor using logic gates	Shift registers (SISO, SIPO, PISO, PIPO)	Programmable Array Logic (PAL)
S 4-5	SLO-1 SLO-2	LAB 1: Study of logic gates	LAB 4: Design and implement encoder and decoder using logic gates	LAB 7: Implement combinational logic functions using standard ICs	LAB 10: Design and implement Synchronous Counters	LAB 13: Construct combinational circuit using Logisim
S-6	SLO-1	Hexadecimal arithmetic	N-MOS	n-bit parallel adder & subtractor	Universal shift register	Programmable Array Logic (PAL)
	SLO-2	Hexadecimal arithmetic	P-MOS	look ahead carry generator	Counters: Asynchronous/Ripple counters	Programmable Logic Array (PLA)

S-7	SLO-1	BCD arithmetic simplification	CMOS logic circuits	Decoder	Synchronous counters, Modulus-n Counter	Programmable Logic Array (PLA)
	SLO-2	Minimization of Boolean Functions: Algebraic simplification	Characteristics of MOS logic	Encoder	Ring counter, Johnson counter	Design combinational circuits using PLD's
S-8	SLO-1	Problems on Algebraic simplification	Compare MOS logic circuits(CMOS) with TTL digital circuit	Multiplexer	Up-Down counter	Design combinational circuits using PLD's
	SLO-2	Karnaugh map simplification	Electrical characteristics	Demultiplexer	Mealy and Moore model	Design combinational circuits using PLD's
S 9-10	SLO-1 SLO-2	LAB 2: Design and implement Adder and Subtractor using logic gates	LAB 5: Design and implement Multiplexer and Demultiplexer using logic gates	LAB 8: Verify characteristic table of flip-flops	LAB 11: Construct and verify shift registers	LAB 14: Model Practical Examination
S-11	SLO-1	Problems on Karnaugh map simplification	Fan-out	Code converters	Synchronous (Clocked) sequential circuits	Design of combinational circuits using PLD's
	SLO-2	Problems on Karnaugh map simplification	Propagation Delay	Magnitude comparators	Synchronous (Clocked) sequential circuits	Design sequential circuits using PLD's
S-12	SLO-1	Quine McCluskey	Power dissipation	Magnitude comparators	Synchronous (Clocked) sequential circuits	Design sequential circuits using PLD's
	SLO-2	Tabulation method	Noise margin	Parity generators (Odd parity)	Analyze and design synchronous sequential circuits	Design sequential circuits using PLD's
S-13	SLO-1	Problems on Quine McCluskey or Tabulation method.	Supply voltage levels	Parity generators (Even parity)	State reduction	Design sequential circuits using PLD's
	SLO-2	Exercise problems using Tabulation method	Operational voltage levels	Implementation of combinational logic by standard IC's.	State assignment	Design sequential circuits using PLD's
S 14-15	SLO-1 SLO-2	Lab 3: Design and Implement 2-bit Magnitude Comparator using logic gates	LAB-6: Design and implement code converters using logic gates	LAB 9: Construct and verify 4-bit ripple counter, Mod-10/Mod-12 ripple counters	Lab 12: Construct mini project work	LAB 15: University Practical Exam

Learning Resources	1. Morris Mano M, Michael D. Ciletti, Digital Design with an Introduction to the Verilog HDL, 5th ed., Pearson Education, 2014 2. Charles H Roth (Jr), Larry L. Kinney, Fundamentals of Logic Design, 5th ed., Cengage Learning India Edition, 2010 3. Thomas L. Floyd, Digital Fundamentals, 10th ed., Pearson Education, 2013	4. Ronald J. Tocci, Digital System Principles and Applications, 10th ed., Pearson Education, 2009 5. Donald P Leach, Albert Paul Malvino, Goutam Saha, Digital Principles and Applications, 6th ed., Tata-Mcgraw Hill, 2008 6. LAB MANUAL, Department of ECE, SRM University

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
r. Level 1	Remember Understand	20%	20%	15%	15%	15%	15%	15%	15%	15%	15%
Level 2	Apply Analyze	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Level 3	Evaluate Create	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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1. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu	1. Mr. Viswanathan B, SRMIST
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	

Course Code	18ECC104T	Course Name	SIGNALS AND SYSTEMS	Course Category	C	Professional Core	L	T	P	C
							3	1	0	4

Pre-requisite Courses	18EES101J	Co-requisite Courses	Nil	Progressive Courses	18ECC204J
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Understand the fundamentals of signals, systems and their classification
CLR-2 :	Learn the methods of representing the continuous signal and its properties
CLR-3 :	Educate about system modeling through Laplace transform and Convolution integral for continuous time systems
CLR-4 :	Learn about discrete time signals and its properties
CLR-5 :	Understand the concept of Z-Transform for the analysis of DT system
CLR-6 :	Learn about continuous and discrete signals and its properties

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO–1: Professional Achievement	14: PSO – 2: Project Management Techniques	15: PSO – 3: Analyze & Research
CLO-1 :	Acquire knowledge of various classifications of Signals and Systems	2	85	65	H	M	-	M	-	-	-	-	-	-	-	-	M	H	M
CLO-2 :	Analyze Periodic and Aperiodic for Continuous time Signals using Fourier series and Fourier Transform	3	85	65	M	H	M	H	-	-	-	-	-	-	-	-	M	-	H
CLO-3 :	Analyze and characterize the Continuous time system through Laplace transform and Convolution integral.	3	85	65	M	H	M	H	-	-	-	-	-	-	-	-	M	-	H
CLO-4 :	Analyze and characterize the Discrete time signals and system through DTFT, Convolution sum	3	85	65	H	H	M	M	-	-	-	-	-	-	-	-	M	-	H
CLO-5 :	Analyze and characterize the Discrete time system using Z transform	2	85	65	H	M	H	M	-	-	-	-	-	-	-	-	M	-	H
CLO-6 :	Understand the properties and modeling of continuous and discrete time signals	3	85	65	H	H	M	M	-	-	-	-	-	-	-	-	M	-	H

		Classification of Signals and Systems	Analysis of Continuous Time Signals	Analysis of LTI CT System	Analysis of DT Signals and Systems	Analysis of LTI DT System using Z-Transform
Duration (hour)		12	12	12	12	12
S-1	SLO-1	Introduction to signals and systems	Introduction to Fourier series	System modeling	Representation of sequences	Z transform – introduction
	SLO-2	Requirements of signal and system analysis in communication	Representation of Continuous time Periodic signals	Description of differential equations	Discrete Time Fourier Transform (DTFT) – Existence	Region of convergence of finite duration sequences-properties.
S-2	SLO-1	Continuous time signals (CT signals)	Fourier series: Trigonometric representation	Solution of Differential equation using classical method	DTFT of standard signals	Unilateral and bilateral z transforms
	SLO-2	Discrete time signals (DT signals)	Fourier series: Trigonometric representation	Differential equation: Zero state response	Properties of DTFT	Properties of z transform
S-3	SLO-1	Representation of signals: Step, Ramp, Pulse, Impulse	Fourier series: Cosine representation	Differential equation: Zero Input response	Problems on Properties of DTFT	Practice problems
	SLO-2	Representation of signals: Sinusoidal, Exponential	Fourier series: Cosine representation	Total Response using classical method	Inverse DTFT	Practice problems
S-4	SLO-1	Basic operation on the signals	Symmetry conditions	Impulse response	Impulse response of a system with DTFT	Relation between DTFT and Z transform
	SLO-2	Problems on signal operations	Properties of Continuous time Fourier series	Step response	Frequency response of a system with DTFT	Practice problems
S-5	SLO-1	Classification of CT and DT signals: Periodic & Aperiodic signals.	Practice problems on Fourier series	Frequency response	Step response	condition for causality in Z domain-Problems
	SLO-2	Classification of CT and DT signals: Deterministic & Random signals.	Practice problems on Fourier series	Practice problems on solution of differential equation	Practice problems	condition for stability in Z domain-Problems
S-6	SLO-1	Energy signal	Gibb's Phenomenon	Convolution integral	Solution of linear constant coefficient difference equations	Inverse Z transform

	SLO-2	*Power signal*	*Parseval's relation for power signals*	*Properties of convolution*	*Problems with and without Initial conditions*	*Power series expansion*
S-7	SLO-1	*Even & Odd signals*	*Power density spectrum,*	*Graphical method of convolution*	*Solution of difference equations using classical method*	*Inverse Z transform with Partial fraction*
	SLO-2	*Even & Odd signals*	*Frequency spectrum.*	*Practice Problems*	*Zero input response , Zero state response, Total response*	*Inverse Z transform with Partial fraction*
S-8	SLO-1	*CT systems and DT systems*	*Fourier transform: Introduction*	*Analysis using Laplace transform*	*Practice problems*	*Residue method*
	SLO-2	*Classification of systems: Static & Dynamic*	*Representation of Continuous time signals*	*ROC and Convergence of Laplace Transform*	*Practice problems*	*Convolution method*
S-9	SLO-1	*Superposition theorem*	*Properties of Continuous time Fourier transform*	*Properties of Laplace transform*	*DFT and IDFT*	*Analysis and characterization of DT system using Z-transform*
	SLO-2	*Linear & Nonlinear system*	*Properties of Continuous time Fourier transform*	*Problems on properties of Laplace transform*	*Properties of DFT*	*Analysis and characterization of DT system using Z-transform*
S-10	SLO-1	*Time-variant & Time-invariant system*	*Parseval's relation for energy signals*	*Inverse Laplace transform*	*Practice problems*	*Practice problems*
	SLO-2	*Time-invariant system*	*Energy density spectrum*	*Problems*	*Convolution sum*	*Practice problems*
S-11	SLO-1	*Causal system*	*Practice problems on Fourier Transform*	*Analysis of LTI system using Laplace transform*	*Convolution properties*	*Realization of Discrete time system- Direct form I, Direct Form II*
	SLO-2	*Noncausal system*	*Practice problems on Fourier Transform*	*Analysis LTI system using Laplace transform-Problems*	*Linear Convolution,-Tabulation method, Matrix method*	*Realization of Discrete time system- Parallel and cascade form*
S-12	SLO-1	*Stable & Unstable,LTI System*	*Practice problems on properties of Fourier Transform*	*Analysis LTI system using Fourier transform*	*Linear convolution-Graphical method*	*Practice problems*
	SLO-2	*Unstable, LTI System*	*Practice problems on properties of Fourier Transform*	*Analysis LTI system using Fourier transform-Problems*	*Circular convolution-concentric circle method, matrix method*	*Practice problems*

Learning Resources	1. *Alan V Oppenheim, Ronald W. Schafer Signals & Systems, 2nd ed., Pearson Education, 2015* 2. *P.Ramakrishna Rao, Shankar Prakriya, Signals & Systems, 2nd ed., McGraw Hill Education, 2015* 3. *Simon Haykin, Barry Van Veen, Signals and Systems, 2nd ed., John Wiley & Sons Inc., 2007*	4. *Lathi B.P, Linear Systems & Signals, 2nd ed., Oxford Press, 2009* 5. *John G. Proakis, Manolakis, Digital Signal Processing, Principles, Algorithms and Applications, 4th ed., Pearson Education, 2007*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECC105T	Course Name	ELECTROMAGNETICS AND TRANSMISSION LINES	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses	18EES101J, 18PYB101J	Co-requisite Courses	Nil	Progressive Courses	18ECC206T
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Clark's Table, IS : 456-2000		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Gain knowledge on the basic concepts and insights of Electric field
CLR-2 :	Gain knowledge on the basic concepts and insights of Magnetic field and Emphasize the significance of Maxwell's equations.
CLR-3 :	Interpret the wave propagation in guided waveguide.
CLR-4 :	Acquire the fundamental knowledge on Transmission Line Theory.
CLR-5 :	Acquire the knowledge on transmission line parameter calculation and impedance matching concepts.
CLR-6 :	Acquire knowledge on theoretical concepts and analysis techniques to find solutions for problems related to electromagnetic wave propagation and Transmission line Theory.

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Apply the concepts and knowledge to solve problems related to electric field.	2	80	70	M	H													
CLO-2 :	Interpret and apply the concepts of Magnetic field and Maxwell's equations in the real world application.	2	80	70	H	M													
CLO-3 :	Understand the phenomenon of guided wave propagation and its mode of propagation.	1	80	70	H	M													
CLO-4 :	Realize the importance of transmission line theory applicable to low frequency transmission lines.	1	80	70	M	H													
CLO-5 :	Solve transmission line parameter and impedance matching through analytical and graphical methods.	2	80	70	M	H													
CLO-6 :	Understand how electromagnetic waves are generated using Maxwell's equations and how Transmission lines are used to transfer electromagnetic energy from one point to another with minimum losses over a wideband of frequencies.	2	80	70	M	H										H			L

Duration (hour)		Electrostatics	Magnetostatics and Maxwells Equations	Electromagnetic Waves and Waveguides	Transmission Line Theory	Transmission Line Calculator and Impedance Matching
		9	9	9	9	9
S-1	SLO-1	Introduction	Energy density in electrostatic field	Introduction	Transmission line parameters	Introduction
	SLO-2	Rectangular co-ordinate	Problem discussion.	Waves in general	Transmission line parameters	Smith chart Introduction
S-2	SLO-1	Cylindrical & Spherical Co-ordinate	Biot savart law-Magnetic field intensity due to Infinite line charge	Plane wave in lossless dielectric	Transmission line equivalent circuit	Reflection coefficient, Standing wave ratio Input impedance calculation in smith chart
	SLO-2	Review of vector calculus	H- due finite and semi finite line charge	Plane wave in free space	Explanation	Practice problems.
S-3	SLO-1	Coulomb's Law and field intensity	Ampere's circuital law& application: Infinite line current	Plane wave in good conductor	Transmission line equation derivation	Single stub matching Introduction
	SLO-2	Problem based on coulomb's law	Infinite Sheet current	Problems based on plane waves in lossless, free space and good conductor	Problem discussion.	Procedure for single stub matching
S-4	SLO-1	Electric field due to continuous charge distribution-.Concept	Infinitely long coaxial Transmission line	Rectangular waveguide	Transmission line characteristics: lossless line	Problems solving in smith chart
	SLO-2	Derivation of E due Infinite Line charge	Problem based on ACL.	Rectangular waveguide-Problems	Distortionless line.	Problems solving in smith chart
S-5	SLO-1	Electric field due to sheet charge	Magnetic flux density	Transverse Electric (TE) mode	Input impedance derivation	Impedance matching using Quarter wave transformer
	SLO-2	Problem based on sheet charge	Problem based on magnetic field and flux.	Transverse Electric (TE) mode-problems	Problems for input impedance calculation.	Problems.

S-6	SLO-1	*Electric field due to volume charge*	*Maxwell's equation for static field*	*Transverse Electric (TE) mode*	*Standing wave ratio*	*Single stub tuner*
	SLO-2	*Electric flux density*	*Faraday's law*	*Transverse Electric (TE) mode-Problems*	*Calculation of standing wave ratio.*	*Problem discussion*
S-7	SLO-1	*Gauss law application-point charge*	*Transformer EMF*	*Wave propagation in guide*	*Reflection coefficient*	*Slotted Line (Impedance Measurement)*
	SLO-2	*Electric flux due infinite line charge*	*Motional EMF*	*Problem discussion*	*Problem discussion.*	*Problem discussion*
S-8	SLO-1	*Electric flux due sheet charge*	*Displacement current.*	*Power Transmission*	*Shorted line, open circuited line*	*Transmission Lines as circuit Elements*
	SLO-2	*Electric flux due coaxial cable*	*Maxwell's equation in time varying field*	*Calculation of Pavg and Ptotal*	*Matched line*	*Problem discussion*
S-9	SLO-1	*Relation between E&V*	*Time varying potential concepts*	*Power attenuation*	*Power calculations*	*Additional smith chart problem solving.*
	SLO-2	*Electric dipole and flux lines*	*Time varying potential derivation.*	*Calculation of αTE and αTE*	*Problem discussion.*	*Additional smith chart problem solving.*

Learning Resources	1. *Matthew N. O. Sadiku., S. V. Kulkarni, Elements of Electromagnetics, 6th ed., Oxford University Press, 2015* 2. *G. S. N. Raju, Electromagnetic Field Theory and Transmission Lines, Pearson Education, 2006* 3. *Nannapaneni Narayana Rao, Principles of Engineering Electromagnetics,6th ed., Pearson Education, 2016*	4. *William H. Hayt,Jr., John A.Buck., Engineering Electromagnetics, 8th ed., Tata McGraw-Hill 2012* 5. *John D.Ryder, Networks, Lines and Fields, PHI, 2009*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*1. Dr. P. Eswaran, SRMIST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECC201J	Course Name	ANALOG ELECTRONIC CIRCUITS	Course Category	C	*Professional Core*	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*18ECC102J*	Co-requisite Courses	*18ECC202J*	Progressive Courses	*18ECE201J*
Course Offering Department	Electronics and Communication Engineering	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Understand the operation and design of BJT amplifier circuits for a given specification*
CLR-2 :	*Understand the operation and design of MOSFET amplifier circuits for a given specification*
CLR-3 :	*Understand the effects of negative feedback on amplifier circuits, and analyze the different RC and LC oscillator circuits to determine the frequency of oscillation*
CLR-4 :	*Understand the operation and design of various types of power amplifier circuits.*
CLR-5 :	*Understand how matched transistor characteristics are used in the IC design and to be able to design BJT and MOSFET current sources.*
CLR-6 :	*Gain hands-on experience to put theoretical concepts learned in the course to practice.*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	*Analyze and design bipolar amplifier circuits to meet certain specifications, and to Analyze the frequency response of amplifier circuits, taking into account various circuit capacitors, to determine the bandwidth of the circuit.*	*2,3*	*80*	*70*	*L*	*M*	*H*	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	*Analyze and design MOSFET amplifier circuits to meet certain specifications, and to Analyze the frequency response of amplifier circuits, taking into account various circuit capacitors, to determine the bandwidth of the circuit.*	*2,3*	*80*	*70*	*L*	*M*	*H*	-	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	*Understand the characteristics and principles of feedback amplifier circuits and oscillator circuits to analyze and design circuits to meet certain specifications.*	*2,3*	*80*	*70*	*L*	*M*	*H*	-	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	*Analyze three principle classes of power amplifiers, and determine the maximum possible conversion efficiency of each type of power amplifier*	*2,3*	*80*	*70*	*L*	*M*	*H*	-	-	-	-	-	-	-	-	-	-	-	-
CLO-5 :	*Present the basic circuit building blocks that are used in the design of IC amplifiers, namely current mirrors and sources*	*2,3*	*80*	*70*	*L*	*M*	*H*	-	-	-	-	-	-	-	-	-	-	-	-
CLO-6 :	*Analyze and design analog electronic circuits using discrete components, and take measurement of various analog circuits to compare experimental results in the laboratory with theoretical analysis.*	*3*	*90*	*80*	-	-	*H*	-	*M*	-	-	*L*	*M*	-	-	*M*	*H*	*L*	-

Duration (hour)		**BJT Amplifiers**	**FET Amplifiers**	**Feedback amplifies & Oscillators**	**Oscillators & Power Amplifiers**	**IC Biasing & Amplifiers with Active Load**
		15	**15**	**15**	**15**	**15**
S-1	SLO-1	*Overview of DC analysis of BJT circuits*	*Overview of FET DC circuit analysis*	*Basic feedback concepts, general feedback structure*	*Crystal Oscillators*	*BJT current sources: Cascode current source, Widlar current source*
	SLO-2	*Overview of BJT models*	*Problem solving*	*Properties of negative feedback*	*Problem solving*	*Multi-transistor current source Problem solving*
S-2	SLO-1	*AC load line analysis*	*Graphical analysis, load lines, and small-signal models*	*Feedback Topologies: Voltage-Series & Current-Series feedback connections*	*Negative-resistance oscillator*	*FET current sources: 2-transistor MOSFET current source*
	SLO-2	*Problem solving*	*Problem solving*	*Problem solving*	*Problem solving*	*Problem solving*
S-3	SLO-1	*AC analysis of Common-Emitter BJT amplifier config. using hybrid-π model*	*AC analysis of Common-Source MOSFET amplifier configuration*	*Feedback Topologies: Voltage-Shunt & Current-Shunt feedback connections*	*Power Amplifiers: Definitions and amplifier types*	*FET current sources: Cascode current mirror and Wilson current mirror*
	SLO-2	*Problem solving*	*Problem solving*	*Problem solving*	*Q point placement*	*Problem solving*
S 4-5	SLO-1 SLO-2	*Lab 1: Learning to design amplifier and oscillator circuits*	*Lab 4: Design & analyze differential amplifier with resistive load*	*Lab 7: Design and analyze RC oscillators*	*Lab 10: BJT & FET Current Sources*	*Lab 13: Design and analyze differential amplifier with active load*

S-6	SLO-1	*AC analysis of Common-Base BJT amplifier configuration using hybrid-π model*	*AC analysis of Common-Gate MOSFET amplifier configuration*	*Practical Feedback Amplifier Circuits*	*Maximum dissipation hyperbola*	*Analysis of CE BJT amplifier circuit with active load*
	SLO-2	*Problem solving*	*Problem solving*	*Problem solving*	*Heat sink*	*Problem solving*
S-7	SLO-1	*AC analysis of Common-Collector BJT amplifier config. using hybrid-π model*	*AC analysis of Common-Drain MOSFET amplifier configuration*	*Oscillators: Principles of Oscillation*	*Class A amplifier*	*Analysis of CS FET amplifier circuit with active load*
	SLO-2	*Problem solving*	*Problem solving*	*Types of Oscillators*	*Problem solving*	*Problem solving*
S-8	SLO-1	*Multi-stage amplifier configurations: CE - CE, CE - CC amplifiers*	*BiFET amplifier configuration*	*Audio Frequency Oscillators: RC Phase-Shift Oscillator*	*Class B and Class AB push-pull amplifiers*	*DC and small-signal analysis of basic BJT differential pairs*
	SLO-2	*Problem solving*	*Problem solving*	*Problem solving*	*Problem solving*	*Problem solving*
S 9-10	SLO-1 SLO-2	*Lab 2: Design and analyze BJT amplifier configurations*	*Lab 5: Design and analyze negative feedback amplifier configurations*	*Lab 8: Design and analyze LC oscillators*	*Lab 11: Design and analyze BJT CE amplifier with active load*	*Lab 14: Model Practical Examination*
S-11	SLO-1	*Multi-stage amplifier configurations: CE - CB, and CC - CC amplifiers*	*Low Frequency response analysis of a basic FET CS amplifier*	*Audio Frequency Oscillators: Wein Bridge Oscillator*	*Class C amplifiers*	*DC and small-signal analysis of basic FET differential pairs*
	SLO-2	*Problem solving*	*Problem Solving*	*Problem Solving*	*Problem solving*	*Problem solving*
S-12	SLO-1	*Low Frequency response analysis of a basic BJT CE amplifier*	*High Frequency response analysis of a basic FET CS amplifier*	*Radio Frequency Oscillators: Hartley Oscillator*	*Class D and Class E amplifiers*	*Analysis of BJT differential amplifier with active load*
	SLO-2	*Problem Solving*	*Problem Solving*	*Problem solving*	*Amplifier distortions*	*Problem solving*
S-13	SLO-1	*High Frequency response analysis of a basic BJT CE amplifier*	*Design problems in MOSFET amplifier configurations*	*Radio Frequency Oscillators: Colpitts & Clapp Oscillators*	*IC Biasing & Amplifiers with Active Load: BJT current sources: 2- & 3-transistor current sources*	*Analysis of FET differential amplifier with active load*
	SLO-2	*Problem Solving*	*Operational voltage levels*	*Problem solving*	*Problem solving*	*Problem solving*
S 14-15	SLO-1 SLO-2	*Lab 3: Design and analyze multistage amplifier configurations*	*Lab 6: Design and analyze MOSFET amplifier configurations*	*Lab 9: Classes of power amplifier (efficiency calculation)*	*Lab 12: Design and analyze FET CS amplifier with active load*	*Lab 15: End Semester Practical Examination*

Learning Resources

1. *David A. Bell, Electronic Devices and Circuits, 5th ed., Oxford University Press, 2015*
2. *Donald Neamen, Electronic Circuits: Analysis and Design, 3rd ed., McGraw-Hill Education, 2011*
3. *Muhammad Rashid, Microelectronic Circuits: Analysis & Design, 2nd ed., Cengage Learning, 2010*
4. *Adel S. Sedra, Kenneth C. Smith, Microelectronic Circuits: Theory and Applications, OUP, 2014*
5. *Robert L. Boylestad, Louis Nashelsky, Electronic Devices and Circuit Theory, 11th ed., Pearson Education, 2013*
6. *Albert P. Malvino, David J. Bates, Electronic Principles, 8th ed., Tata McGraw Hill, 2015*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
r. Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	2. Dr. M. Sangeetha, SRMIST

Course Code	18ECC202J	Course Name	LINEAR INTEGRATED CIRCUITS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18ECC102J	Co-requisite Courses	18ECC201J	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Study the basic principles, configurations and practical limitations of op-amp
CLR-2 :	Understand the various linear and non-linear applications of op-amp
CLR-3 :	Understand the operation and analysis of op-amp oscillators, single chip oscillators and frequency generators
CLR-4 :	Identify the active filter types, filter response characteristics, filter parameters and IC voltage regulators.
CLR-5 :	Gain knowledge on data converter terminology, its performance parameters, and various circuit arrangements for A/D and D/A conversions.
CLR-6 :	Gain hands-on experience to put theoretical concepts learned in the course to practice.

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO–1: Professional Achievement	14: PSO – 2: Project Management Techniques	15: PSO – 3: Analyze & Research
CLO-1 :	Infer the DC and AC characteristics of operational amplifiers and its effect on output and their compensation techniques	3	80	70	H	M	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Elucidate and design the linear and non-linear applications of an opamp and special application ICs	3	85	75	M	M	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	Explain and compare the working of multivibrators using special application IC 555 and general purpose opamp	3	75	70	L	M	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	Classify and comprehend the working principle of data converters and active filters	3	85	80	L	M	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-5 :	Illustrate the function of application specific ICs such as Voltage regulators, PLL and its application in communication	3	85	75	L	M	H	-	-	-	-	-	-	-	-	-	M	-	H
CLO-6 :	Analyze and design electronic circuits and systems using linear ICs, and take measurement of various analog circuits to compare experimental results in the laboratory with theoretical analysis	3	85	75		H	H	-	M	-	-	-	M	-	-	-	H	L	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Op-amp symbol, terminals, packages	Basic op-amp circuits: Inverting & Non-inverting voltage amplifiers	Waveform Generators: Sine-wave Generators - Design	Filters: Comparison between Passive and Active Networks	Digital to Analog Conversion: DAC Specifications
	SLO-2	Op-amp-Specifications	Voltage follower	Implementation & Solving problems	Active Network Design	Solving problems
S-2	SLO-1	Block diagram Representation of op-amp	Summing, scaling & averaging amplifiers,	Square Wave generators- Design	Filter Approximations	Weighted Resistor DAC
	SLO-2	Ideal op-amp & practical op-amp - Open loop & closed loop configurations	AC amplifiers	Implementation & Solving problems	Design of LPF & Solving problems	Solving problems
S-3	SLO-1	DC performance characteristics of op-amp	Linear Applications: Instrumentation Amplifiers	Triangle wave generators	Design of HPF & Solving problems	R-2R Ladder DAC
	SLO-2	Solving Problems	Instrumentation Amplifiers, Solving Problems	Saw-tooth Wave generators.	Design of BPF& Solving problems	Solving problems
S 4-5	SLO-1 SLO-2	Lab-1:Basic op-amp circuits	Lab 4: Comparators	Lab 7: Waveform generators: using op-amp & 555 Timer	Lab 10: Design of LPF, HPF, BPF and Band Reject Filters	Lab 13: Flash Type ADC
S-6	SLO-1	AC performance characteristics of op-amp	V-to-I Converters	IC 555 Timer: Circuit schematic	Design of Band Reject Filters	Inverted R-2R Ladder DAC
	SLO-2	Solving Problems	I-to-V converters	Operation and its applications	Solving problems	Monolithic DAC
S-7	SLO-1	Frequency response	Differentiators	IC 555 Timer: Monostable operation	State Variable Filters – All Pass Filters,	Analog to Digital conversion: ADC specifications
	SLO-2	Frequency response	Integrators	Applications & Solving problems	Solving problems	Solving problems

S-8	SLO-1	*Frequency compensation*	*Non-linear Applications: Precision Rectifiers*	*IC 555 Timer: Astable operation*	*Switched Capacitor Filters.*	*Ramp Type ADC*
	SLO-2	*Frequency compensation*	*Wave Shaping Circuits (Clipper and Clampers)*	*Applications & Solving problems*	*Solving problems*	*Solving problems*
S 9-10	SLO-1 SLO-2	*Lab 2: Integrators and Differentiators*	*Lab 5: Wave shaping circuits*	*Lab 8: Waveform generators: using op-amp & 555 Timer*	*Lab 11: IC Voltage regulators*	*Lab 14: Simulation experiments using EDA tools*
S-11	SLO-1	*Basic op-amp internal schematic*	*Log and Antilog Amplifiers,*	*PLL: Operation of the Basic PLL*	*Voltage Regulators: Basics of Voltage Regulator*	*Successive Approximation ADC*
	SLO-2	*operations of blocks*	*Analog voltage multiplier circuit and its applications,*	*Closed loop analysis of PLL*	*Specifications and characteristic parameters*	*Solving problems*
S-12	SLO-1	*Basic op-amp internal schematic*	*Operational Trans-Conductance Amplifier (OTA)*	*Voltage Controlled Oscillator*	*Linear Voltage Regulators using Op-amp,*	*Dual Slope ADC*
	SLO-2	*operations of blocks*	*Comparators : operation*	*Solving problems*	*IC Regulators (78xx, 79xx, LM 317, LM 337, 723),*	*Flash Type ADC,*
S-13	SLO-1	*Review of data sheet of an op-amp.*	*Comparators applications*	*PLL applications*	*Switching Regulators -operation*	*Solving problems on Flash Type ADC,*
	SLO-2	*Solving Problems*	*Sample and Hold circuit.*	*Solving problems*	*Types*	*Monolithic ADC*
S 14-15	SLO-1 SLO-2	*Lab 3: Rectifiers*	*Lab 6: Waveform generators: using op-amp & 555 Timer*	*Lab 9: Design of LPF, HPF, BPF and Band Reject Filters*	*Lab 12: R-2R ladder DAC*	*Lab 15: Simulation experiments using EDA tools*

Learning Resources	1. *Ramakant A. Gayakwad, Op-Amps and Linear Integrated Circuits, 4th ed., Prentice Hall, 2000* 2. *David A. Bell, Operational Amplifiers and Linear ICs, 3rd ed., OUP, 2013* 3. *Roy Choudhury, Shail Jain, Linear Integrated Circuits, 4th ed., New Age International Publishers, 2014* 4. *Robert F. Coughlin, Frederick F. Driscoll, Operational-Amplifiers and Linear Integrated Circuits, 6th ed., Prentice Hall, 2001* 5. *Sergio Franco, Design with operational amplifier and analog integrated circuits, McGraw Hill, 1997*	6. *LABORATORY MANUAL, Department of ECE, SRM University* 7. *David A Bell, Laboratory Manual for Operational Amplifiers & Linear ICs, 2nd ed., D.A. Bell, 2001* 8. *David La Lond, Experiments in Principles of Electronic Devices and Circuits, Delmar Publishers, 1993* 9. *Muhammed H Rashid, Introduction to PSpice using OrCAD for circuits and electronics, 3rd ed., Pearson, 2004* 10. *L. K. Maheshwari, M. M. S. Anand, Laboratory Experiments and PSPICE Simulations in Analog Electronics, PHI, 2006*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

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ACADEMIC CURRICULA

Professional Core Courses

MECHANICAL ENGINEERING

Regulations - 2018

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Kancheepuram, Tamil Nadu, India

Course Code	18MEC101T	Course Name	THERMODYNAMICS	Course Category	C	Professional Core	L	T	P	C
							3	1	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechanical Engineering	Data Book / Codes/Standards	Steam tables and Mollier chart		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Identify the fundamental concepts of thermodynamic systems and energy transfer
CLR-2 :	Utilize thermodynamic laws and their applications
CLR-3 :	Utilize the concept of entropy and availability
CLR-4 :	Utilize the evaluation of properties of pure substances and vapour power cycles
CLR-5 :	Utilize the evaluation of properties of gas and gas mixtures
CLR-6 :	Utilize the thermodynamic relations and its significance

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	13 PSO - 1	14 PSO - 2	15 PSO - 3
CLO-1 :	Apply the concept of thermodynamic properties to quantify energy transfer	3	90	80	H	H	M	M	M	L	L	L	M	M	M	M	M	M	M
CLO-2 :	Apply thermodynamic laws to analyze various thermodynamic systems	3	90	80	H	H	M	M	M	L	L	L	M	M	M	M	M	M	M
CLO-3 :	Apply the concept of entropy and availability to thermodynamic systems and to do exergy analysis	3	90	80	H	H	M	M	M	L	L	L	M	M	M	M	M	M	M
CLO-4 :	Evaluate the properties of pure substances and analyze vapour power cycles	3	90	80	H	H	M	M	M	L	L	L	M	M	M	M	M	M	M
CLO-5 :	Evaluate the properties of gas and gas mixtures	3	90	80	H	H	M	M	M	L	L	L	M	M	M	M	M	M	M
CLO-6 :	Apply the knowledge of thermodynamic relations to evaluate non measurable properties	3	90	80	H	M	M	M	M	L	L	L	M	M	M	M	M	M	M

Duration (hour)		12	12	12	12	12
S-1	SLO-1	Thermodynamic system and Control volume	Limitations of first law	Clausius theorem	Pure substances, Phase change phenomenon of a pure substance	Properties of ideal gases
	SLO-2	Thermodynamic properties, State, Process and Cycle	Cyclic heat engine, Energy reservoirs,	Concept of entropy, T-s diagram	Property diagrams for phase change process	Properties of real gases
S-2	SLO-1	Thermodynamic equilibrium, Quasi-static process	Refrigerator and heat pump	Clausius inequality, Entropy principle	T-v, P-v,P-T diagram, P-v-T surface, Critical point and Triple point	Equation of state
	SLO-2	Pure substance , State postulate	Thermal efficiency and COP	Application of the concept of Clausius theorem	T-s and h-s diagram, Dryness fraction,	Vander Waal's equation of state
S-3	SLO-1	Concept of temperature, Zeroth law of thermodynamics,	Kelvin-Planck statement and Clausius statement of second law	Clausius inequality on solving problems of heat engines, heat pump and refrigerators.	Use of Steam tables,Mollier chart	Compressibility factor, compressibility chart
	SLO-2	Work and heat interaction	Equivalence of the two statements	Evaluation of change in entropy for solids and liquids	Identification of states & Determination of properties	Problem solving on evaluation of properties of ideal gas and real gas.
S-4	SLO-1	Path function and point function.	Tutorials on Second law of thermodynamics	Tutorials on change in entropy for solids and liquids	Tutorials on calculation of steam properties	Tutorials on properties of ideal gas and real gas.
	SLO-2	pdVwork for various quasi-static processes	Tutorials on Second law of thermodynamics	Tutorials on change in entropy for solids and liquids	Tutorials on calculation of steam properties	Tutorials on properties of ideal gas and real gas.
S-5	SLO-1	Tutorials on Work and Heat Transfer.	Reversible and irreversible process	Evaluation of change in entropy for ideal gases undergoing various processes	Rankine cycle	Properties of mixture of gases
	SLO-2	other types of work transfer including flow work	Causes of irreversibility	Evaluation of change in entropy for ideal gases undergoing various processes	Operation of Rankine cycle	Dalton's law of partial pressures
S-6	SLO-1	First law of thermodynamics for a closed system	Carnot cycle	Available and unavailable energy	Analysis of Rankine cycle	Amagat's law of additive volumes
	SLO-2	Concept of total energy E	Working of a Carnot engine	Dead state	Analysis of Rankine cycle	Internal energy, enthalpy
S-7	SLO-1	Various modes of energy	Thermal efficiency of a Carnot heat engine	Availability	Problems solving on Rankine cycle	specific heats and entropy of gas mixtures

	SLO-2	*Tutorials on first law for a closed system*	*Tutorials on Carnot engines*	*Irreversibility*	*Problems solving on Rankine cycle*	*Problem solving on evaluation of properties of gas mixtures*
S-8	SLO-1	*Tutorials on first law: Constant volume, constant pressure, process in which PV=C*	*Reversed Carnot cycle*	*Tutorials on change in entropy for ideal gases*	*Tutorials on Rankine cycle with different turbine inlet conditions*	*Tutorials on properties of gas mixtures*
	SLO-2	*Tutorials on first law: Polytropic, adiabatic process, Combination of different process*	*Carnot's theorem*	*Tutorials on change in entropy for ideal gases*	*Tutorials on Rankine cycle with different turbine inlet conditions*	*Tutorials – Mixing of gases*
S-9	SLO-1	*Internal energyand Enthalpy, specific heats*	*Thermodynamic temperature scale.*	*Availability of energy entering a system*	*Reheat Rankine cycle*	*Maxwell's relations*
	SLO-2	*Process and cycle*	*Efficiency of Carnot heat engine*	*Availability of energy entering a system*	*Operation of reheat Rankine cycle*	*T-ds relations*
S-10	SLO-1	*First law applied to flow processes*	*COP of Carnot refrigerator*	*Problems solving on Availability of a closed system*	*Analysis of reheat Rankine cycle*	*Equations for dH and dU.*
	SLO-2	*Derivation of general energy equation for a control volume*	*Carnot heat pump, COP*	*Problems solving on Availability of a closed system*	*Concept of regeneration in Rankine cycle*	*Clausius-Clapeyron Equation*
S-11	SLO-1	*Application of SFEE to various steady flow devices*	*Tutorials on combined heat engine & refrigerator/heat pump system*	*Availability in a steady flow process*	*Problem solving on reheat Rankine cycle*	*Joule-Thomson experiment*
	SLO-2	*Problem solving on first law applied to flow processes*	*Tutorials on combined heat engine & refrigerator/heat pump system*	*Problem solving on availability*	*Problem solving on reheat Rankine cycle*	*Joule -Thomson coefficient.*
S-12	SLO-1	*Tutorial on first law applied to various steady flow devices*	*Tutorials on combined heat engine & refrigerator/heat pump system*	*Tutorials on availability*	*Tutorials on reheat Rankine cycle*	*Tutorials on Thermodynamic relations*
	SLO-2	*Tutorial on first law applied to various steady flow devices*	*Tutorials on combined heat engine & refrigerator/heat pump system*	*Tutorials on availability*	*Tutorials on reheat Rankine cycle*	*Tutorials on Thermodynamic relations*

Learning Resources

1. *Mahesh M. Rathore, Thermal Engineering, Tata McGraw Hill Education, 2012*
2. *Yunus. ACengel., Michael A Boles, Thermodynamics – An Engineering Approach, 8th ed., Tata McGraw Hill-Education, 2015*
3. *Nag. P.K, Engineering Thermodynamics, 5th ed., Tata McGraw Hill Education, 2013*
4. *R. K. Rajput, Thermal Engineering, 10th ed., Laxmi Publications (P) Ltd, New Delhi, 2017*
5. *Michael J Moran, and Howard N Shapiro, Fundamentals of Engineering Thermodynamics, 8th ed., John Wiley & Sons, New York, 2015*
6. *Claus Borgnakke, Richard E. Sonntag, Fundamentals of Thermodynamics, 7th ed., Wiley, 2009*
7. *Ramalingam. K. K, Steam tables, Sci.Tech Publishers, 2009*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.R.Kalimuthu, ISRO, Mahendragiri, r_kalimuthu@vssc.gov.in	*1. Dr. R Velraj, IES,CEG, Anna University, Chennai, velrajr@annauniv.edu*	*1. Mr. V Thirunavukkarasu, SRMIST*
2. Dr.A.Velayutham, DRDO, Avadi, velayudham.a@cvrde.drdo.in	*2. Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	*2. Dr. M. Cheralathan, SRMIST*

Course Code	18MEC102T	Course Name	FLUID MECHANICS	Course Category	C	Professional Core	L	T	P	C
							3	1	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechanical Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Utilize the properties of fluid and pressure measurement techniques using manometer
CLR-2 :	Utilize the basic equations of fluid mechanics to solve fluid flow problems
CLR-3 :	Utilize the applications of dimensional and model analysis
CLR-4 :	Identify the working principle and design of hydraulic turbines and pumps
CLR-5 :	Utilize the concept of boundary layer, lift and drag forces
CLR-6 :	Identify the behavior of fluids at rest as well as in motion

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1 Level of Thinking (Bloom)	2 Expected Proficiency (%)	3 Expected Attainment (%)	Program Learning Outcomes (PLO) 1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	13 PSO - 1	14 PSO - 2	15 PSO - 3
CLO-1 :	Identify the properties of fluid	2	85	80	H	H	H	H	M	L	L	L	M	L	-	H	L	H	L
CLO-2 :	Solve the fluid flow problems	3	85	80	H	H	H	H	M	L	L	L	M	L	-	H	L	H	L
CLO-3 :	Apply the mathematical techniques for practical fluid flow problem	3	85	80	H	H	H	H	M	L	L	L	M	L	-	H	L	H	L
CLO-4 :	Identify the energy exchange process in fluid machinery	3	85	80	H	H	H	H	M	L	L	L	M	L	-	H	L	H	L
CLO-5 :	Identify the boundary layer theory and flow over submerged bodies	2	85	80	H	H	H	H	M	L	L	L	M	L	-	H	L	H	L
CLO-6 :	Analyze the dynamics of fluid flows and their governing parameters	3	85	80	H	H	H	H	M	L	L	L	M	L	-	H	L	H	L

Duration (hour)		12	12	12	12	12
S-1	SLO-1	Types of Fluids, Properties of fluid	Types of fluid flow	Dimensional analysis	Hydraulic machines	Boundary layer
	SLO-2	Density, Specific weight, Specific volume,	Lagrangian and Eulerian approach of study	Dimensions, Dimensional Homogeneity	Turbines and Pumps	Laminar boundary layer
S-2	SLO-1	Specific gravity, Vapor pressure	Velocity of Fluid particles	Buckingham's pi theorem	Classification of turbines and pumps	Turbulent boundary layer
	SLO-2	Viscosity: Dynamic and Kinematic viscosity	Acceleration of Fluid particles	Model analysis	Pelton turbine-Working principle	Boundary layer thickness
S-3	SLO-1	Newton's law of viscosity	Continuity equation	Advantages and applications	Velocity triangle	Displacement thickness
	SLO-2	Surface tension and Capillarity	Continuity equation in three dimensions	Similitude, Dimensionless numbers	Design parameters, Performance	Problem solving on boundary layer thickness
S-4	SLO-1	Tutorials on fluid properties	Tutorials on Velocity, Acceleration and Continuity equation	Tutorials on Buckingham's pi theorem	Tutorials on Pelton turbine	Tutorials on Boundary layer thickness
	SLO-2	Tutorials on fluid properties	Tutorials on Velocity, Acceleration and Continuity equation	Tutorials on Buckingham's pi theorem	Tutorials on Pelton turbine	Tutorials on Boundary layer thickness
S-5	SLO-1	Bulk modulus of elasticity and Compressibility	Fluid Dynamics	Model laws- Reynold's, Froude	Francis turbine-Working principle	Momentumthickness
	SLO-2	Fluid statics: Pascal'slaw	Euler equation of motion	Model laws- Euler	Velocity triangle	Energy thickness
S-6	SLO-1	Hydrostatic law	Bernoulli's equation	Tutorials on Reynold's and Froude model laws	Kaplan turbine-Working principle	Drag force on a flat plate due to boundary layer
	SLO-2	Manometers: Types	Applications of bernoulli's equation	Weber and Mach model laws	Velocity triangle	von Karman momentum integral equation

S-7	SLO-1	Piezometer	Venturimeter	Laminar flow-Reynold's experiment	Cavitation in turbines	Separation of boundary layer
	SLO-2	Applications and Limitation	Orificemeter	Hagen poiseuille law	Problem solving on Turbine performances	Problem Solving on momentum integral equation
S-8	SLO-1	Tutorials on laws of fluid statics	Tutorials on Venturimeter and Orificemeter	Tutorials on major and minor losses	Tutorials on Francis and Kaplan turbine	Tutorial problems on momentum integral equation
	SLO-2	Tutorials on laws of fluid statics	Tutorials on Venturimeter and Orificemeter	Tutorials on major and minor losses	Tutorials on Francis and Kaplan turbine	Tutorial problems on momentum integral equation
S-9	SLO-1	U-Tube manometer	Pitot tube	Turbulent flow-Darcy equation	Reciprocating pump	Forces exerted by a flowing fluid on a stationary body
	SLO-2	Problem Solving on U-tube manometer	Nozzle flow meter	Minor loss due to sudden enlargement	Single and double acting pumps-working principle	Separation of flow over bodies
S-10	SLO-1	Single column manometer	Bernoulli's equation for real fluid	Minor loss due to sudden contraction	Centrifugal pump - Working principle	Streamlined and bluff bodies
	SLO-2	Differential U-tube manometer	Types of flow lines, Stream line	entrance and exit of pipe	Velocity triangle, Design parameters	Development of lift on a circular cylinder
S-11	SLO-1	Inverted differential U-tube manometer	Streak line and Path line	Flow through pipes in series	Cavitation in pumps	Development of lift on an aerofoil
	SLO-2	Problem solving in differential manometer	Impulse Momentum equation	Flow through pipes in parallel	Performance curves on turbines and pumps	Problem Solving on lift and drag forces
S-12	SLO-1	Tutorials on differential manometer	Tutorials on finding force exerted by fluid on pipe bend	Tutorials on major and minor losses	Tutorials on centrifugal pump	Tutorials on lift and drag forces
	SLO-2	Tutorials on differential manometer	Tutorials on finding force exerted by fluid on pipe bend	Tutorials on major and minor losses	Tutorials on centrifugal pump	Tutorials on lift and drag forces

Learning Resources	1. Rajput. R. K, A text book of Fluid Mechanics and Hydraulic Machines, S.Chand & Company Ltd., 6th ed., 2015 2. Bansal. R. K, A text book of Fluid Mechanics and Hydraulics Machines, Laxmi publications (P) Ltd., 9th ed., 2015 3. Modi P.N, Seth S.M, Hydraulics and Fluid Mechanics, Standard Book House, 15th ed., 2002	4. White. F. M, Fluid Mechanics, Tata McGraw-Hill, 7th ed., 2011 5. Streeter. V. L, Wylie. E. B, Fluid Mechanics , McGraw Hill, 5th ed., 1984 6. Modi P.N, Seth S.M, Hydraulics and Fluid Mechanics, Standard Book House, 15th ed., 2002

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember / Understand	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
Level 2	Apply / Analyze	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
Level 3	Evaluate / Create	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

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2. Dr.A.Velayutham, DRDO, Avadi, velayudham.a@cvrde.drdo.in	2. Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in	2. Dr. K. Suresh Kumar, SRMIST

Course Code	18MEC103T	Course Name	MANUFACTURING TECHNOLOGY	Course Category	C	Professional Core	L	T	P	C
							3	1	0	4

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Mechanical Engineering*	Data Book / Codes/Standards	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Utilize the Concepts of casting Technology*
CLR-2 :	*Identify the Mechanical working of metals*
CLR-3 :	*Identify the Theory of metal cutting*
CLR-4 :	*Utilize machine tools principles and its application in manufacturing industry*
CLR-5 :	*Identify the various metal joining process for the assembly operations.*
CLR-6 :	*Utilize principles and techniques of casting, forming, joining and finishing operations and determine their suitability*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1	Learning 2	Learning 3	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12	PLO 13	PLO 14	PLO 15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Identify metal casting processes and to recognize the various casting techniques to apply for making the product*	2	90	85	H	L	M	M	-	-	-	-	M	-	-	-	H	L	H
CLO-2 :	*Identify metal forming processes and sheet metal techniques to apply the techniques for any fabrication work*	2	90	85	H	M	M	M	-	-	-	-	M	-	-	-	H	L	H
CLO-3 :	*Use the theory behind the metal cutting operation and acquire the knowledge about cutting tool and cutting fluids*	2	90	85	H	M	M	M	-	-	-	-	M	-	-	-	H	L	H
CLO-4 :	*Identify machine parts and operations of milling, shaping, slotting, planning and broaching machines*	2	90	85	H	L	M	L	-	-	-	-	M	-	-	-	H	L	H
CLO-5 :	*Identify various metal joining process and its application in various industrial sectors*	2	90	85	H	L	H	H	-	-	-	-	M	-	-	-	H	L	H
CLO-6 :	*Identify manufacturing processes, tools, environment and suitable manufacturing processes for fabrication work*	2	90	85	H	M	M	M	-	-	-	-	M	-	-	-	H	L	H

Duration (hour)		12	12	12	12	12
S-1	SLO-1	*Introduction to Casting*	*Introduction to Hot Working*	*Orthogonal cutting*	*Introduction to Gear Manufacturing*	*Types of Welding Processes, Types of Joints, Types of Welds,*
	SLO-2	*Patterns and its types and Materials*	*Cold Working*	*Oblique cutting*	*Machining and Generating Processes*	*Power Density, Heat Balance in Fusion Welding*
S-2	SLO-1	*Pattern Allowances*	*Hot and Cold Rolling*	*Classification of cutting tools*	*Classification of Milling Machines and its basic construction,*	*General Technology of Arc Welding*
	SLO-2	*Moulding and its types,*	*Types of rolling; Two, three, four, multi and Universal rolling*	*Single point cutting tools*	*Types of cutters in Milling machines*	*consumable and non-consumable electrodes Oxy-fuel Gas Welding*
S-3	SLO-1	*Moulding sand*	*Open die and Closed die forging*	*Multipoint cutting tools*	*Types of milling operations; (up and down, peripheral, face milling*	*Fundamentals of Shielded Metal Arc Welding*
	SLO-2	*Design of Gating system*	*Wire drawing*	*Tool signature for single point cutting tool*	*Simple and differential Indexing methods and its calculations*	*Gas Metal Arc Welding, and Submerged Arc Welding*
S-4	SLO-1	*Tutorial for design of gating system*	*Tutorial Session*	*Tutorial on Numerical in cutting force calculation*	*Tutorial 10 Numerical in indexing methods*	*Tutorial Session*
	SLO-2	*Tutorial for design of gating system*	*Tutorial Session*	*Tutorial on Numerical in cutting force calculation*	*Tutorial 10 Numerical in indexing methods*	*Tutorial Session*
S-5	SLO-1	*Numerical problems on pouring time*	*Hot, Cold wire drawing*	*Mechanics of orthogonal cutting*	*Shaping and slotting Machine*	*Fundamentals of Gas tungsten arc welding*
	SLO-2	*Numerical problems on Caine's rule*	*Forward, backward and tube extrusion*	*Force relationship*	*Description and Operations*	*Resistance welding, and Plasma arc welding*
S-6	SLO-1	*Numerical Problems on Riser design*	*Shearing, Piercing*	*Merchant Circle*	*Planing; Double house and open side*	*Parametric considerations in solid-state welding*
	SLO-2	*Numerical Problems on Riser design*	*Trimming and Stretch forming*	*Merchant Circle*	*Quick return mechanism, Work and tool holding Devices*	*Difference between fusion welding and solid-state process*

S-7	SLO-1	*Cores*	*Theory of Bending, Bending length*	*Determination of shear angle*	*Boring machine and its Specification, operations*	*Forge Welding, Roll Welding, Explosion Welding, Ultrasonic welding*
	SLO-2	*Core making*	*Bending force calculations*	*Determination of shear angle*	*Jig boring machine*	*Friction welding and Friction stir welding, Friction surfacing and processing*
S-8	SLO-1	*Tutorial on Numerical in riser design and pouring time*	*Tutorial on Numerical in bending force calculation*	*Tutorial on Numerical in Merchant circle*	*Tutorial on Discussion about mechanism of special purpose machine*	*Tutorial Session*
	SLO-2	*Tutorial on Numerical in riser design and pouring time*	*Tutorial on Numerical in bending force calculation*	*Tutorial on Numerical in Merchant circle*	*Tutorial on Discussion about mechanism of special purpose machine*	*Tutorial Session*
S-9	SLO-1	*Shell casting*	*Drawing*	*Chip formation*	*Specification of Broaching machine, its types and operations; internal, surface*	*Basic Solidification Concepts, Grain structure*
	SLO-2	*Investment Casting*	*Blank size and and drawing force calculations*	*Cutting tool materials*	*Tool nomenclature of broaching tool*	*Post-Solidification Phase Transformations, CCT diagram*
S-10	SLO-1	*Die casting*	*Tube forming, Embossing and coining*	*Tool wear calculation*	*Grinding process, Types of Grinding machines*	*Residual Stresses and Distortion, weld defects, Inspection and Testing Methods,*
	SLO-2	*Centrifugal Casting*	*Progressive dies*	*Taylor tool life calculation*	*Surface, Cylindrical and Centerless Grinding*	*factors of weldability, Types of weldability test techniques,*
S-11	SLO-1	*Casting defects*	*Compound and Combination dies*	*Machinability*	*Grinding Wheel and its types, Grinding specifications and type of abrasive bonds*	*Introduction on brazing and soldering methods*
	SLO-2	*Remedies for defects*	*Defects in forming*	*Cutting Fluids*	*Lapping, Buffing, Honing, and Super finishing*	*filler materials*
S-12	SLO-1	*Tutorial Session*	*Tutorial Session*	*Tutorial Session*	*Tutorial Session*	*Tutorial Session*
	SLO-2	*Tutorial Session*	*Tutorial Session*	*Tutorial Session*	*Tutorial Session*	*Tutorial Session*

Learning Resources	1. *SeropeKalpakjian, Steven R Schmid Manufacturing Engineering and Technology, 7th ed., Pearson, 2018* 2. *Mikell P. Groover, Fundamentals of Modern Manufacturing Materials, Processes, and Systems, 4th ed., John Wiley & Sons, 2010* 3. *Roy A. Lindberg, Processes and materials of manufacture, Boston: Allyn and Bacon, Pearson education, 2006* 4. *A.C. Davies, The science and practice of welding, Vol. 1 and 2, 10th ed., Cambridge University Press, 2002*	5. *John A. Schey, Introduction to manufacturing processes, 3rd ed., McGraw-Hill, 2000* 6. *Sindo Kou, Welding Metallurgy, 2nd ed., John Wiley & Sons, 2003.* 7. *John C. Lippold, Welding Metallurgy and Weldability, John Wiley & Sons, 2015* 8. *Welding Handbook – Volume 1 to 5, 9th ed., American Welding Society.2013*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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2. Dr. A. Velayutham, DRDO, Avadi, velayudham.a@cvrde.drdo.in	*2. Dr. N. Arunachalam, IIT Madras, chalam@iitm.ac.in*	*2. Dr. Manidipto Mukherjee, SRMIST*

Course Code	18MEC104L	Course Name	FLUID DYNAMICS LABORATORY	Course Category	C	Professional Core	L	T	P	C
							0	0	2	1

Pre-requisite Courses	Nil	Co-requisite Courses	18MEC102T	Progressive Courses	Nil
Course Offering Department	Mechanical Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Practice working of flow measuring devices
CLR-2 :	Practice Kinematics and dynamics of fluid flow in pipes
CLR-3 :	Identify the various energy losses in pipes
CLR-4 :	Identify the performance of pumps
CLR-5 :	Analyze the performance of turbines
CLR-6 :	Analyze fluid flow concepts, working principles of flow meters, energy heads and losses, performance of pumps, turbines

Course Learning Outcomes (CLO): At the end of this course, learners will be able to:		Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO - 3
CLO-1 :	Practice the concept of flow measurement devices	3	95	85	H	H	H	H	M	L	L	L	M	M	M	M	L	L	L
CLO-2 :	Analyze the different type of energy heads	3	95	85	H	H	H	H	M	L	L	L	M	M	M	M	L	L	L
CLO-3 :	Evaluate the various energy losses in pipe	3	95	85	H	H	H	H	M	L	L	L	M	M	M	M	L	L	L
CLO-4 :	Analyze the performance of pumps	3	95	85	H	H	H	H	M	L	L	L	M	M	M	M	L	L	L
CLO-5 :	Analyze the performance of turbines	3	95	85	H	H	H	H	M	L	L	L	M	M	M	M	L	L	L
CLO-6 :	Analyze fluid flow concepts, working principles of flow meters, energy heads and losses, performance of pumps, turbines	3	95	85	H	H	H	H	M	L	L	L	M	M	M	M	L	L	L

Duration (hour)		6	6	6	6	6
S-1	SLO-1 / SLO-2	Flow measurement using Orificemeter	Flow visualization using Reynolds apparatus	Study of major Energy loss in a pipe	Study of Kaplan turbine Test Rig	Study of Submersible Pump Test Rig
S-2	SLO-1 / SLO-2	Determine the co-efficient of discharge of Orifice meter	Free and forced vortex flow visualization	Determine friction factor at a given pipe	Performance test on Kaplan turbine	Performance test on Submersible pump
S-3	SLO-1 / SLO-2	Flow measurement using Venturimeter	Obtain surface profile of forced vortex and find the depth of the forced vortex curve	Study of Pelton turbine	Study of Francis turbine Test Rig	Study of Reciprocating Pump Test Rig
S-4	SLO-1 / SLO-2	Determine the co-efficient of discharge of Venturimeter	Verify Bernoulli's theorem	Performance test on Pelton turbine	Performance test on Francis turbine	Performance test on Reciprocating pump
S-5	SLO-1 / SLO-2	Flow measurement using Pitot tube/ Visualization of cavitation in pipe flow	Determine total heads of fluids at given points in the pipe	Study on impact of jet of water on vanes	Study of Centrifugal Pump Test Rig	Study of Jet pump/ Performance test on Gear Pump Test Rig
S-6	SLO-1 / SLO-2	Determine velocity at a point by using Prandtl type Pitot tube	Study of Minor losses &Determine minor losses due to pipe fittings	Determine co-efficient of impact of jet of water on different vanes	Performance test on Centrifugal pump	Performance test on Jet pump Performance test on Gear pump

Learning Resources

1. Robert W. Fox, Alan T. McDonald, Philip J. Pritchard, Introduction to Fluid Mechanics, 8^{th} ed., Wiley, 2013
2. P.N. Modi, S.M. Seth, Hydraulics& Fluid Mechanics Including Hydraulics Machines, 20^{th} ed., Standard Book House,2018
3. Frank M.White, Fluid Mechanics,7th ed., McGraw-Hill, 2018
4. K L Kumar, Engineering Fluid Mechanics, 10th ed., S Chand & Co., 2015
5. Laboratory Manual

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	-	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*
Level 2	Apply Analyze	-	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*
Level 3	Evaluate Create	-	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.R.Kalimuthu, ISRO, Mahendragiri, r_kalimuthu@vssc.gov.in	*1. Dr. R Velraj, IES, CEG, Anna University, Chennai, velrajr@annauniv.edu*	*1. Dr. R Senthil, SRMIST*
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Course Code	18MEC105L	Course Name	MANUFACTURING PROCESS LABORATORY	Course Category	C	*Professional Core*	L	T	P	C
							0	0	2	1

Pre-requisite Courses	*Nil*	Co-requisite Courses	*18MEC103T*	Progressive Courses	*Nil*
Course Offering Department	*Mechanical Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Practice Various types of lathe operations*
CLR-2 :	*Practice the Production of flat surface and contour shapes on the given component*
CLR-3 :	*Practice basic Gear making processes*
CLR-4 :	*Practice Surface finishing process*
CLR-5 :	*Practice and Preparation of Sand Mould*
CLR-6 :	*Utilize machines like lathe, CNC Lathe, Shaper, Slotter, Milling, CNC MIlling, Gear hobbing, grinding and sand moulding*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO - 3
CLO-1 :	*Machine using lathe to create new components according to specified dimensions*	3	85	80	H	H	H	L	H	L	H	L	L	H	L	H	L	L	L
CLO-2 :	*Produce the flat surface and contour shapes on the given component*	3	90	85	H	M	L	L	H	L	L	L	L	H	L	H	L	L	L
CLO-3 :	*Practice basic Gear Making Processes*	3	95	90	M	L	H	H	L	L	L	L	H	H	L	H	L	L	L
CLO-4 :	*Practice Surface Finish Process*	3	85	80	H	L	H	L	L	L	H	H	L	L	L	H	L	L	L
CLO-5 :	*Practice casting and molding*	3	95	90	M	H	H	L	L	L	H	L	L	L	L	L	L	L	L
CLO-6 :	*Practice machines like lathe, CNC Lathe, Shaper, Slotter, Milling, CNC MIlling, Gear hobbing, grinding and sand moulding*	3	90	85	H	M	H	M	M	L	M	M	M	M	L	H	L	L	L

Duration (hour)		6	6	6	6	6
S-1	SLO-1 SLO-2	*Perform plain turning in lathe*	*Perform eccentric turning in lathe*	*Perform V block shaping in shaper machine*	*Helical Gear cutting in Hobbing machine*	*Grinding of single point cutting tool in Tool and Cutter grinding machine*
S-2	SLO-1 SLO-2	*Perform step turning in lathe*	*Perform Taper boring in lathe*	*Perform V block shaping in shaper machine.*	*Helical Gear cutting in Hobbing machine*	*Grinding of single point cutting tool in Tool and Cutter grinding machine*
S-3	SLO-1 SLO-2	*Perform chamfering in lathe*	*Perform Knurling in lathe*	*Perform Polygon milling in milling machine*	*Perform surface grinding in Grinding machine*	*Preparation of Sand mold using solid/split pattern with loose-piece pattern*
S-4	SLO-1 SLO-2	*Perform taper turning by compound rest/offset method in lathe*	*Perform plain turning in CNC Lathe*	*Perform Polygon milling in milling machine*	*Perform surface grinding in Grinding machine*	*Preparation of Sand mold using solid/split pattern with loose-piece pattern*
S-5	SLO-1 SLO-2	*Perform drilling in lathe*	*Perform step turning in CNC Lathe*	*Spur Gear cutting in milling machine*	*Perform cylindrical grinding in Grinding machine*	*Preparation of Sand mold using solid/split pattern with loose-piece pattern*
S-6	SLO-1 SLO-2	*Perform external and internal thread cutting in lathe*	*Performing chamfering in CNC Lathe*	*Spur Gear cutting in milling machine*	*Perform cylindrical grinding in Grinding machine*	*Preparation of Sand mold using solid/split pattern with loose-piece pattern*

Learning Resources	1. *Chapman.W.A.J, Workshop Technology, Vol. I and II, Arnold Publisher, 2001* 2. *Hajra Choudhary.S.K., Hajra Choudhary.A.K, Elements of Manufacturing Technology Vol II, Media Publishers, 2007*	3. *James Madison, CNC Machining Hand Book, Industrial Press Inc., New York, 1996* 4. *Laboratory Manual*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	-	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*
Level 2	Apply Analyze	-	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*
Level 3	Evaluate Create	-	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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2. Dr. A. Velayutham, DRDO, Avadi, velayudham.a@cvrde.drdo.in	*2. Dr. N. Arunachalam, IIT Madras, chalam@iitm.ac.in*	*2. Mr. Sundar Singh Sivam S.P, SRMIST*

Course Code	18MEC106T	Course Name	MECHANICS OF SOLIDS	Course Category	C	Professional Core	L	T	P	C
							3	1	0	4

Pre-requisite Courses	18MES201T	Co-requisite Courses	Nil	Progressive Courses	18MEC208T, 18MEE305T
Course Offering Department	Mechanical Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Utilize concepts of stress and strain
CLR-2 :	Analyze bending and shear stresses in beams
CLR-3 :	Utilize concepts to design shafts
CLR-4 :	Analyze of slope and deflection in beams
CLR-5 :	Utilize concepts to design column and cylinders
CLR-6 :	Utilize concepts of stress, strain, slope and deflection in beams and design of shaft, column and cylinders

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1 Level of Thinking (Bloom)	Learning 2 Expected Proficiency (%)	Learning 3 Expected Attainment (%)	PLO 1 Engineering Knowledge	PLO 2 Problem Analysis	PLO 3 Design & Development	PLO 4 Analysis, Design, Research	PLO 5 Modern Tool Usage	PLO 6 Society & Culture	PLO 7 Environment & Sustainability	PLO 8 Ethics	PLO 9 Individual & Team Work	PLO 10 Communication	PLO 11 Project Mgt. & Finance	PLO 12 Life Long Learning	PLO 13 PSO - 1	PLO 14 PSO - 2	PLO 15 PSO - 3
CLO-1 :	Identify concepts of stress and strain	3	85	80	H	H	L	L	L	L	L	L	L	L	L	L	L	M	L
CLO-2 :	Analyze bending and shear stresses developed in beams	3	85	80	H	H	L	L	L	L	L	L	L	L	L	L	L	M	L
CLO-3 :	Apply the concepts necessary to design of shafts	3	85	80	H	H	H	L	L	L	L	L	L	L	L	L	L	M	L
CLO-4 :	Analyze the slope and deflection in beams	3	85	80	H	H	L	L	L	L	L	L	L	L	L	L	L	M	L
CLO-5 :	Apply the concepts necessary to design of column and cylinders	3	85	80	H	H	H	L	L	L	L	L	L	L	L	L	L	M	L
CLO-6 :	Analyze the stresses, slope and deflection in beams and apply the concepts to design of shaft, column and cylinders	3	85	80	H	H	H	L	L	L	L	L	L	L	L	L	L	M	L

Duration (hour)		12	12	12	12	12
S-1	SLO-1	Concept of stress and strain, Hooke's law	Introduction to types of beams and loads	Theory of pure torsion	Introduction, Beam deflection	Columns and struts
	SLO-2	Tensile, compressive and shear stresses, Poisson's ratio	Shear force, bending moment diagram for cantilever beam: (a) due to pure point load	shear stress in terms of torque in a circular shaft	Relation between deflection, slope, radius of curvature, shear force, bending moment	Members subjected to combined bending and axial loads
S-2	SLO-1	Stress-strain diagram Elastic constants and their relationship	(b) due to pure Uniformly Distributed Load (c) pure Uniformly Varying Load	Strength, Stiffness of shaft, Torsional rigidity & power transmitted	Problems on Relations	Expression for crippling load with different end conditions based on Euler's theory
	SLO-2	Volumetric strain	Problems on Shear force and bending moment diagrams for cantilever beam	Problems on solid shaft, finding dimensions	Problems on Relations	Problems on crippling load with different end conditions based on Euler's theory
S-3	SLO-1	Bars of uniform and varying sections subjected to single loads	Shear force, bending moment diagram for simply supported beam: (a) due to pure point load	Torque expression for (a) solid circular shaft subjected to torsion	Slope and deflection of cantilever beam with (a) a point load	Expression for crippling load by Rankine's theory
	SLO-2	Bars of uniform and varying sections subjected to multiple loads	(b) due to pure Uniformly Distributed Load (c) pure Uniformly Varying Load	(b) hollow circular shaft subjected to torsion.	(b) Uniformly Distributed Load	Problems on crippling load by Rankine's theory
S-4	SLO-1	Tutorial on stress, strain, Hooke's law, elastic constants and volumetric strain	Tutorial on Shear force, bending moment diagrams for simply supported beam	Tutorial on hollow shaft (a) finding dimensions,	Tutorial on Slope, deflection of cantilever beam with (a) a point load	Tutorial on crippling load by Rankine's theory
	SLO-2	Tutorial on bars of uniform and varying sections subjected to single, multiple loads	Tutorial on Shear force, bending moment diagrams for simply supported beam	(b) percentage of material savings	(b) Uniformly Distributed Load	Tutorial on crippling load by Rankine's theory
S-5	SLO-1	Analysis of bars of composite sections	Shear force, bending moment diagram for overhanging beam due to(a)pure point load	Circular shafts in series	Slope and deflection of simply supported beam with (a) a point load	Thin cylindrical shells subjected to internal pressure
	SLO-2	Analysis of bars of composite sections	(b)pure Uniformly Distributed Load (c) pure Uniformly Varying Load	Circular shafts in parallel	(b) a Uniformly Distributed Load (Double integration method)	Change in dimensions of thin cylindrical shells due to internal pressure
S-6	SLO-1	Problems on Analysis of bars of composite sections	Problems on Shear force and bending moment diagrams for overhanging beam	Problems on Circular shafts in series and parallel	Problems on Slope and deflection of simply supported beam with (a) a point load	Problems on thin cylindrical shells subjected to internal pressure

	SLO-2	*Problems on Analysis of bars of composite sections*	*Problems on Shear force and bending moment diagrams for overhanging beam*	*Problems on Circular shafts in series and parallel*	*(b) Uniformly Distributed Load (Double integration method)*	*change in dimensions of thin cylindrical shells due to internal pressure*
S-7	SLO-1	*Concept of Thermal stresses in simple bars*	*Theory of ure bending derivation,*	*Concepts on Strain energy due to torsion*	*Slope and deflection of simply supported beam with (a) a point load*	*Thin spherical shells subjected to internal pressure*
	SLO-2	*Concept of Thermal stresses in composite bars*	*Bending stress in beams of regular sections*	*Concepts on Strain energy due to torsion*	*(b) Uniformly Distributed Load (Macaulay's method)*	*Change in dimensions of thin spherical shells*
S-8	SLO-1 SLO-2	*Tutorial. on Thermal stresses in simple and composite bars*	*Tutorial on Bending stress in beams of regular sections*	*Tutorial on Strain energy due to torsion*	*Tutorial on Slope, deflection of simply supported beam with point load, Uniformly Distributed Load*	*Tutorial on thin spherical shells subjected to internal pressure, change in dimensions of thin spherical shells due to internal pressure*
S-9	SLO-1	*Principal plane, principal stress, Direct stress in two mutually perpendicular directions*	*Bending stress in beams having I- section*	*Solid circular shaft subjected to combined bending and torsion*	*Slope and deflection of cantilever beam with (a) a point load*	*Lame's theory on stresses in thick cylinders*
	SLO-2	*Direct stress in two mutually perpendicular directions accompanied by a simple shear stress*	*Bending stress in beams having T- section*	*Hollow circular shaft subjected to combined bending and torsion*	*(b) Uniformly Distributed Load (Moment area method)*	*Lame's theory on stresses in thick cylinders*
S-10	SLO-1	*Problems on Direct stress in two mutually perpendicular directions*	*Problems on bending stress in beams having I and T sections*	*Problems on circular shaft subjected to combined bending and torsion*	*Slope and deflection of simply supported beam with (a) point load*	*Problems on Lame's theory on stresses in thick cylinders*
	SLO-2	*Problems on Direct stress in two mutually perpendicular directions*	*Problems on bending stress in beams having I and T sections*	*Problems on circular shaft subjected to combined bending and torsion*	*(b) Uniformly Distributed Load (Moment area method)*	*Problems on Lame's theory on stresses in thick cylinders*
S-11	SLO-1	*Mohr's circle: direct stress in tow mutually perpendicular directions without shear stress*	*Derivation of shear stress distribution in beams of different sections*	*Composite solid circular shaft*	*Castigliano's theorem*	*Stresses in compound thick cylinder and Shrink fit*
	SLO-2	*Mohr's circle: direct stress in two mutually perpendicular directions with shear stress*	*Derivation of shear stress distribution in beams having I and T sections*	*Composite hollow circular shaft*	*Maxwel's reciprocal theorem*	*Problems on stresses in compound thick cylinder*
S-12	SLO-1 SLO-2	*Tutorial on direct stress in two mutually perpendicular directions*	*Tutorial on shear stress distribution in beams of different sections such as I and T*	*Tutorial on composite circular shafts*	*Tutorial on Castigliano's and Maxwel's reciprocal theorem*	*Tutorial on stresses in compound thick cylinder and Shrink fit*

Learning Resources	1. *Ferdinand P. Beer, E. Russell Johnston Jr., John T. DeWolf, David F. Mazurek, Mechanics of Materials, 7th ed., McGraw Hill, 2014* 2. *William A. Nash, Theory and Problems of Strength of Materials, Schaum's Outline Series, 3rd ed., McGraw Hill, 2007*	3. *Egor P. Popov, Engineering Mechanics of Solid, 2nd ed., Prentice Hall of India Pvt. Ltd., 2009* 4. *James M. Gere, Mechanics of Materials, 8th ed., Brooks/Cole, USA, 2013* 5. *Shigley. J. E., Applied Mechanics of Materials, International Student edition, McGraw Hill, 2000*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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Course Code	18MEC107T	Course Name	APPLIED THERMAL ENGINEERING	Course Category	C	Professional Core	L	T	P	C
							3	1	0	4

Pre-requisite Courses	*18MEC101T*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Mechanical Engineering*	**Data Book / Codes/Standards**	*Refrigeration Tables &Psychrometric chart*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Analyze the sequence of operation of energy cycles*
CLR-2 :	*Identify the fundamentals of Fuels and calculation of enthalpies*
CLR-3 :	*Analyze the performance testing of IC Engines*
CLR-4 :	*Apply the construction, principle of working and analysis of compressors*
CLR-5 :	*Analyze the working principle of refrigeration systems*
CLR-6 :	*Utilize the fundamentals and psychrometric processes*

		Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Identify the basic operations required for energy release and method to calculate the efficiency*	2	85	80	H	H	M	M	M	L	L	L	M	M	M	M	M	M	M
CLO-2 :	*Comprehend the Fuel properties and its applications*	2	85	80	H	H	M	M	M	L	L	L	M	M	M	M	M	M	M
CLO-3 :	*Analyze the performance of IC Engines*	3	85	80	H	H	M	M	M	L	L	L	M	M	M	M	M	M	M
CLO-4 :	*Identify the construction, operation of compressors, their performance evaluation*	3	85	80	H	H	M	M	M	L	L	L	M	M	M	M	M	M	M
CLO-5 :	*Comprehend the types of refrigeration systems and evaluate its performance*	2	85	80	H	H	M	M	M	L	L	L	M	M	M	M	M	M	M
CLO-6 :	*Analyze the fundamental processes of air conditioning systems and do fundamental calculations*	2	85	80	H	M	M	M	M	L	L	L	M	M	M	M	M	M	M

Duration (hour)		12	12	12	12	12
S-1	SLO-1	*Introduction to air standard cycles*	*Introduction to fuels, Solid fuels*	*Classification of IC engines*	*Classification of Air Compressors*	*Vapor compression refrigeration system and its working principle*
	SLO-2	*Air standard efficiency, Assumptions*	*Liquid fuels*	*Basic operations*	*Construction and working of reciprocating compressor*	*Refrigerants and properties*
S-2	SLO-1	*Otto cycle: Air standard efficiency*	*Gaseous fuels, Fuel properties*	*Actual p-v diagram of four stroke SI engines*	*Compression with clearance volume*	*Eco-friendly refrigerants*
	SLO-2	*Mean effective pressure*	*Stoichiometric air fuel ratio*	*Actual p-v diagram of four strokeCI engines*	*Compression without clearance*	*Analysis of vapor compression refrigeration cycle*
S-3	SLO-1	*Power developed*	*Theoretical air and excess air.*	*Comparison of four stroke and two IC engines*	*Equation for work-Single acting reciprocating compressor*	*P-h Chart*
	SLO-2	*Tutorials on Otto cycle*	*Air fuel ratio from analysis of products*	*Comparison of CI and SI Engines*	*Volumetric efficiency of compressor*	*Sub-cooling and superheating phenomena in VCR cycle*
S-4	SLO-1	*Tutorials on Otto cycle*	*Conversion between volumetric analysis to weight analysis*	*Engine Performance parameters*	*Tutorial problems on single stage compressor with clearance*	*Tutorial: Numerical problems on VC refrigeration system*
	SLO-2	*Diesel cycle: Air standard efficiency*	*Analysis of exhaust and flue gas*	*Measurements of fuel consumption*	*Tutorial problems on single stage compressor without clearance*	*Tutorial: Numerical problems on VC refrigeration system*
S-5	SLO-1	*Mean effective pressure*	*Internal energy and enthalpy of formation*	*Measurements of air consumption*	*Free air delivered*	*Simple vapor absorption refrigeration system*
	SLO-2	*Power developed*	*Determination of calorific values of the fuel-Solid fuel and liquid fuel.*	*Measurement of brake power*	*Free air delivered*	*Simple vapor absorption refrigeration system*
S-6	SLO-1	*Dual cycle: Air standard efficiency*	*Determination of calorific values of the fuel-Gaseous fuel*	*Measurement of in-cylinder pressure*	*Multistage compression*	*Properties of atmospheric air and Psychrometric chart*
	SLO-2	*Mean Effective pressure*	*Tutorials on determination of calorific value*	*Tutorials on IC Engine performance*	*Multistage compression*	*Properties of atmospheric air and Psychrometric chart*

S-7	SLO-1	*Power developed*	*Tutorials on determination of calorific value*	*Tutorials on IC Engine Performance*	*Problems on multistage compression*	*Psychrometric processes. sensible heating and cooling*
	SLO-2	*Tutorials on Diesel cycle*	*Tutorials on determination of calorific value*	*Tutorials on IC Engine Performance*	*Problems on volumetric efficiency*	*Psychrometric processes. sensible heating and cooling*
S-8	SLO-1	*Tutorials on Diesel cycle*	*Tutorial: Numerical problems on First law analysis*	*Tutorial: Numerical problems on engine performance parameters*	*Tutorials on multi stage compression, FAD*	*Cooling and dehumidification*
	SLO-2	*Tutorials on Dual cycle*	*Tutorial: Numerical problems on First law analysis*	*Tutorial: Numerical problems on engine performance parameters*	*Tutorials on multi stage compression, FAD*	*Heating and humidification*
S-9	SLO-1	*Problems on Mean effective pressure*	*Heat calculations using enthalpy tables*	*Heat balance sheet*	*Rotary compressors*	*Tutorial: Numerical problems on psychrometric processes*
	SLO-2	*Comparison of Otto, Diesel and Dual cycles*	*Problem Solving in Heat calculations*	*Heat balance sheet*	*Vane compressor*	*Summer air conditioning system*
S-10	SLO-1	*Brayton cycle*	*Adiabatic flame temperature*	*Problems on Heat balance sheet*	*Roots blower*	*Winter air conditioning system*
	SLO-2	*Brayton cycle efficiency*	*Adiabatic flame temperature*	*Problems on Heat balance sheet*	*Different compressors and features*	*Year-round air conditioning systems*
S-11	SLO-1	*Concept of Reheat in Brayton cycle*	*Chemical Equilibrium*	*Problems on Heat balance sheet*	*Reciprocating compressors and rotary compressors - comparison*	*Heat load and simple calculations*
	SLO-2	*Concept of Regeneration in Brayton cycle*	*Chemical equilibrium calculations*	*Problems on Heat balance sheet*	*Reciprocating compressors and rotary compressors - comparison*	*Heat load and simple calculations*
S-12	SLO-1	*Tutorials on power developed*	*Tutorial Problems on Adiabatic flame temperature for various fuels*	*Engine performance curves: Constant speed engines*	*Tutorial: Numerical problems on multi stage compression*	*Tutorial: Numerical problems on psychrometric processes*
	SLO-2	*Tutorials on power developed*	*Tutorial Problems on Adiabatic flame temperature for various fuels*	*Engine performance curves: Variable speed engines*	*Tutorial: Numerical problems on multi stage compression*	*Tutorial: Numerical problems on psychrometric processes*

Learning Resources	*1. Mahesh Rathore , Thermal Engineering, Tata McGraw Hill, 2012* *2. Eastop T. D., Mcconkey. A, Applied Thermodynamics for Engineering Technologists, 5th ed., Pearson Edition, 2009* *3. Kenneth A Kroos, Merle C. Potter, Thermodynamics for Engineers, Cengage learning, 2016*	*4. Rajput.R. K, Thermal Engineering, 10th ed., Laxmi Publications, 2015* *5. Yunus A Cengel, Michael A Boles, Thermodynamics: An Engineering Approach,8th ed., Tata McGraw Hill, 2015*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.R.Kalimuthu, ISRO, Mahendragiri, r_kalimuthu@vssc.gov.in	*1. Dr. R Velraj, IES, CEG, Anna University, Chennai, velrajr@annauniv.edu*	*1. Mr. G. Manikandaraja, SRMIST*
2. Dr.A.Velayutham, DRDO, Avadi, velayudham.a@cvrde.drdo.in	*2. Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	*2. Dr. G. Kasiraman,SRMIST*

Course Code	18MEC108T	Course Name	MATERIALS TECHNOLOGY	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	18MEC111L	Progressive Courses	Nil
Course Offering Department	Mechanical Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Acquire knowledge about solidification of metals, phase diagrams and salient features of iron-carbon system
CLR-2 :	Apply mechanism of plastic deformation, strengthening mechanisms, heat treatment and surface hardening processes
CLR-3 :	Utilize the mechanical behavior of materials and learn about failure analysis
CLR-4 :	Identify about structure, properties and applications of ferrous and non-ferrous materials
CLR-5 :	Acquire knowledge about properties and applications of advanced engineering materials
CLR-6 :	Utilize knowledge about mechanical behavior, phase diagrams, structure, properties of materials and their applications

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO - 3
CLO-1 :	Interpret phase diagrams and correlate structure property relationships	2	90	85	H	-	-	-	M	-	-	-	-	-	-	-	-	-	
CLO-2 :	Identify strengthening mechanism, effect of heat treatment and surface hardening on the properties of materials	3	90	85	H	-	-	-	M	-	-	-	-	-	-	-	-	-	-
CLO-3 :	Analyze failure of engineering materials	2	90	85	H	H	-	M	M	-	-	-	-	-	-	-	-	M	-
CLO-4 :	Select ferrous and non-ferrous alloys for various engineering applications	3	90	85	H	-	-	-	-	-	L	-	-	-	-	L	-	-	-
CLO-5 :	Apply advanced materials for specific applications based on their properties	2	90	85	H	-	-	-	-	-	M	M	-	-	-	-	-	-	L
CLO-6 :	Interpret phase diagrams, analyze mechanical behavior of materials, select materials for various engineering applications	3	90	85	H	H	-	M	M		M	M	-	-	-	L	-	M	L

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Crystal structures	Deformation by slip	Introduction to fracture	Properties of plain carbon steel	Introduction to Smart materials
	SLO-2	Imperfection in solids: Point, line	Slip systems, critically resolved shear stress	Types of fracture in metals	Properties of tool steel and stainless steel	Types of Smart materials
S-2	SLO-1	interfacial and volume defects Solidification	Shear strength of perfect and real crystals,	Stress-strain behavior of metals	Dual phase steels: properties	Shape memory alloys
	SLO-2	Nucleation and Growth	Concept of work hardening, Stages of work hardening	ceramics and polymers; True stress – true strain	Dual phase steels: processing, composition and applications	Properties of Nickel based and other superalloys
S-3	SLO-1	Dendritic growth	Solid solution strengthening	Hardness: Rockwell, Brinell, Vickers hardness	Brief introduction on High Strength Low Alloy (HSLA) steel	Classes of polymers
	SLO-2	Segregation and Homogenization	Grain boundary strengthening, Hall-Petch relation	Impact test: Charpy and Izod	effects of microalloying elements	Properties and applications of PE, PP, PS, PVC, Teflon
S-4	SLO-1	Introduction to Solid solutions	Dispersion strengthening: Precipitation	Griffith's theory of brittle fracture	Transformation induced plasticity (TRIP) steel, its properties and applications	Classes of ceramics
	SLO-2	Types and factors governing substitutional solubility based on Hume Rothery's rules	Particulates and Fibers	Griffith equation	Twinning induced plasticity (TWIP) steel, its properties and applications	Properties and applications of Al2O3, ZrO2, SiC, Si3N4, AlN
S-5	SLO-1	Introduction to Phase diagrams	Non-equilibrium phases	Stress intensity factor	Properties of cast irons: grey, white,	Types and classification of composite materials
	SLO-2	Phase rules and its application	Martensite, Bainite	Fracture toughness, Ductile to brittle transition	Properties of cast irons: malleable and spheroidal cast irons	Reinforcement and matrix material, Rule of Mixture
S-6	SLO-1	Interpretation of phase diagrams	Introduction to TTT	Introduction to Fatigue, S-N curve	Copper and copper alloys with their applications	Properties of MMC, CMC and PMC
	SLO-2	Interpretation of phase diagrams	CCT diagrams, and their importance	Low and high cycle fatigue test	Copper, Brass, Bronze, Cupronickel, Muntz metal, Gun metal	Applications of MMC, CMC and PMC

S-7	SLO-1	*Classification of phase diagram*	*Heat treatment processes: Annealing, Normalizing,*	*Stages of fatigue*	*Classification and properties of Aluminium alloys*	*Nanocrystalline materials, Classification based on dimension with examples,*
	SLO-2	*Classification of phase diagram*	*Tempering, Quenching*	*High temperature fracture, Creep curve*	*Age hardening, Different alloy series*	*CNT, graphene and their applications*
S-8	SLO-1	*Iron Iron-carbide phase diagram*	*Case hardening: carburizing,*	*Failure analysis: sources of failure*	*Magnesium alloys – advantages and problems*	*Biomaterials - applications, Types - metals, ceramics*
	SLO-2	*Iron Iron-carbide phase diagram*	*nitriding, cyaniding, carbo-nitriding*	*Procedure of failure analysis*	*Magnesium alloys – Types and designations*	*polymers and composites, Biocompatibility*
S-9	SLO-1	*Microstructural aspects and invariant reactions in Fe-C diagram*	*Flame and induction hardening*	*Introduction to Non-Destructive Testing (NDT)*	*Titanium alloys - α, β and α+β alloys*	*Introduction to structure and characterization of materials*
	SLO-2	*Microstructural aspects and invariant reactions in Fe-C diagram*	*Effect of hardening processes on hardness and microstructure*	*Liquid penetrant testing, Magnetic particle testing*	*Types of alloying additions, Properties and applications*	*XRD, SEM and TEM*

Learning Resources

1. *Flake.C Campbell, Elements of Metallurgy and Engineering Alloys, ASM International, 2008*
2. *Dieter.G.E, Mechanical Metallurgy, McGraw Hill, Singapore, 2001*
3. *Thomas H. Courtney, Mechanical Behaviour of Engineering materials, McGraw Hill, Singapore, 2000*
4. *Flinn.R.A , Trojan.P.K, Engineering Materials and their applications, Jaico, Bombay, 1995*
5. *Budinski.K.G, Budinski.M.K, Engineering Materials Properties and selection, Prentice Hall of India, 2004*
6. *ASM Metals Hand book, Failure analysis and prevention, Vol: 10, 14th ed., New York, 2002*
7. *Reza Abbaschian, Lara Abbaschian& Robert E. Reed-Hill, Principles of Physical Metallurgy, Cengage Learning, 2010*
8. *Michelle Addington and Daniel Schodek, "Smart Materials and New Technologies", Elsevier print, 2005*
9. *George S. Brady, Henry R. Clauser, JhonA.Vaccari, Materials Science Hand Book, McGraw-Hill, 2002*
10. *Sidney H Avnar, Introduction to physical metallurgy, 2nd ed., Tata McGraw-Hill, 1997*
11. *William D. Callister, David G. Rethwisch, Materials Science and Engineering: An Introduction,8th ed., Wiley publication, 2009*
12. *Donald R. Askeland, Wendelin J. Wright, Science and Engineering of Materials, 7th ed., Cengage Learning, 2011*
13. *Donald R. Askeland, Wendelin J. Wright, Essentials of Materials Science & Engineering, 3rd ed., Cengage, 2013*
14. *Raghavan V. Physical Metallurgy: Principles and Practice, Prentice Hall of India, 2012*
15. *Polmear I. Light Alloys: From Traditional Alloys to Nanocrystals, Butterworth-Heinemann, UK, 2005*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember / Understand	30 %	-	30 %	-	30 %	-	30 %	-	30%	-
Level 2	Apply / Analyze	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
Level 3	Evaluate / Create	30 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. R. Kalimuthu, ISRO, Mahendragiri, r_kalimuthu@vssc.gov.in, rkpearls@yahoo.com	*1. Dr. P. Hariharan, Anna University,* hari@annauniv.edu, *hariharan2311@gmail.com*	*Dr. ShubhabrataDatta, SRMIST*
2. Dr. A. Velayutham, DRDO, Avadi, velayudham.a@cvrde.drdo.in	*2. Dr. N. Arunachalam, IIT Madras, chalam@iitm.ac.in*	*Mr. D. Selwyn Jebadurai, SRMIST*

Course Code	18MEC109L	Course Name	STRENGTH OF MATERIALS LABORATORY	Course Category	C	Professional Core	L	T	P	C
							0	0	2	1

Pre-requisite Courses	Nil	Co-requisite Courses	18MEC206T	Progressive Courses	Nil
Course Offering Department	*Mechanical Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Identify the procedures for conducting various destructive tests*
CLR-2 :	*Identify the concept of hardness and influence of heat treatment*
CLR-3 :	*Utilize mechanical properties of various materials under different loading*
CLR-4 :	*Utilize behavior of materials under cyclic loading*
CLR-5 :	*Identify the aspects of testing the strength of various materials under different loading conditions*
CLR-6 :	*Utilize destructive tests to determine strength of materials under externally applied loads*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO - 3
CLO-1 :	*Identify the procedures for conducting various destructive testing methods like impact, compression test*	3	80	85	H	H	M	M	H	-	-	-	H	-	-	-	-	-	-
CLO-2 :	*Identify to measure hardness of materials and to interpret the same after heat treatment*	3	80	85	H	H	M	M	M	-	-	-	H	-	-	-	-	-	-
CLO-3 :	*Determine the Young's modulus using deflection test on beams and tensile test on rods & springs*	3	80	85	H	H	M	M	H	-	-	-	H	-	-	-	-	-	-
CLO-4 :	*Compare the fatigue behavior of a notched and un-notched specimen*	3	80	85	H	H	M	M	M	-	-	-	H	-	-	-	-	-	-
CLO-5 :	*Identify the aspects of testing the strength of various materials under different loading conditions*	3	80	85	H	H	M	M	M	-	-	-	H	-	-	-	-	-	-
CLO-6 :	*Conduct destructive tests to determine strength of materials under externally applied loads*	3	80	85	H	H	M	M	M	-	-	-	H	-	-	-	-	-	-

Duration (hour)		6	6	6	6	6
S-1	SLO-1 SLO-2	*Tensile test on Mild steel rod*	*Test on open coil springs*	*Torsion test on Graded steels*	*Double shear test on metallic materials*	*Bend test of metallic rods*
S-2	SLO-1 SLO-2	*Tensile test on Mild steel rod*	*Test on closed coil Helical springs*	*Torsion test on Graded steels*	*Double shear test on metallic materials*	*Bend test of metallic rods*
S-3	SLO-1 SLO-2	*Compression test of Concrete cubes*	*Izod impact test*	*Deflection test on beams of different materials*	*Rockwell & Brinell hardness test of metallic materials*	*Fatigue testing of materials under notched conditions*
S-4	SLO-1 SLO-2	*Compression test of Cylinders*	*charpy impact test*	*Deflection test on beams of different materials*	*Rockwell & Brinell hardness test of metallic materials*	*Fatigue testing of materials under un-notched conditions*
S-5	SLO-1 SLO-2	*Comparison of mechanical properties of Unhardened specimen*	*Strain measurement on rods using rosette strain gauge*	*Measurement of pressure on thin walled cylinders using strain gauge.*	*Buckling analysis of struts*	*Study on photo elasticity*
S-6	SLO-1 SLO-2	*Comparison of mechanical properties of Quenched and tempered specimen*	*Strain measurement on beams using rosette strain gauge*	*Measurement of pressure on thin walled cylinders using strain gauge.*	*Buckling analysis of struts*	*Study on photo elasticity*

Learning Resources	1. *Ferdinand Beer, E. Russell Johnston, Jr., John DeWolf, David Mazurek, Mechanics of Materials, 7th ed., McGraw - Hill, 2013*	2. *Kazimi S. M. A, Solid Mechanics, 2nd ed.,Tata McGraw Hill, 2001* 3. *Laboratory Manual*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	-	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*
Level 2	Apply Analyze	-	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*
Level 3	Evaluate Create	-	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. R. Kalimuthu, ISRO, Mahendragiri, r_kalimuthu@vssc.gov.in, rkpearls@yahoo.com	*1.Dr. Shankar Krishnapillai, IIT Madras, skris@iitm.ac.in*	*1. Dr. P. Nandakumar, SRMIST*
2. Dr. A. Velayutham, DRDO, Avadi, velayudham.a@cvrde.drdo.in	*2.Dr. K. Jayabal, IIITDM, Kancheepuram, jayabal@iiitdm.ac.in*	*2. Mr. A. Vinoth, SRMIST*

Course Code	18MEC110L	Course Name	HEAT POWER LABORATORY	Course Category	C	Professional Core	L	T	P	C
							0	0	2	1

Pre-requisite Courses	*Nil*	Co-requisite Courses	*18MEC107T*	Progressive Courses	
Course Offering Department	*Mechanical Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Analyze components and functions of IC Engines*
CLR-2 :	*Utilize the properties of lubricants and fuels*
CLR-3 :	*Analyze performance and heat balance test on IC engines*
CLR-4 :	*Utilize Morse, retardation and emissions test*
CLR-5 :	*Analyze performance test on steam power plant and air compressor*
CLR-6 :	*Utilize operations and performance of Internal combustion engines, air compressors and steam power plant*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO - 3
CLO-1 :	*Identify the components and functions of IC Engines*	2	95	85	H	M	-	M	-	-	-	-	H	-	-	-	H	-	-
CLO-2 :	*Analyze the properties of lubricants and fuels*	2	95	85	H	H	-	L	-	-	-	-	H	-	-	-	-	L	-
CLO-3 :	*Conduct performance and heat balance test on IC engines*	2	95	85	H	H	M	L	M	-	-	-	H	-	-	-	-	M	-
CLO-4 :	*Conduct Morse, retardation and emissions test*	3	95	85	H	H	-	-	-	-	-	-	H	-	-	-	-	-	M
CLO-5 :	*Analyze performance test on steam power plant and air compressor*	3	95	85	H	H	-	-	-	-	-	-	H	-	-	-	-	H	H
CLO-6 :	*Analyze operations and performance of Internal combustion engines, air compressors and steam power plant*	3	95	85	H	H	M	L	-	-	-	-	H	-	-	-	H	-	-

Duration (hour)		6	6	6	6	6
S 1-2	SLO-1 / SLO-2	*Components of Internal combustion engine*	*Determine viscosity using Redwood viscometer*	*Performance test on petrol engine with electrical dynamometer*	*Heat balance test on four stroke diesel engine with calorimeter*	*Heat balance test on boiler*
S 3-4	SLO-1 / SLO-2	*Valve timing diagram of IC Engines*	*Determine viscosity using Saybolt viscometer*	*Performance test on single cylinder high speed diesel engine with Rope brakedynamometer/Morse Test*	*Heat balance test on four stroke diesel engine without calorimeter*	*Performance test on steam turbine*
S 5-6	SLO-1 / SLO-2	*Port timing diagram of IC Engines*	*Determine flash and fire point/cloud and pour point*	*Performance test on single cylinder high speed diesel engine withEddy current/hydraulic dynamometer*	*Retardation test on slow speed diesel engine/engine emission measurements*	*Performance test on two stage reciprocating air compressor*

Learning Resources	
	1. *Ganesan. V, Internal Combustion Engines, Tata McGraw-Hill, New Delhi, 2015*
	2. *Mathur.M. L, Sharma. R. P, A course in Internal Combustion Engines, DhanpatRai & Sons, 2010*
	3. *Laboratory Manual*

Learning Assessment

	Bloom's Level of Thinking	CLA – 1 (10%) Theory	CLA – 1 (10%) Practice	CLA – 2 (15%) Theory	CLA – 2 (15%) Practice	CLA – 3 (15%) Theory	CLA – 3 (15%) Practice	CLA – 4 (10%)# Theory	CLA – 4 (10%)# Practice	Final Examination (50% weightage) Theory	Final Examination (50% weightage) Practice
Level 1	Remember / Understand	-	40 %	-	30 %	-	30 %	-	30 %	-	30%
Level 2	Apply / Analyze	-	40 %	-	40 %	-	40 %	-	40 %	-	40%
Level 3	Evaluate / Create	-	20 %	-	30 %	-	30 %	-	30 %	-	30%
	Total	100 %		100 %		100 %		100 %		100 %	

Continuous Learning Assessment (50% weightage)

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. R. Kalimuthu, ISRO, Mahendragiri, r_kalimuthu@vssc.gov.in	*1. Dr. R Velraj, IES,CEG, Anna University, Chennai, velrajr@annauniv.edu*	*1.Dr. G. Balaji, SRMIST*
2. Dr. A. Velayutham, DRDO, Avadi, velayudham.a@cvrde.drdo.in	*2. Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	*2.Dr. D. Sivakrishna Reddy, SRMIST*

Course Code	18MEC111L	Course Name	MATERIALS TECHNOLOGY LABORATORY	Course Category	C	*Professional Core*	L	T	P	C
							0	0	2	1

Pre-requisite Courses	*Nil*	Co-requisite Courses	*18MEC108T*	Progressive Courses	*Nil*
Course Offering Department	*Mechanical Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Utilize the concepts and need of specimen preparation and procedures to be followed for microscopic observation*
CLR-2 :	*Identify and utilize the microstructure of various metals, alloys and its metallurgical properties*
CLR-3 :	*Utilize heat treatment process for various applications*
CLR-4 :	*Evaluate heat treatment impact on hardness and micro structural changes*
CLR-5 :	*Analyze the wear behavior and understand stress acting on a tensile specimen*
CLR-6 :	*Utilize the knowledge for identifying metals, alloys based on microstructure and analyze the effect of heat treatment*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO - 3
CLO-1 :	*Identify concepts of specimen preparation for microscopic observation*	1	95	90	H	-	-	-	H	-	-	-	H	-	-	-	L	-	-
CLO-2 :	*Identify microstructure of various metals, alloys and micro structural changes for various heat treatment processes*	1	95	90	H	-	-	M	H	-	-	-	M	-	-	-	L	-	-
CLO-3 :	*Evaluate hardness and analyze the effect of heat treatment processes*	2	95	90	H	-	-	H	H	-	-	-	M	-	-	-	H	-	H
CLO-4 :	*Analyze the effects of heat treatments and properties of GC Iron and SG Iron*	3	95	90	H	-	-	H	M	-	-	-	H	-	-	-	H	-	H
CLO-5 :	*Analyze wear behavior and understand stress acting on a tensile specimen*	2	95	85	H	H	-	H	H	-	-	-	H	-	-	-	H	-	H
CLO-6 :	*Identify metals, alloys based on microstructure, analyze effect of heat treatment on hardness and microstructural changes*	3	95	90	H	-	-	H	H	-	-	-	M	-	-	-	H	-	H

Duration (hour)		6	6	6	6	6
S 1-2	SLO-1	*Study the Mounting Process*	*Identify Alloy - Steel based alloys*	*Identify various heat treatment for MCS*	*Jomny End quenched Steel*	*Coating thickness Evaluation*
	SLO-2	*Preparing the sample for identification under microscope*				
S 3-4	SLO-1	*Identify Metal - Plain Carbon steel*	*Identify Alloy - Copper based alloys*	*Various heat treated steels like Quenched, Normalised, annealed, Tempered*	*Micro Vickers Tester*	*Analyze various stress using tensometer*
	SLO-2					
S 5-6	SLO-1	*Identify Metal - Cast iron*	*Identify Alloy -Light Metal alloys*	*Case hardened steel-Induction Hardened and Laser Hardened*	*properties of GC Iron and SG Iron*	*Wear analysis using Pin-on-disc*
	SLO-2					

Learning Resources	1. *Sidney H Avnar, Introduction to physical metallurgy, 2nd ed., Tata McGraw-Hill, 1997* 2. *Donald R. Askeland, Wendelin J. Wright, Science and Engineering of Materials, 7th ed., Cengage Learning, 2011*	3. *ASTM standards* 4. *Laboratory Manual*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	-	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*
Level 2	Apply Analyze	-	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*
Level 3	Evaluate Create	-	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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ACADEMIC CURRICULA

Professional Core Courses

MECHATRONICS ENGINEERING

Regulations - 2018

SRM
INSTITUTE OF SCIENCE & TECHNOLOGY
(Deemed to be University u/s 3 of UGC Act, 1956)

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Kancheepuram, Tamil Nadu, India

Course Code	18MHC101J	Course Name	MECHANICS OF SOLIDS AND FLUIDS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Mechatronics Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Understand the behavior of materials under load*
CLR-2 :	*Identify types of beam and understand their deflection under different types of load*
CLR-3 :	*Understand the behavior of materials under torque*
CLR-4 :	*Analyze the buckling load for columns with different support conditions.*
CLR-5 :	*Analyze the physical behavior of fluids using the concepts of continuity equation and Bernoulli's theorem.*
CLR-6 :	*Explain the basic idea of dimensional analysis*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO - 3
CLO-1 :	*Estimate the different types of stress induced in material*	3	90	85	H	H	M	-	L	-	-	-	H	-	-	-	H	-	H
CLO-2 :	*Analyze the shear force and bending moment in beam*	3	85	80	H	H	M	-	L	-	-	-	H	-	-	-	H	-	H
CLO-3 :	*Calculate torque induced in shaft*	3	90	85	H	H	M	-	L	-	-	-	H	-	-	-	H	-	H
CLO-4 :	*Analyze the buclking of column.*	3	85	80	H	H	M	-	L	-	-	-	H	-	-	-	H	-	H
CLO-5 :	*Dertermine the coefficient of discharge of different devices*	3	85	80	H	H	M	-	L	-	-	-	H	-	-	-	H	-	H
CLO-6 :	*Estimate losses in pipes*	3	85	80	H	H	M	-	L	-	-	-	H	-	-	-	H	-	H

		Stress, Strain and Deformation of Solids	Transverse Loading on Beams, Shear Force and Bending Moment	Torsion and Columns	Fluid Flow Concepts and Dynamics of Fluids	Dimensional Analysis and Flow through Pipes
Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Concept of stress-strain and its types, Hooke's law, modulus of elasticity*	*Types of beams and loadings, shear force and bending moments*	*Theory of torsion*	*Introduction to Fluids Mechanics*	*Introduction of Dimensions and units*
	SLO-2	*Factor of safety, Poisson's ratio, elastic constants and their relationship*	*Sign convention for shear force and bending moments*	*Derive torsional equation*	*Properties of fluid*	*Concepts of dimensional homogeneity, Rayleigh method*
S-2	SLO-1	*Analysis of bars of uniform cross sections subjected to different loads*	*Analyze shear force, bending moment for cantilever beam with point load at free end*	*Analyze torque transmitted by a solid shaft*	*Application of fluid*	*Problems in Rayleigh method*
	SLO-2	*Analysis of bars varying cross sections subjected to different loads*	*Analyze shear force, bending moment for cantilever beam with different loads at different points*	*Problems in Analysis of torque transmitted by a solid shaft*	*Basics numerical problem in fluid properties*	*Application of Rayleigh method*
S-3	SLO-1	*Problems in Analysis of bars of uniform cross sections subjected to different loads.*	*Problems in Analysis of shear force and bending moment for cantilever beam with Uniformly Distributed Load*	*Analyze torque transmitted by a hollow shaft*	*Derivation of Continuity Equation*	*Introduction of Buckingham's Π theorem*
	SLO-2	*Problems in Analysis of bars of varying cross sections subjected to different loads*		*Problems in Analysis of torque transmitted by a hollow shaft*	*Problems in velocity and discharge of fluids in pipe using continuity equation*	*Properties of Buckingham's Π theorem*
S 4-5	SLO-1 SLO-2	*Lab 1: Tensile test on mild steel*	*Lab 4: Charpy and Izod impact test on steel specimen*	*Lab 7: Torsional test on mild steel*	*Lab 10: Determine coefficient of discharge of Orificemeter*	*Lab 13: Verify Bernoulli's theorem*
S-6	SLO-1	*Principle of superposition*	*Analyze shear force and bending moment for simply supported beam with point loads*	*Analysis of strength of varying cross sections of shafts*	*Equations of motion, derivation of Euler's equation and Bernoulli's equation*	*Numerical problems in Buckingham's Π theorem*
	SLO-2	*Problems in Principle of Superposition*	*Analysis of shear force, bending moment for simply supported beam with UDL*	*Analysis of strength of varying cross sections of shafts*	*Derive Euler's equation and Bernoulli's equation*	*Advantage and disadvantage of Rayleigh method and Buckingham's Π theorem*
S-7	SLO-1	*Analyze uniform and varying cross section of composite bar*	*Problems in cantilever beams*	*Problems in shafts with varying cross section*	*Problems in Euler's equation and Bernoulli's equation*	*Introduction of Losses in pipes*
	SLO-2	*Problems in composite bar with uniform and varying cross section*	*Problems in simply supported beams*	*Problems in shafts with varying cross section*	*Assumptions and Disadvantages of Bernoulli's equation*	*Types of losses, analysis of Minor losses in pipes*

S-8	SLO-1	*Analyze stress in composite bars due to temperature difference.*	*Analyze shear force, bending moment for overhanging beam with point loads and UDL*	*Types of columns, applications*	*Application of Bernoulli's equation*	*Problems in Minor losses*
	SLO-2	*Problems in stress in composite bars due to temperature difference*	*Analyze shear force, bending moment for overhanging beam with point loads and UDL*	*Expression for buckling load of columns with different support conditions*	*Introduction to Venturimeter*	*Problems in Minor losses*
S 9-10	SLO-1 / SLO-2	*Lab 2: Deflection test on different beams*	*Lab 5: Double shear and (or) Compression test*	*Lab 8: Fatigue test*	*Lab 11: Determine coefficient of discharge of Venturimeter*	*Lab 14: Determine Minor losses: Expansion and contraction losses in pipes*
S-11	SLO-1	*Principal plane and Principal stresses*	*Analyze maximum bending moment and point of contraflexure in overhanging beam*	*Determine buckling load for columns with different support conditions using Euler's formula*	*Derivation and assumption of Venturimeter*	*Introduction to Major losses in pipes*
	SLO-2	*Analysis of direct stresses in one plane and two mutually perpendicular planes*	*Analysis of maximum bending moment and point of contraflexure in overhanging beam*	*Determine buckling load for columns with different support conditions using Euler's formula*	*Problems in Venturimeter*	*Problems in Darcy Weisbach and Chezy formula*
S-12	SLO-1	*Analyze direct stresses in one plane and two mutually perpendicular planes using Mohr's circle*	*Theory and assumption of simple bending in beam*	*Problem in buckling*	*Introduction to Orifice meter*	*Analyze discharge, velocity of fluids flows through pipes in series*
	SLO-2		*Derivation of simple bending in a beam*	*Determine buckling load for columns with different support conditions using Euler's formula*	*Derivation and assumption of Orifice meter*	*Analyze discharge, velocity of fluids flows through pipes in parallel*
S-13	SLO-1	*Problems in Analysis of direct stresses in one plane and two mutually perpendicular planes*	*Numerical Problems in theory of simple bending in beam*	*Determine buckling load for columns with different support conditions using Euler's formula*	*Numerical Problems in Orificemeter*	*Construction and working principle of centrifugal pump*
	SLO-2		*Analysis of bending stress in symmetrical and unsymmetrical beam section*	*Problems in columns using Euler's formula*	*Application of Orifice meter*	*Construction and working principle of reciprocating pump*
S 14-15	SLO-1 / SLO-2	*Lab 3: Deflection test on different beams*	*Lab 6: Charpy and Izod impact test on steel specimen*	Lab 9: *Fatigue test*	*Lab 12: Determine Major losses in pipe flow*	*Lab 15: Determine Minor losses: Expansion and contraction losses in pipes*

Learning Resources	1. *Bansal. R. K, Strength of Materials, 6th ed., Lakshmi publications Pvt. Ltd., 2018* 2. *Ramamurtham S and Narayanan R, Strength of Materials, 18th ed., DhanpatRai Pvt. Ltd., 2018* 3. *Bansal. R. K, Fluid Mechanics and Hydraulic Machines, 10th ed., Laxmi publications (P) Ltd., 2018*	4. *Kumar. K. L, Engineering Fluid Mechanics, 8th ed., S. Chand and co limited, 2012* 5. *Timoshenko. S. P., Gere .M. J, Mechanics of Materials, 5th ed., Stanley Thornes (PUB) Ltd, 1999.* 6. *Strength of Material Laboratory Manual, SRMIST* 7. *Fluid Mechanics Laboratory Manual, SRMIST*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
r. Level 1	Remember / Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply / Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate / Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

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Course Code	18MHC102T	Course Name	ELECTRICAL MACHINES AND ACTUATORS	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses	18EES101J	Co-requisite Courses	18MHC104L	Progressive Courses	Nil
Course Offering Department	*Mechatronics Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-1 :	*Understand the construction and principle of operation of DC machines*																		
CLR-2 :	*Understand the construction and principle of operation of AC machines*																		
CLR-3 :	*Understand the construction and principle of operation of Special machines*																		
CLR-4 :	*Identify different Control circuits for DC and AC motors*																		
CLR-5 :	*Analyse the DC and AC machines for suitable applications*																		
CLR-6 :	*Apply the Control circuits for different applications*																		
Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Operate different types of DC machines*	3	75	70	H	H	-	-	-	L	-	-	-	-	-	M	-	-	-
CLO-2 :	*Operate different types of AC machines*	3	75	70	H	H	-	-	-	L	-	-	-	-	-	M	-	-	-
CLO-3 :	*Operate different types of Special machines*	3	75	70	H	M	-	-	-	L	-	-	-	-	-	M	-	-	-
CLO-4 :	*Analyze the control circuits for suitable actuation*	3	75	70	H	-	M	M	M	L	-	-	-	-	-	M	-	-	-
CLO-5 :	*Apply the different machines for suitable Applicatios*	3	75	70	H	-	M	M	M	L	-	-	H	-	-	M	-	-	-
CLO-6 :	*Operate, analyze and apply different machines and control circuits for suitable applications*	3	75	70	H	-	M	M	M	L	-	-	H	-	-	M	-	-	-

		DC Machines	Trandformers and Induction Motors	Synchronous and Special Machines	Thyrister for Controller for Actuators	Applications of Actuators
Duration (hour)		9	9	9	9	9
S-1	SLO-1	*DC machines: Introduction*	*Transformer: Construction*	*Synchronous motor*	*Introduction to Relays*	*Applications of actuators*
	SLO-2	*Construction*	*Principle, Types of Transformers*	*Construction*	*Fuses and Circuit Breakers*	*Different types of drives*
S-2	SLO-1	*Principle of operation*	*Emf equation*	*Synchronous motor*	*Introduction to Thyristor*	*Electric vehicles*
	SLO-2	*Types of DC machines based on construction*	*Voltage regulation*	*Principle of operation*	*Thyristor Rectifier*	*DC drive with chopper control for electric vehicle*
S-3	SLO-1	*Shunt Motor,*	*Simple problems in Transformers*	*Methods of starting Synchronous motor*	*Thyristor Choppers*	*Introduction to traction*
	SLO-2	*Series Motor, Compound motor*	*Introduction to 3-phase system*	*Difference between Induction and Synchronous motors*	*Thyristor Choppers*	*chopper controlled traction drive*
S-4	SLO-1	*Back Emf, Voltage equations*	*Three phase induction motor construction*	*Applications of Synchronous motors*	*Thyristor Inverters*	*Robotic gripper*
	SLO-2	*Torque equation, Simple Problems*	*principle of operation*	*Introduction to special machines*	*Applications of converters*	*Applications of robotic grippers*
S-5	SLO-1	*Characteristics of D.C Shunt motor, Series motor*	*Production of RMF*	*PMDC motors: Construction*	*Thyristor controller starters*	*Introduction to mems*
	SLO-2	*Speed Control Methods*	*Production of RMF*	*principle of operation*	*Electronic speed control methods for DC motors*	*Applications of mems actuators*
S-6	SLO-1	*Necessity of a starter*	*Torque-slip characteristics*	*Stepper motors: construction,*	*Thyristor speed control of DC Shunt Motor*	*Introduction to solenoids*

	SLO-2	*Types of Starters*	*Torque equation*	*principle of operation of VR, PM Stepper Motors*	*Thyristor speed control of DC Series Motor*	*Solenoid operated fuel injection systems*
S-7	SLO-1	*3 point Starters*	*Linear Induction Motors: Construction*	*Hybrid type Stepper Motors: Construction*	*Speed control of single phase Induction motor using Inverter*	*Stepper motor throttle actuators*
	SLO-2	*3 point Starters*	*Principle of operation*	*Principle of operation*	*Speed control of single phase Induction motor using Inverter*	*Stepper motor throttle actuators*
S-8	SLO-1	*4 point Starters*	*Difference between Three phase and Single Phase induction Motors*	*BLDC motors: Construction*	*Electronic Speed control of Synchronous Motor*	*Actuators for capsule filling machines*
	SLO-2	*4 point Starters*	*Difference between Three phase and Single Phase induction Motors*	*Principle of operation*	*Driver circuit for Stepper motors*	*Actuators for capsule filling machines*
S-9	SLO-1	*Braking methods- Dynamic and plugging*	*Introduction to Single Phase induction Motors*	*Servo Motors: Types, Construction*	*Unipolar drive for Variable reluctance*	*Actuators for Labelling Machines*
	SLO-2	*Regenerative braking*	*Principle and operation of single phase induction motor*	*Principle of operation*	*Bipolar drive for Permanent Magnet and Hybrid motors*	*Actuators for Labelling Machines*

Learning Resources	1. *B. L Theraja, A. K. Theraja, A text book of electrical technology,Volume II, S.Chand Publications, 2008* 2. *S. K. Bhattacharya,S.Chatterjee,industrial Electronics and control, TTTI, Chandigarh*	3. *Gopal K.Dubey, Fundamentals of Electrical drives,Narosa publications 2014*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

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2. Dr. S. Janardhanam, CAPGEMINI.	*2. Dr. K. Sujatha, Dr. MGR Educational and Research Institute, drksujatha23@gmail.com*	*2. Dr. T. Muthuramalingam, SRMIST*

Course Code	18MHC103T	Course Name	SOLID STATE DEVICES AND CIRCUITS	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*18EES101J*	Co-requisite Courses	*18MHC104L*	Progressive Courses	*18MHC108L*
Course Offering Department	*Mechatronics Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Utilize the characteristics of semiconductor devices*
CLR-2 :	*Identify the different amplifier using 'h parameter and equivalent circuit'*
CLR-3 :	*Build the various concepts of feedback and oscillators and multi vibrators*
CLR-4 :	*Utilize the various rectifier and regulator circuits*
CLR-5 :	*Identify the different power supply circuits*
CLR-6 :	*Gain knowledge on operational amplifiers and its basic applications*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO - 3
CLO-1 :	*Describe band theory of solids with special reference to semi-conductors.*	2	75	70	H	M	M	H	M	L	M	L	M	M	-	H	H	H	H
CLO-2 :	*Design Amplifier using 'h' Parameters and Equivalent Circuits*	3	75	70	H	M	M	H	M	L	M	-	M	M	L	H	H	H	H
CLO-3 :	*Illustrate the various concepts of feedback and oscillators and multi vibrators*	3	75	70	H	M	M	M	L	L	M	L	M	M	L	H	-	-	-
CLO-4 :	*Design various Rectifier and Regulator circuits*	3	75	70	H	M	M	-	L	L	M	L	-	M	L	H	H	H	H
CLO-5 :	*Evaluate the performance of Power Supply Circuits.*	3	75	70	H	M	M	H	L	-	M	L	M	M	L	H	-	-	-
CLO-6 :	*Gain knowledge on operational amplifiers and its basic applications*	3	75	70	H	M	-	H	M	L	M	L	M	M	L	H	H	H	H

		Special Semiconductor Devices	Amplifier	Feedback Circuits	Switching Circuits and Power Supplies	Operational Amplifiers
Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Semiconductor devices: Introduction*	*Introduction to amplifiers. Transistor as an amplifier, FET as an amplifier*	*Basic concepts of feedback*	*Basic about Switching action of transistor*	*Introduction to Operational amplifier*
	SLO-2	*Classification of semiconductor devices*	*Types of Biasing*	*Types-Positive and negative feedback*	*Concept of Switching action of transistor*	*Ideal characteristics of op-amp*
S-2	SLO-1	*Characteristics of Zener diode*	*Self- biasing of transistor*	*Principle of feedback in amplifiers*	*Introduction of astable multivibrator*	*Internal block diagram of op-amp*
	SLO-2	*Application of Zener diode*	*Fixed biasing, Voltage divider biasing*	*Principle of feedback in oscillators*	*Working principle of astable multivibrator*	*Slew rate of op-amp*
S-3	SLO-1	*Working principle, characteristics Schottky, diode PIN and Shockley diode*	*Small signal model of BJT*	*Voltage series network*	*Introduction of monostable multivibrator*	*Introduction about DC characteristics of op- amp*
	SLO-2	*Applications of Schottky, diode PIN and Shockley diode*	*Two port network of BJT*	*Voltage shunt network*	*Working of monostable multivibrator*	*Concept of DC characteristics op- amp*
S-4	SLO-1	*Working principle, characteristics Tunnel diode*	*Hybrid parameter for BJT*	*Current series network*	*Introduction of bistable multivibrator*	*Introduction about AC characteristics of op-amp*
	SLO-2	*Applications of Tunnel diode and varactor diode*	*h- parameter model for CE, CB and CC configuration*	*Current shunt network*	*Working of bistable multivibrator*	*Concept of AC characteristics op- amp*
S-5	SLO-1	*Working principle, characteristics Tunnel diode and varactor diode*	*h- parameter model for CE configuration and analysis for CE configuration*	*LC oscillator: Hartley oscillator - working principle*	*Circuit diagram of Schmitt trigger*	*Introduction of differential amplifier*
	SLO-2	*Applications of Tunnel diode and varactor diode*	*Analysis for CE configuration*	*Hartley oscillator -derivation for the frequency of oscillation*	*Working of Schmitt trigger*	*Types of differential amplifier*
S-6	SLO-1	*Working principle, characteristics of thyristor: UJT*	*Power amplifiers: Class A working principle*	*Colpitt's oscillator - working principle*	*Introduction to Rectifiers and its types*	*Inverting buffer amplifier*
	SLO-2	*Applications of Thyristor: UJT*	*Class A derivation for the efficiency*	*Colpitt's oscillator - derivation for the frequency of oscillation*	*Regulators and its types*	*Non-inverting buffer amplifier*

S-7	SLO-1	*Working principle, characteristics of thyristor: SCR*	*Class B working principle*	*Clap oscillator - working principle*	*Circuit diagram and working of Series regulator*	*Basic applications: Inverting Summing amplifier*
	SLO-2	*Applications of thyristor: SCR*	*Class B derivation for the efficiency*	*Clap oscillator - derivation for the frequency of oscillation*	*Circuit diagram and working of Shunt regulator*	*Non-Inverting Summing amplifier*
S-8	SLO-1	*Working principle, characteristics of DIAC*	*Class AB, Class C working principle*	*RC oscillator: RC Phase shift oscillator - working*	*Block diagram of SMPS*	*Subtractor*
	SLO-2	*Applications of DIAC*	*Class AB, Class C derivation for the efficiency*	*RC Phase shift oscillator - derivation for the frequency of oscillation*	*Working principle of SMPS*	*V-I and I-V converter*
S-9	SLO-1	*Working principle, characteristics of TRIAC*	*Tuned amplifiers*	*Wien bridge oscillator - working*	*Block diagram of UPS*	*Introduction and basic concept of Comparator*
	SLO-2	*Applications of TRIAC*	*Types of Tuned amplifiers*	*Wien bridge oscillator - derivation for the frequency of oscillation*	*Working principle of UPS*	*Application of Comparator*

Learning Resources	1. *David A Bell, Electronic devices and circuits, Oxford Publication., 2008* 2. *Robert Boylestad and Louis Nashelsky, Electronic devices and circuit theory, 7th ed., Prentice Hall., 2005* 3. *Roy Choudhury, Shail B. Jain, Linear integrated circuits, New Age International publishers, 2010*	4. *J. B. Gupta, Electronic devices and Circuits, Sanjay Kumar Kattaria Publication, 2010* 5. *Milman., Halkias. C, Electronic devices and circuits, Tata McGraw Hill publications, 2001*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.S.AnandaKumar, Deputy Chief Engineer, Control and Instrumentation, TPS-2, NLC India Limited, sith.anandkumar@gmail.com	*1. Dr. B. Chittibabu, IIITDM, Kanchipuram, bcbabu@iiitdm.ac.in*	*1. Mrs. V. Krithika, SRMIST*
2.Mrs.T.Priya, Kavin Engineering and Services Private Limited, priya@kavinengg.com	*2. Dr. P. Karthikeyan, MIT campus, Anna university, pkarthikeyan@annauniv.edu*	*2. Mr. K. Sridharan, SRMIST*

Course Code	18MHC104L	Course Name	ELECTRICAL AND ELECTRONICS LABORATORY	Course Category	C	Professional Core	L	T	P	C
							0	0	4	2

Pre-requisite Courses	18EES101J	Co-requisite Courses	18MHC102T	Progressive Courses	Nil
Course Offering Department	Mechatronics Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Design the circuits using discrete components.
CLR-2 :	Understand the basic concepts of integrated circuits and design circuits
CLR-3 :	Understand the basic concepts and operation of DC machines
CLR-4 :	Understand the basic concepts and operation of AC machines
CLR-5 :	Improve their ability in selecting components for particular application
CLR-6 :	Utilize characteristics of semiconductor devices, amplifiers, multivibrator and operational amplifiers and electrical drives

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO - 3
CLO-1 :	Implement the functionality of the circuits using discrete components	2	85	80	H	-	-	-	H	-	H	-	H	H	-	-	-	-	-
CLO-2 :	Develop knowledge on basic concepts of integrated circuits and design circuits	3	85	80	H	-	-	H	H	-	H	-	H	H	-	-	-	-	-
CLO-3 :	Apply the knowledge on basic concepts in operating DC and AC machines	3	85	80	H	-	-	-	H	-	H	-	H	H	-	-	-	-	-
CLO-4 :	Analyse the Performance Characteristics of DC and AC and Special machines	2	85	85	H	-	-	H	H	-	-	-	H	H	-	-	-	-	-
CLO-5 :	Apply the knowledge in selecting components for particular application	2	85	85	H	-	-	-	-	-	H	-	H	H	-	-	-	-	-
CLO-6 :	Apply characteristics of semiconductor devices, amplifiers, multivibrator and operational amplifiers and electrical drives	3	85	80	H	-	-	-	-	-	-	-	H	H	-	-	-	-	-

Duration (hour)		12	12	12	12	12
S 1-4	SLO-1	Characteristics of PN and Zener diode	Rectifiers without filter: Half wave, full wave and bridge	Load Test on DC Shunt Motor	Load Test on Single Phase Transformer	Speed Control of Stepper Motor
	SLO-2					
S 5-8	SLO-1	Characteristics of transistor: BJT, UJT	Rectifiers with filter: Half wave, full wave and bridge	Load Test on DC Series Motor	Load Test on Single Phase Induction Motor	Characteristics of servo Motor
	SLO-2					
S 9-12	SLO-1	Design of oscillator and multivibrator circuits	Op Amp: Non-inverting, inverting and buffer amplifier	Speed Control of DC Shunt Motor	Load Test on Three Phase Induction Motor	Interpretation of technical data sheet
	SLO-2					

Learning Resources	1. Electronics laboratory manual	2. Electrical laboratory manual

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	-	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*
Level 2	Apply Analyze	-	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*
Level 3	Evaluate Create	-	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. N. Gunavardhini, TANGEDCO, Salem, gunatneb1990@gmail.com	*1. Dr.S. S Dash, Government College of Engineering Kednhhar, Orisha, munu_dash_2k@yahoo.com*	*1. Dr. M. Santhosh Rani, SRMIST*
2. Dr. S. Janardhanam, CAPGEMINI	*2. Dr. K. Sujatha, Dr. MGR Educational and Research Institute, drksujatha23@gmail.com*	*2. Dr. T. Muthuramalingam, SRMIST*

Course Code	18MHC105J	Course Name	FLUID POWER SYSTEM AND AUTOMATION	Course Category	C	*Professional Core*	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Mechatronics Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Utilize fundamental knowledge on fluid power, working of pneumatic and electro-pneumatic system components*
CLR-2 :	*Utilize working principles of pneumatic and electro-pneumatic components; design and develop fluid power circuits*
CLR-3 :	*Design, develop fluid power circuits for various applications, utilize working of hydraulic systems components*
CLR-4 :	*Utilize working principle of various hydraulics application circuits.*
CLR-5 :	*Utilize programmable logic controllers and PLC programming for fluid power system control.*
CLR-6 :	*Utilize fluid power system components and design and control fluid power circuits for automation applications*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO - 3
CLO-1 :	*Recognize the use of fluid power systems, and identify various pneumatic and electro-pneumatic components*	2	80	75	H	L	L	L	M	L	-	-	-	-	-	L	L	M	L
CLO-2 :	*Identify various pneumatic and electro-pneumatic components and design fluid power circuit for a given application*	3	80	75	H	H	H	H	M	L	-	-	M	-	M	M	M	M	M
CLO-3 :	*Design fluid power circuit for a given application and understand the working of various hydraulic components.*	3	75	70	H	H	H	H	M	L	L	-	M	-	M	M	M	M	M
CLO-4 :	*Apply hydraulic components, diagnose faults and precautions to be followed in fluid power systems.*	3	75	70	H	M	M	M	M	L	L	-	-	-	M	L	L	M	M
CLO-5 :	*Establish programming control using PLC for fluid power systems.*	3	75	70	H	H	M	M	M	L	-	-	M	-	M	M	M	M	H
CLO-6 :	*Design, develop and control fluid power systems for various applications.*	3	75	70	H	H	M	M	M	L	L	-	M	-	M	M	M	M	M

		Introduction to Pneumatics and Electro-pneumatics	**Pneumatics and Electro-Pneumatics Components, Design of Circuits**	**Design of Circuits Intoductions to Hydraulics**	**Hydraulics and Electrohydraulic components and circuits**	**Programmable Logic Controllers**
Duration (hour)		**15**	**15**	**15**	**15**	**15**
S-1	SLO-1	*Introduction to Fluid Power System, Physics of Fluid Power System*	*Flow Control Valves and their functions*	*Cascading Electro-Pneumatic Circuit - Two Groups in Two Cylinder Sequential Control*	*Synchronization Circuits*	*Introduction to Programmable Logic Controllers (PLC)*
	SLO-2	*Advantages, Applications, Comparison of Pneumatic and Hydraulic Systems*	*Simple and Pressure Compensated Flow Control Valve*	*Cascading Electro-Pneumatic Circuit - Two Groups, Three-Cylinder Sequential-Control*	*Conditions for Synchronization*	*Advantages and Applications of PLC*
S-2	SLO-1	*Introduction to Pneumatic Components, Rotary Compressor - Construction and Principle of Operation*	*Non – Return Valves: Check Valve, Pilot Operated Check Valve*	*Cascading Pneumatic Circuit: Three Groups, Three-Cylinder Sequential Control*	*Hydraulic Accessories- Filters, Seals*	*Parts of PLC*
	SLO-2	*Reciprocating Compressors -Construction and Principle of Operation*	*Speed Control Circuits*	*Cascading Pneumatic Circuit: Three Groups, Three-Cylinder Sequential Control*	*Simple Pressure Relief Valve and Compound Pressure Relief Valve*	*Operation of PLC, Architecture of PLC*
S-3	SLO-1	*Air Treatment, Air Dryer*	*Logical Valves – Dual Pressure Valve, Shuttle Valve*	*Cascading Electro-Pneumatic Circuit - Three Groups, Three Cylinder Sequential Control*	*Sequence valve with application circuit*	*Introduction to PLC Programming Techniques*
	SLO-2	*FRL – Filter, Regulator and Lubricator*	*Pnuematic circuits using logical valves*	*Cascading Electro-Pneumatic Circuit - Three Groups, Three Cylinder Sequential Control*	*Pressure reducing valve with applicaton circuit*	*Introduction to ladder logic programming*
S 4-5	SLO-1 SLO-2	*Lab 1: Introduction to Symbolic Representation of Pneumatic Components*	*Lab 4: Speed Control Circuits*	*Lab 7: Pneumatic, Electro-pneumatic Implementation of Two Cylinder Cascading Circuit*	*Lab 10: Timer and Counter Based Electro-Pneumatic Control Circuits*	*Lab 13: Introduction to PLC and Ladder Logic Programming Software*
S-6	SLO-1	*Pneumatic Actuators, Linear, Rotary and Semi Rotary Type*	*Quick Exhaust Valve, Time Delay Valve*	*Timer Based Control of Pneumatic Cylinder*	*Pressure unloading and counter balance valve*	*Ladder Logic Program -Implementation of Logic Gates*
	SLO-2	*Cushioning in Cylinders*	*Pneumatic Circuits using Quick Exhaust Valve, Time Delay Valve*	*Counter Based Control of Pneumatic Cylinder*	*Pressure unloading and counter balance application circuit*	*Ladder Logic Program -Implementation of Start/Stop Operation and Latching*

S-7	SLO-1	*Special Cylinders*	*Introduction to Sequential Control*	*Discussion on Different Pneumatic and Electro-pneumatic Circuit Implementation*	*Accumulators – Working Principle and Types*	*Ladder Logic Program – Continuous Reciprocation Circuits*
	SLO-2	*2/2, 3/2, 5/2, 5/3 Direction Control Valves-Construction and Principle of Operation*	*Pneumatic Circuit - Two and Three Cylinder Sequential Control*	*Selection of Pneumatic Components*	*Application Circuits of Accumulator*	*Ladder Logic Program – Sequential Circuit Implementation*
S-8	SLO-1	*Direct and Indirect Control of Single Acting Cylinder*	*Electro-pneumatic Circuit - Two Cylinder Sequential Control*	*Introduction to Hydraulic Components*	*Proportional Valve – Working Principle and Control*	*Ladder Logic Program – Sequential Circuit Implementation*
	SLO-2	*Direct and Indirect Control of Double Acting Cylinder*	*Electro-pneumatic Circuit - Two Cylinder Sequential Control*	*Fluids for Hydraulic Systems*	*Force and Torque Proportional Control*	*Ladder Logic Program – Pneumatic Application*
S 9-10	SLO-1 SLO-2	*Lab 2: Direct and Indirect Control of Single acting and Double acting Cylinder*	*Lab 5: Pneumatic Implementation of Two Cylinder Sequential Control Circuit*	*Lab 8: Pneumatic Implementation of Three Cylinder Cascading Circuit*	*Lab 11: Hydraulic Synchronization Circuits*	*Lab 14: Developing PLC Program for Sequential Control of Pneumatic Cylinder*
S-11	SLO-1	*Introduction to Electro-pneumatics*	*Electro-pneumatic Circuit - Three Cylinder Sequential Control*	*Gear Pumps*	*Servo Valve – Working Principle and Types*	*Interlocks in PLC*
	SLO-2	*Electro-pneumatic Components – Electrical Switches and Solenoid*	*Electro-pneumatic Circuit - Three Cylinder Sequential Control*	*Vane Pumps*	*Flapper Type, Jet Pipe, Electro Hydraulic Servo Valves*	*Ladder Logic Program – Interlocking*
S-12	SLO-1	*Construction and Working Principle of Relays*	*Circuits with Overlapping Signals*	*Piston Pumps*	*Design, Selection of Components of Hydraulic Press, Hydraulic Machine Tools*	*Timers in PLC*
	SLO-2	*Timers and Counters*	*Steps to Solve Signal Overlapping Problem using Cascading Technique*	*Pump Performance, Characteristics and Selection*	*Design and Selection of Components of Articulated Mechanisms*	*Counters in PLC*
S-13	SLO-1	*Continuous Reciprocation of Single acting and Double Acting Cylinder – Pneumatic Implementation*	*Cascading Pneumatic Circuit - Two Groups in Two Cylinder Sequential Control*	*Direction Control Valves 3/2, 4/2*	*Fault Diagnostics in Fluid Power Circuits*	*Ladder Logic Program – Implementation of Timer and Counter Based Applications*
	SLO-2	*Continuous Reciprocation of Single acting and Double Acting Cylinder – Electro Pneumatic Implementation*	*Cascading Pneumatic Circuit - Two Groups in Three Cylinder Sequential Control*	*4/3 DCV – Different Center Positions*	*Safety and Emergency Mandrels in Hydraulic and Pneumatic Systems*	*Summary of the Course discussion*
S 14-15	SLO-1 SLO-2	*Lab 3: Continuous Reciprocation of Single acting and Double acting Cylinder*	*Lab 6: Electro-pneumatic Implementation of Two Cylinder Sequential Control Circuit*	*Lab 9: Electro-pneumatic Implementation of Three Cylinder Cascading Circuit*	*Lab 12: Developing Automation Solution for Industrial Application using Sensors*	*Lab 15: Model Practical Examination*

Learning Resources	1. *Anthony Esposito, Fluid Power with applications, 7th ed., Prentice Hall, 2014* 2. *FESTO, Fundamentals of Pneumatics, Vol I, II, III.* 3. *Majumdar .S.R., Oil Hydraulics: Principle and Maintenance, Tata McGraw Hill Education, 2012*	4. *Andrew Parr, Hydraulics and pneumatics, Jaico Publishing House, 2006* 5. *Frank D. Petrezulla, Programmable Logic Controller, 4th ed., McGraw Hill Education, 2011* 6. *Laboratory manual for Fluid Power System and Automation, SRMIST.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (20%)		CLA – 2 (30%)		CLA – 3 (30%)		CLA – 4 (20%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
r. Level 1	Remember Understand	20%	20%	15%	15%	15%	15%	15%	15%	15%	15%
Level 2	Apply Analyze	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Level 3	Evaluate Create	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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2. Mr.Girish Joshi, Senior Manager, BoschRexroth ltd, joshi.gs@boschrexroth.co.in	*2. Dr.B.Mohan, Professor, Anna University, mohanb@mitindia.edu*	*2. Ms. G. Madhumitha SRMIST*

Course Code	18MHC106T	Course Name	KINEMATICS AND DYNAMICS OF RIGID BODIES AND MECHANISMS	Course Category	C	*Professional Core*	L	T	P	C
							3	1	0	4

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Mechatronics Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Utilize the concept of machines, mechanisms and flywheel*
CLR-2 :	*Utilize knowledge on the performance of cams, gyroscope*
CLR-3 :	*Impart knowledge on the performance of gears and gear trains*
CLR-4 :	*Explore the undesirable effects of unbalanced force in engines and its remedies*
CLR-5 :	*Utilize knowledge in vibratory systems*
CLR-6 :	*Utilize various laws governing rigid body motions, vibration characteristics and balancing of mechanical machines*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO - 3
CLO-1 :	*Comprehend the concept of machines, mechanisms and flywheel.*	1	85	80	H	L	-	H	M	-	L	L	M	-	-	-	M	-	-
CLO-2 :	*Analyze the performance of cams, gyroscope*	2	85	80	H	H	-	H	M	-	L	L	M	-	-	-	-	-	-
CLO-3 :	*Analyze the performance of gears and gear trains.*	2	85	80	H	H	-	H	M	-	L	L	M	-	-	-	-	-	-
CLO-4 :	*Utilize the knowledge of undesirable effects of unbalanced force in engines*	2	85	80	H	H	-	H	M	-	L	L	M	-	-	-	-	-	-
CLO-5 :	*Interpret and solve problems in vibratory systems and analyze the effects*	2	85	80	H	H	-	H	M	-	L	L	M	-	-	-	-	-	-
CLO-6 :	*Implement various laws governing rigid body motions, vibration characteristics and balancing of mechanical machines*	2	85	80	H	H	-	H	M	-	L	L	M	-	-	-	-	-	-

		Basic Elements of Mechanisms	**Cams and Gyroscope**	**Gears and Gear trains**	**Balancing of masses**	**Vibrations**
Duration (hour)		**12**	**12**	**12**	**12**	**12**
S-1	SLO-1	*Introduction to kinematic links, pairs, chain, machine and structure*	*Classifications of cam and follower*	*Fundamentals of toothed gearing*	*Introduction to balancing of masses*	*Introduction to Vibration*
	SLO-2	*Degrees of freedom(DOF)*	*Classifications of cam and follower*	*Types of gear*	*static and dynamic mass balancing*	*Types of vibration*
S-2	SLO-1	*Grashoff's law, Kutzback's criterion for planar mechanism*	*Construction of cam profile when the follower moves with uniform velocity and simple harmonic motion*	*Gear nomenclature*	*Balancing of several masses rotating in single plane.*	*Longitudinal, transverse vibration*
	SLO-2	*Kinematic inversions of four bar mechanism and slider crank mechanism and its kinematic inversions*				
S-3	SLO-1	*Modelling Simulation of Crank and slotter lever mechanism*	*Construction of cam profile when the follower moves with uniform acceleration and retardation*	*Law of gearing, forms of teeth*	*Balancing of several masses rotating in single plane.*	*Dunkerley's method.*
	SLO-2	*Modelling Simulation of Whitworth quick return mechanism*		*Length of path of contact*		*Critical speed of shafts*
S-4	SLO-1	*Practice 1: Problems on DOF of Planar mechanisms, crank and slotted lever mechanism*	*Practice 4: Problems on construction of cam profile profile when the follower moves with uniform velocity and simple harmonic motion*	*Practice 7: Problems on Length of path of contact*	*Practice 10: Problems on Balancing of several masses rotating in single plane.*	*Practice 13: Problems on Longitudinal, transverse vibrations*
	SLO-2					
S-5	SLO-1	*Turning moment diagram of a single cylinder engine*	*Construction of cam profile when the follower moves in cycloidal motion*	*Length of arc of contact*	*Balancing of several masses rotating in different planes.*	Viscous damping
	SLO-2			*Contact ratio, interference*		damping factor
S-6	SLO-1		*Gyroscope: Forces and couples*	*Gear trains.*	*Balancing of reciprocating masses.*	*Torsional vibrations.*

	SLO-2	*Turning moment diagram of a multi cylinder engine*		*Types of gear trains- simple gear train*		
S-7	SLO-1	*Fluctuation of energy, coefficient of fluctuation of energy*	*Effect of gyroscopic couple in aeroplanes*	*Compound gear train.*	*Balancing of single cylinder engine.*	*Single and two rotor systems*
	SLO-2			*Reverted gear train.*		
S-8	SLO-1	*Practice 2: Problems turning moment diagram for single cylinder and multi cylinder*	*Practice 5: Problems on construction of cam profile profile when the follower moves in cycloidal motion*	*Practice 8: Problems on simple, compound and reverted gear trains*	*Practice 11: Problems on Balancing of single cylinder engine*	*Practice 14: Problems on Dunkerley method and critical speed of shaft*
	SLO-2					
S-9	SLO-1	*Coefficient of Fluctuation of speed*	*Stability of a four wheel drive moving in a curved path*	*epicyclic gear train .*	*Balancing of multi cylinder inline engine.*	*Three rotor systems.*
	SLO-2					
S-10	SLO-1	*Energy stored in flywheel*	*Gyroscope: stability of two-wheel*	*Tabular method – epicyclic and reverted gear train*	*Hammer blow*	*Torsional vibrations on geared systems*
	SLO-2				*swaying couple*	
S-11	SLO-1	*Dimensions of flywheel rim.*	*Effect of gyroscopic couple in ships*	*Compound epicyclic gear train.*	*Tractive force.*	*Vibration analysis of geared systems.*
	SLO-2					
S-12	SLO-1	*Practice 3: Problems on energy stored in flywheel and flywheel rim dimensions*	*Practice 6: Problems on effect of gyroscopic couple on aeroplanes and four wheeler and two wheeler*	*Practice 9: Problems on Compound epicyclic gear train.*	*Practice 12: Problems on Balancing of multi cylinder inline engine.*	*Practice 15: Problems on two rotor system and three rotor system*
	SLO-2					

Learning Resources	1. *Ratan.S.S, Theory of Machines, 4th ed., Tata McGraw Hill, 2014* 2. *R.L. Norton, Kinematics and Dynamics of Machinery, 1st ed., Tata McGraw Hill, 2010* 3. *Sadhu singh Theory of machines, 3rd ed., Pearson, 2011* 4. *Gordon R. Pennock & Shigley J.E John J Uicker, 4th ed., Theory of machines and mechanisms, Oxford university press, 2014* 5. *R.K. Bansal, J.S. Brar, Theory of Machines, 5th ed., Lakshmi publications, 2016*	6. *Singiresu S.Rao, Mechanical Vibrations, Nem Chand and Bros, 1998* 7. *Thomas Beven, Theory of Machines, 3rd ed., CBS Publishers and Distributors, 2013* 8. *Sing.V.P, Mechanical Vibrations, Dhanpat Rai and Co., 1998* 9. *Rao.J.S., Dukkipati.R.V, Mechanism and Machine Theory, Wiley Eastern Ltd., 2006* 10. *John Hannah, Stephens.R.C, Mechanics of Machines, Viva Low Price student edition, 1999* 11. *Ghosh .A., Mallick.A.K, Theory of Mechanisms and Machines, Affiliated East - West Pvt. Ltd., 2006*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. K.Balaguru, Hindhustan Aeronautics Ltd, gurubalao7@gmail.com	*1. Dr.S. S Dash, Govt. College of Engineering Kednhhar, Orisha, munu_dash_2k@yahoo.com*	*1. Mr. J. Thiyagarajan, SRMIST*
2. Mr. M. Arun kumar Rolls-Royce India (P) Ltd., arumkumar.manickam@rolls_royce.com	*2. Dr. K. Sujatha, Dr. MGR Educational and Research Institute, drksujatha23@gmail.com*	*2.*

Course Code	18MHC107T	Course Name	SYSTEM DYNAMICS	Course Category	C	*Professional Core*	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Mechatronics Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning 1	Learning 2	Learning 3	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12	PLO 13	PLO 14	PLO 15
CLR-1 :	*Classify and manipulate the signals with systems*																		
CLR-2 :	*Understand the significance of Laplace transform in modeling and solving the LTI systems*																		
CLR-3 :	*Model all possible systems and derive their transfer functions*																		
CLR-4 :	*Determine the time domain characteristics of system and stability analysis using root locus*																		
CLR-5 :	*Obtain the frequency response and determine stability margins for linear systems*																		
CLR-6 :	*Impart the knowledge on modeling of systems with analysis and design*																		
Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Understand and identify the different types of signals and systems*	2	80	75	H	H	M	L	M	L	M	M	L	L	M	H	M	L	M
CLO-2 :	*Importance of Laplace transform in system analysis and design*	2	75	75	H	H	M	H	M	L	M	M	L	L	M	H	M	L	M
CLO-3 :	*Find the transfer function of possible systems using different methods*	2	75	75	H	H	H	H	M	L	L	M	L	L	M	H	M	L	M
CLO-4 :	*Design a system with required specifications*	3	70	70	H	H	H	H	M	L	M	M	M	L	M	H	H	L	M
CLO-5 :	*Analyze a system in frequency domain and determine the margins for stability of system*	3	70	70	H	H	H	H	M	L	M	M	M	L	M	H	H	L	M
CLO-6 :	*Identify, analyze and design of a system for the required specifications*	3	75	70	H	H	H	H	M	L	M	M	M	L	M	H	H	L	M

		Introduction to Signals and Systems	**Linear Time - Invariant Systems**	**Modeling in S-Domain**	**Time Domain Analysis and Root Locus**	**Frequency Response Analysis**
Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Introduction to Signals*	*Introduction to LTI systems*	*Transfer functions of simple mechanical systems*	*First order System and its specifications*	*Introduction to frequency response*
	SLO-2	*Representation of signals in continuous and discrete time*	*Impulse response of LTI systems*	*Transfer functions of simple mechanical systems*	*Step, ramp and impulse response analysis of first order systems*	*Frequency domain specifications*
S-2	SLO-1	*Elementary/basic Signals*	*Derivation of Convolution integral formula*	*Transfer functions of simple electrical networks*	*Second order system and its specifications*	*Correlation between time domain and frequency domain specifications*
	SLO-2	*Relationship among the elementary signals*	*Properties of convolution integral*	*Transfer functions of simple electrical networks*	*Impulse response of second order systems*	*Construction of Bode plot*
S-3	SLO-1	*Properties of signals*	*Properties of LTI system*	*Analogous systems Mechanical and electrical*	*Step response of second order systems*	*Construction of Bode plot*
	SLO-2	*Properties of signals*	*Properties of LTI system*	*Mechanical and Electrical analogous system*	*Step response of second order systems*	*Determination of gain and phase margins*
S-4	SLO-1	*Signal power and energy*	*Differential equation representation of systems*	*Transfer function of electromechanical systems*	*Transient response specifications of under damped systems*	*Problems on drawing Bode plot and determining the margins for stability*
	SLO-2	*Problems on properties of signal*	*Responses of the system in time domain*	*Transfer function of electromechanical systems*	*Time domain specifications of the under damped systems*	*Problems on drawing Bode plot and determining the margins for stability*
S-5	SLO-1	*Operations on signals*	*Solving differential equation in time domain*	*Block diagram representation of system*	*Steady state error for closed loop system*	*Determination of transfer functions from Bode Plot*
	SLO-2	*Manipulations on the dependent and independent variables*	*Solving differential equation in time domain*	*Block diagram reduction technique rules*	*Steady state error for different types and inputs of a system with generalized error coefficients*	*Determination of transfer functions from Bode Plot*
S-6	SLO-1	*Representation of Systems*	*Introduction to Laplace transformation and region of convergence*	*Problems on Block diagram reduction*	*Stability of the system with respect to the position of poles in s plane*	*Introduction and properties of Polar Plots*

	SLO-2	*Continuous and discrete time systems*	*Laplace transform of standard functions*	*Problems on Block diagram reduction*	*Stability analysis using Routh-Hurwitz criterion*	*Gain and phase margins in Polar plot*
S-7	SLO-1	*Classification and properties of system*	*Properties of Laplace transform*	*Introduction to Signal flow graphs*	*Problems on stability checking using Routh-Hurwitz criterion*	*Problems on drawing Polar plots and determining the margins*
	SLO-2	*Classification and properties of system*	*Properties of Laplace transform*	*Relationship between block diagram and signal flow graph*	*Problems on stability checking using Routh-Hurwitz criterion*	*Problems on drawing Polar plots and determining the margins*
S-8	SLO-1	*Problems on properties of system*	*Transfer function approach for dynamic system using Laplace transform*	*Determination of transfer function using*	*Introduction of Root locus and its properties*	*Nyquist stability criterion*
	SLO-2	*Problems on properties of system*	*Poles and zeros of system in 's' plane*	*Determination of transfer function using*	*Construction of Roots locus*	*Assesment of relative stability*
S-9	SLO-1	*Properties of system which contains differential equations*	*Solving differential equation using Laplace transform*	*Problems on determining the transfer function using Mason's Gain formula*	*Problems on the construction of Root locus*	*Problems on Nyquist stability criterion*
	SLO-2	*Properties of system which contains differential equations*	*Solving differential equation using Laplace transform*	*Problems on determining the transfer function using Mason's Gain formula*	*Problems on the construction of Root locus*	*Problems on Nyquist stability criterion*

Learning Resources	1. *K Ogata, System Dynamics, 3rd ed., Prentice Hall, 1998* 2. *B P Lathi, Principles of Linear Systems and Signals, 2nd ed., Oxford University Press, 2009* 3. *Alan V Oppenheim., Alan S Willsky, Ian T. Young., Signals and Systems, Prentice Hall, 1983*	4. *J Nagrath, M Gopal, Control Systems Engineering, 5th ed., New Age International, 2007* 5. *Norman S Nise, Control Systems Engineering, 7th ed., Wiley, 2015*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. K. Karthikeyan, R&D Specialist, ABB India Ltd, Bangalore, India, sayalkarthik@yahoo.co.in	*1. Dr. Dr. B. Chittibabu, IIITDM, Kanchipuram, bcbabu@iiitdm.ac.in*	*1.Dr. M. Mohamed Rabik, SRMIST*
2. Dr. Vishal P Barde, Senior Lead Engineer, Mahindra & Mahindra, Chennai, vishalbarde@gmail.com	*2. Dr. P. Karthikeyan, MIT campus, Anna university, pkarthikeyan@annauniv.edu*	*2..Mr. S. Vasanth, SRMIST*

Course Code	18MHC108J	Course Name	DIGITAL SYSTEMS AND MICROPROCESSORS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechatronics Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Perceive the fundamental Knowledge of Digital devices
CLR-2 :	Know the working principle of digital circuit for performing its function
CLR-3 :	Know the working nature of the sequential Devices
CLR-4 :	Expose the architecture and instruction set of different microprocessors
CLR-5 :	Deal with the Assembly Language program using typical instruction
CLR-6 :	Gain knowledge about different peripheral interfacing Devices

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO - 3
CLO-1 :	Understand the concept and applications of various digital circuits	1	95	90	H	M	L	L	L	-	-	-	L	-	-	L	M	-	M
CLO-2 :	Design the combinational and sequential circuits	3	90	85	H	H	M	M	M	-	-	-	M	-	M	H	M	M	L
CLO-3 :	Enlighten the architecture of microprocessors	1	85	80	H	L	-	L	M	-	-	-	-	-	L	M	M	H	M
CLO-4 :	Develop the assembly language programs	3	80	75	H	H	M	M	M	-	-	-	M	-	L	M	M	H	M
CLO-5 :	Use the processors for various applications	2	80	75	H	L	L	L	H	-	-	-	M	-	H	M	H	H	H
CLO-6 :	Use microprocessor with different peripherals	1	90	85	H	L	L	L	M	-	-	-	H	-	H	M	M	H	M

		Combinational Circuit Design	Sequential circuit Design	8085 Microprocessor	8086 Microprocessor	Peripheral Interfacing
Duration (hour)		15	15	15	15	15
S-1	SLO-1	Introduction to logic gates, Digital logic circuits, Boolean laws and Expression	Introduction to Latches and Flip-Flop,	Introduction to microprocessors	Introduction, Pin Descriptions of 8086 microprocessor	Introduction to Data transfer Schemes
	SLO-2	Minterm, Maxterm, Sum of Products (SOP) and Product of Sums (POS)	Triggering of flip flops	Pin Descriptions of 8085 microprocessor	Modes of operation : Maximum and Minimum mode	Software interrupt
S-2	SLO-1	Boolean Laws and theorems	Truth Table, Characteristic Table, Excitation table and equations for flip flops	Architecture of 8085 microprocessor	Architecture of 8086 microprocessor	Pin Description of programmable interrupt controller-8259
	SLO-2	Minimization of Boolean expressions using Boolean Laws and theorems				Architecture of Programmable Interrupt Controller-8259
S-3	SLO-1	Minimization of Boolean expressions using K - map	Conversion of SR flip flop to any flip flop	Instruction set of 8085 microprocessor:Types	Instruction set of 8086 microprocessor	Pin Description of Programmable Peripheral Interface-8255
	SLO-2		Conversion of JK flip flop to any flip flop	Data Transfer Instruction Set	Data Transfer Instruction Set	Architecture of Programmable Peripheral Interface-8255
S 4-5	SLO-1 SLO-2	Lab 1: Verification of logic gates and implementation of Boolean expression	Lab 4: Implementation of Code converters	Lab 7: Implementation of Shift registers	Lab 10: Code conversion using 8085 microprocessor	Lab 13: Sorting of an array using 8086 microprocessor
S-6	SLO-1	Minimization of Boolean expressions using karnaugh map with don't care conditions	Conversion of D flip flop to any flip flop	Arithmetic Instruction set	Arithmetic Instruction set	Pin Description of programmable Communication Interface (USART)-8251
	SLO-2		Conversion of T flip flop to any flip flop	Logical Instruction Set	Logical Instruction Set	Architecture of programmable Communication Interface (USART)-8251
S-7	SLO-1	Design steps for combinational circuits.	Master –Slave Flip-flop	Branching Instruction Set	Branching/Program Control Instruction Set	Pin Description of Direct Memory Access-8257
	SLO-2	Design of adder and subtractor.	Steps to design Sequential Circuits			Architecture of Direct Memory Access-8257
S-8	SLO-1	Design of Multiplexer	Design of synchronous counter	Control Instruction set	String Manipulation Instruction set	Pin Description of programmable Interval timer -8253

	SLO-2	*Design of De-Multiplexer*			*Processor Control Instruction set*	*Architecture of programmable Interval timer -8253*
S 9-10	SLO-1	*Lab 2: Implementation of Adder Subtractor, Multiplexer, Demultiplexer*	*Lab 5: Implementation of Flip flops*	*Lab 8: Study of microprocessor*	*Lab 11: Multiplication and division using 8086 microprocessor*	*Lab 14: Generation of waveforms by interfacing with 8085 microporcessor*
	SLO-2					
S-11	SLO-1	*Design of Encoder*	*Design of asynchronous sequential circuits*	*Addressing modes of 8085 microprocessors: Direct and indirect addressing mode*	*Addressing modes of 8086 microprocessors: Register and Immediate data – Group I*	*Applications: stepper motor control using 8085 microprocessor*
	SLO-2	*Design of Decoder*		*Register addressing mode register indirect addressing mode and implied addressing mode*	*Addressing mode for memory data – Group II*	
S-12	SLO-1	*Logic Diagram of Parallel binary adder/Subtractor*	*Design of Asynchronous Up, Down counter*	*Timing Diagram of 8085 microprocessor*	*Addressing mode for I/O – Group III*	*A/D and D/ A conversion using 8086 microprocessor*
	SLO-2		*Design of Asynchronous Up/ Down counter*		*Interrupts of 8086 microprocessor*	
S-13	SLO-1	*Design of code converters*	*Concept and Types of Shift Registers(Serial In Serial Out, Serial In Parallel Out, Parallel In Serial Out and Parallel In Parallel Out shift registers*	*Simple Assembly language programs using the instructions of 8085 microprocessor*	*Timing Diagram of 8086 microprocessor*	*A/D and D/ A conversion using 8085 microprocessor*
	SLO-2	*Design of magnitude comparator*			*Assembler Directives and assembly language programs of 8086microprocessor*	
S 14-15	SLO-1	*Lab 3: Implementation of encoder and decoder*	*Lab 6: Design of synchronous counter*	*Lab 9: Arithmetic operations using 8085 microprocessor*	*Lab 12: Stepper motor Interfacing using 8085 Microprocessor*	*Lab 15: Model Practical Examination*
	SLO-2					

Learning Resources	1. *M. Morris Mano, Michael D Ciletti, Digital Design, 5th ed., Pearson, 2014* 2. *Charles H.Roth, Fundamentals of Logic Design, 6th ed., Thomson Learning, 2013* 3. *Ramesh S. Gaonkar, Microprocessor Architecture. Programming and Applications with the 8085, 5th ed., Penram International Publishing (India) Private Limited. 2005*	4. *Mohammed Rafiquzzaman, Microprocessors and Microcomputer based System Design, Universal Book Stall, New Delhi, 1990* 5. *Doughlas V.Hall, Microprocessors and Interfacing, Programming and Hardware, Tata McGraw Hill, 2012* 6. *Laboratory manual for Digital Systems and Microprocessors, SRMIST*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
r. Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. K. Karthikeyan, R&D Specialist, ABB India Ltd, Bangalore, India, sayalkarthik@yahoo.co.in	*1. Dr. Dr. B. Chittibabu, IIITDM, Kanchipuram, bcbabu@iiitdm.ac.in*	*1.Dr. M. Mohamed Rabik, SRMIST*
2. Dr. Vishal P Barde, Senior Lead Engineer, Mahindra & Mahindra, Chennai, vishalbarde@gmail.com	*2. Dr. P. Karthikeyan, MIT campus, Anna university, pkarthikeyan@annauniv.edu*	*2..Mr. S. Vasanth, SRMIST*

ACADEMIC CURRICULA

Professional Core Courses

NANOTECHNOLOGY

Regulations - 2018

SRM
INSTITUTE OF SCIENCE & TECHNOLOGY
(Deemed to be University u/s 3 of UGC Act, 1956)

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Kancheepuram, Tamil Nadu, India

Course Code	18NTC101T	Course Name	NANOSCALE CHEMISTRY	Course Category	C	*Professional Core*	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Nanotechnology*	Data Book / Codes/Standards	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Understand the role of chemistry in nanoparticle synthesis*
CLR-2 :	*Improve their ability in understanding the thermodynamic behavior of nanomaterials*
CLR-3 :	*Acquire knowledge about size effects and reaction kinetics and phase properties at nanoscale*
CLR-4 :	*Enhance knowledge about Symmetry and lattice parameters*
CLR-5 :	*Enhance knowledge about the various nanosynthesis techniques*
CLR-6 :	*Utilize the knowledge of processing in nanochemistry*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO - 3
CLO-1 :	*Identify the difference between bulk and nanoscale thermodynamics*	2	80	75	M	M	H	H	M	M	H	H	H	H	M	H	H	H	H
CLO-2 :	*Identify symmetry, point groups and its application in lattice determination*	2	80	70	H	H	H	H	M	M	M	H	H	H	M	H	M	M	M
CLO-3 :	*Describe phase diagram and transition in nanoscale*	2	75	70	H	M	H	M	H	H	H	H	M	M	H	H	H	H	H
CLO-4 :	*Analyze the physical chemistry of nanomaterials*	2	80	75	M	H	M	H	M	H	H	H	M	H	M	M	H	H	H
CLO-5 :	*Analyze the mechanism of different chemical synthesis routes*	2	80	70	H	M	H	H	H	M	H	H	H	H	M	H	H	H	H
CLO-6 :	*Analyze the chemistry based processes at nanoscale*	2	80	70	H	M	H	H	H	M	H	H	H	H	M	H	H	H	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Fundamental Properties of nanomaterials*	*Symmetry of molecules*	*Crystalline phase transitions in nanocrystals*	*Supercritical fluids-introduction*	*Introduction on different synthesis route of nanoparticles*
	SLO-2	*Size effects on structure and morphology of free and supported nanoparticles*	*point groups of molecules*	*Phase transitions and grain size dependence*	*Processes involving supercritical fluids*	*Overview on precipitative methods*
S-2	SLO-1	*Size and confinement effects of nanomaterials*	*Symmetry of nanosystems*	*Phase diagram of Water and Carbondioxide*	*Phase diagram of a pure substance*	*Chemical precipitation and co-precipitation methods to synthesize nanomaterials*
	SLO-2	*Fraction of surface atoms*	*Point groups of nanoclusters*	*Different forms of phase transition*	*Pressure–density diagram for CO_2*	*Chemical reduction method to synthesize metallic nanocrystals*
S-3	SLO-1	*Specific surface energy and surface stress of nanomaterials*	*Miller indices and representation of directions*	*Classification of phase transitions*	*Physicochemical properties: solubility or dissolving power of different fluids*	*Metathesis to prepare nanoparticles*
	SLO-2	*Effect of size on the lattice parameter*	*Bragg's law of diffraction*	*Tools to detect phase transition*	*Variation of viscosity with respect to presure*	*Steps involved in Sol-gel synthesis*
S-4	SLO-1	*Classification of nano-structured materials*	*XRD analysis of bulk and nanomaterials*	*Wulff anf Wulff-Kirchoff plot for equilibrium geometry*	*Transport properties of supercritical fluids*	*Reaction mechanisms: Hydrolysis and polycondensation*
	SLO-2	*0D, 1D, 2D,3D structures*	*Identification of crystal planes in bulk and nanomaterials*	*Phase transition of Barium Titanate nanoparticles as example*	*Diffusion and Brownian motion*	*Introduction to micelles, reverse micelles and microemulsions*
S-5	SLO-1	*Introduction to thermodynamics of bulk materials*	*Scherer equation to calculate the grain or crystallite size*	*Influence of the surface or interface on nanocrystals*	*Thermal conductivity or heat transport phenomenon of supercritical fluids*	*Synthesis of nanomaterials using microemulsion route*
	SLO-2	*Gibb's equation*	*Specific features of nanoscale growth*	*Modification of transition barrier, geometric evolution of the lattice in nanocrystals*	*Purification and extraction of supercritical fluids*	*Prepare inorganic nanomaterials using hydrothermal and solvothermal routes*
S-6	SLO-1	*Derivation of free energies of nanostructures with different geometry*	*Size control of nanoparticles*	*Influence of the nanocrystal surface or interface on the lattice parameter*	*Synthesis of supercritical fluids*	*Preparation of arrays of oxide nanocrystals using thermolysisroute*
	SLO-2	*Surface energy and work function of nanostructures with different geometry*	*Triggering the phase transition in small particles fabrication*	*Crystallization of metallic glasses*	*Cryochemistry of metals-Introduction*	*Microwave heating assisted synthesis of nanomaterials*
S-7	SLO-1	*Thermodynamics of nanospheres*	*Application to solid nanoparticles*	*Grain growth and grain growth kinetics*	*Silver and other metals*	*Introduction to sonochemistry*

	SLO-2	*Thermodynamics of nanorods*	*Controlling nucleation in nanomaterial synthesis*	*High pressure phase stabilization and DSC studies of nanomaterials*	*Stabilization of nanoparticles by polymers*	*Sonochemical synthesis of nanometals*
S-8	SLO-1	*Thermodynamics of nanoclusters*	*Controlling growth in nanomterial synthesis*	*TGA studies of nanomaterials*	*Stabilization of nanoparticles by mesogenes*	*Synthesis of nanosized hydroxides using sonochemical method*
	SLO-2	*Kinetic versus thermodynamic stability*	*Controlling aggregation of nanoparticles*	*Solid solutions*	*Reactions of rare-earth elements activity, selectivity and size effect*	*Core-shell synthesis of semiconductor nanocrystals*
S-9	SLO-1	*Understanding the thermodynamics at nanoscale*	*Stability of colloidal dispersions*	*Congruence in solid solutions*	*Reactions at superlow temperatures*	*Electrochemical synthesis of nanoparticles*
	SLO-2	*Factors affecting thermodynamics at nanoscale*	*Breaking matter into pieces*	*Phase change and applications of nanosystems*	*Reactions of silver particles of various sizes and shapes*	*Photochemical synthesis of nanoparticles*

Learning Resources	1. *Ben Rogers, Jesse Adams, SumithaPennathur,Nanotechnology – Understanding small systems, 3rd ed., CRC press, 2017*	2. *Nils O Peterson, Foundations for Nanoscience and Nanotechnology, CRC press, 2017*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember / Understand	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply / Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate / Create	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. P. Sudhakara, CLRI – CSIR, Jalandhar, sudhakarp@clri.res.in	*1. Dr. Kothandaraman Ramanujam, IITM Chennai, rkraman@iitm.ac.in*	*1. Dr. N.Angeline Little Flower, SRMIST*
2. Dr. Nagesh Kini, Thermax, Pune, Maharastra, nagesh.kini@gmail.com	*2. Prof. G. Ranga Rao, Department of Chemistry, IITM Chennai, grrao@iitm.ac.in*	*2. Dr. S. HariniPriya, SRMIST*

Course Code	18NTC102T	Course Name	QUANTUM MECHANICS FOR NANOTECHNOLOGISTS	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Nanotechnology	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Utilize the concept of old and new Quantum Mechanics
CLR-2 :	Analyze the bound and scattering states
CLR-3 :	Utilize quantum physics behind applications - Nanodimension
CLR-4 :	Solve the many body problems using various assumptions
CLR-5 :	Identify the implications of quantum theory and approximations at nanoscale
CLR-6 :	Utilize the basis of quantum mechanics and get acquainted with its applications

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO - 3
CLO-1 :	Explain the basics of Quantum Mechanics	2	80	75	M	M	H	M	M	M	M	H	H	H	M	H	H	H	M
CLO-2 :	Apply Quantum Mechanics in low-dimensional systems	2	80	70	H	M	H	H	M	M	M	H	M	H	M	H	M	M	M
CLO-3 :	Perform approximation methods to solve problems in nanoscale	2	75	70	M	M	H	M	H	H	H	H	H	H	H	M	H	H	H
CLO-4 :	Gain expertise in processes based on quantum phenomena	2	80	75	M	H	H	H	M	H	H	H	M	H	M	H	H	H	H
CLO-5 :	Solve problems using quantum mechanics	2	80	70	H	M	M	M	H	M	M	H	H	H	M	H	H	H	H
CLO-6 :	Analyze the basis of quantum mechanics and get acquainted with its applications	2	80	70	M	H	M	H	H	M	M	H	H	H	M	H	H	H	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Old quantum mechanics, wave particle duality	Classical interpretation of scattering state	Energy eigen functions and eigen values with precession coordinates	Principle of variational method	Two particle system's Schrödinger equation
	SLO-2	Heisenberg uncertainty principle	Quantum interpretation of scattering State	Infinite well potential in one dimensions	Proof of variational method and implementation	Derivation of two particle system's Schrödinger equation
S-2	SLO-1	Generalized Heisenberg uncertainty principle	Reflection of particles (wavefunction)	Numericals on infinite well potential in one and three dimensions	Energy eigen value in case of time independent perturbation theory for non-degenerate energy levels	Transformation to center of mass frame from laboratory frame
	SLO-2	Ehrenfest theorem	Transmission of Particles (wavefunction)	Quantum confinement effect in nanoscale	Energy eigen value in case of time independent perturbation theory for non-degenerate energy levels (quantitative approach)	Exchange operator
S-3	SLO-1	Linear vector space	Rectangular potential barrier ($E<V_0$): quantitative	Finite Well Potential, Delta potential	Eigen function in case of time independent perturbation theory for non-degenerate energy levels	Symmetrization of wave function
	SLO-2	Hilbert space	Rectangular potential barrier ($E>V_0$)	Eigen values, Schrödinger equation in spherical coordinates	Eigen function in case of time independent perturbation theory for non-degenerate energy levels(quantitative approach)	Antisymmetric wave function
S-4	SLO-1	Statistical interpretation, stationary states	Transmission probability plot as a function of energy ofparticle	Angular equation	Energy eigen value in case of Time independent perturbation theory for degenerate energy levels	Bosons and Fermions
	SLO-2	Orthogonal wave function	Numericals in rectangular potential barrier	Introduction on radial equation	Quantitative approach of energy eigen value in case of Time independent perturbation theory for degenerate energy levels	Exchange forces

S-5	SLO-1	*Normalization of wave function*	*Tunneling effect*	*Derivation of radial equation*	*Eigen function in case of time dependent perturbation theory for two-level systems*	*Solids, free electron gas*
	SLO-2	*Hermitian operator*	*Relation of tunneling with nanotechnology*	*Infinite spherical well*	*Quantitative approach of eigen Function in case of Time dependent perturbation theory for two-level systems*	*Band structure of solids*
S-6	SLO-1	*Properties of Hermitian operator*	*Alpha-particle emission*	*Numerical on infinite spherical well*	*Sinusoidal perturbations*	*Quantum scattering theory*
	SLO-2	*Commutation*	*Failure of Classical Mechanics to explain Alpha-particle emission*	*Ground state properties of hydrogen atom*	*Sinusoidal perturbations (quantitative approach)*	*Quantum scattering theory (quantitative approach)*
S-7	SLO-1	*Energy eigen value equation*	*Derivation on Alpha-particle emission*	*Angular momentum (L_x,L_y,L_z)*	*Incoherent perturbation*	*Differential and total cross sections*
	SLO-2	*Boundary condition of wavefunction*	*Numericals in particle emission*	*Angular momentum (L_x,L_y,L_z) in spherical coordinate*	*Role of incoherent perturbation*	*Differential and total cross sections (quantitative approach)*
S-8	SLO-1	*Schrödinger's time dependent wave equations*	*Resonant tunneling*	*Generalized angular momentum (J_x,J_y,J_z), Eigen values*	*Transition rate*	*Green's functions*
	SLO-2	*Schrödinger's time independent wave equations*	*Applications of resonant tunneling*	*Eigen values of momentum operator*	*Transition rate role is perturbation*	*Born approximation*
S-9	SLO-1	*Schrödinger's representation*	*Negative differential resistance*	*Spin ½, spin for two particle system*	*Adiabatic approximations (elementary concepts)*	*Applications in nanotechnology*
	SLO-2	*Heisenberg representation, interaction picture*	*Negative differential resistance in 2D materials*	*Role of spin in nanospintronics*	*Sudden approximations (elementary concepts)*	*Overall role and implication of quantum phenomena in nanotechnology*

Learning Resources	*1. G. Aruldhas, Quantum Mechanics, 2nd ed., PHI, 2013* *2. David J. Griffiths, Introduction to Quantum Mechanics, 2nd ed., Pearson, 2009*	*3. Ajoy Ghatak, S. Lokanathan, Quantum Mechanics, 5th ed., Macmillan, 2009* *4. Bransden B.H., JoachainC.J. Quantum Mechanics, 2nd ed., Pearson, 2007*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Noriaki Terakubo, JGC CORPORATION, Japan, terakubo.noriaki@jgc.co.jp	*1. Dr. Uday Narayan Maiti, IITG Guwahati, udaymaiti@gmail.com*	*1. Dr. Ranjit Thapa, SRMIST*
2. Mr. R. Seshadri, TITAN Company Limited, seshadri@titan.co.in	*2. Dr. Noejung Park, Ulsan National Institute of Science and Technology, noejung@unist.ac.kr*	*2. Dr. Kiran Mangalampalli, SRMIST*

Course Code	18NTC103L	Course Name	NANOSCALE MATERIALS LABORATORY	Course Category	C	Professional Core	L	T	P	C
							0	0	2	1

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Nanotechnology*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Analyze the chemical properties of nanostructured materials based on their size*
CLR-2 :	*Utilize microscopes to view the morphology and spectrometers to find the absorbance of the nanomaterial*
CLR-3 :	*Demonstrate various synthesis methods for nanomaterials preparation*
CLR-4 :	*Utilize the characterization techniques and calculate the size and bandgap*
CLR-5 :	*Analyze the optical and magnetic properties of the nanomaterials*
CLR-6 :	*Compare the green synthesis and chemical reduction methods*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	**Learning**			**Program Learning Outcomes (PLO)**														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Perform various experimental methods for nanoparticles synthesis*	2	80	75	M	M	H	H	M	M	M	H	H	H	M	H	H	H	M
CLO-2 :	*Analyze the role of chemistry innanoparticle synthesis*	2	80	70	M	H	H	H	M	M	M	H	M	H	M	H	M	M	M
CLO-3 :	*Analyze and interpret data in determining the properties of materials*	2	75	70	H	M	H	H	H	H	M	H	H	H	H	H	H	H	H
CLO-4 :	*Describe the behavior of nanomaterials based on its chemistry*	2	80	75	M	M	H	H	M	M	H	H	H	H	M	H	H	H	M
CLO-5 :	*Identify the mechanism of different chemical synthesis routes*	2	80	70	H	M	H	H	H	M	H	H	H	H	M	H	H	H	H
CLO-6 :	*Perform various characterizations of nanomaterials*	2	80	75	H	H	H	H	H	M	M	H	H	H	M	H	H	H	H

Duration (hour)		**6**	**6**	**6**	**6**	**6**
S 1-2	SLO-1	*Introduction to the basics of laboratory*	*Synthesis of gold nanoparticles by chemical reduction* *Determination of absorption coefficient using UV-Vis spectrometer*	*Synthesis of photocatalytic solution using co-precipitation method*	*Cryochemical synthesis of metal nanoparticles anddetermination of particle size using UV-Vis spectrometer*	*Synthesis of iron oxide nanoparticles using precipitation method* *Scherrer formula to determine the crystallite size of nanoparticle using X-ray diffraction technique*
	SLO-2					
S 3-4	SLO-1	*Synthesis of zinc sulfide quantum dot using co-precipitation method*	*Synthesis of ferro fluids using chemical precipitation*	*Synthesis of nanoparticles loaded polymer fibers using electrospinning technique*	*Preparation of nanoparticles using sonochemical method and elemental identification using XRF analysis*	*Determination of pH of unknown solution*
	SLO-2	*Determination of optical bandgap using UV-Vis spectrometer*	*Determination of zeta potential of aqueous dispersion at different pH conditions*			
S 5-6	SLO-1	*Synthesis of silica nanospheres using stober's method*	*Synthesis of metal oxide nanoparticles using sol-gel technique*	*Repeat/revision of experiments*	*Fabrication of polymer membrane using phase inversion technique and characterization using scanning electron microscope (SEM) technique*	*Thin film preparation by spin coating technique and to determinethe dislocation density and strain of given sample by XRD method*
	SLO-2					

Learning Resources	1. *Nanoscale chemistry laboratory course manual, 2016* 2. *Kenneth J. Klabunde, Nanoscale Materials in Chemistry, WileyInterscience publications,2001* 3. *Vincenzo Turco Liveri, Controlled Synthesis of Nanoparticles in Microheterogeneous Systems,Springer,2006*	4. *L.H. Sperling, Introduction to Physical Polymer Science, Wiley Inter science, 2006* 5. *http://chemistry.beloit.edu/classes/Chem150/index.html*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	-	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*
Level 2	Apply Analyze	-	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*
Level 3	Evaluate Create	-	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. P. Sudhakara, CLRI – CSIR, Jalandhar, sudhakarp@clri.res.in	*1. Dr. Kothandaraman Ramanujam, IITM Chennai, rkraman@iitm.ac.in*	*1. Dr. N.Angeline Little Flower, SRMIST*
2. Dr. Sudhakar selvakumar, CSIR-Central Electrochemical Research Institute, ssudhakar79@gmail.com	*2. Dr. Arthanreeswaran, NIT, Trichy,arthanareeg@nitt.edu*	*2. Dr. S. HariniPriya, SRMIST*

Course Code	18NTC104T	Course Name	THERMODYNAMICS AND STATISTICAL MECHANICS	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Nanotechnology	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	*Utilize the basic principles and laws of thermodynamics*
CLR-2 :	*Identify the thermodynamic properties of pure substances and different kinds of equilibrium*
CLR-3 :	*Utilize the concept of ensembles and classical statistics*
CLR-4 :	*Analyze the concepts of quantum statistics*
CLR-5 :	*Analyze the principles of nanothermodynamics*
CLR-6 :	*Apply the concepts of Non-equilibrium thermodynamics to Nanoscale systems*

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO - 3
CLO-1 :	*Describe various thermodynamic processes and concepts explained by laws*	2	80	75	M	H	H	H	M	M	L	M	M	H	L	H	H	H	H
CLO-2 :	*Analyze the concepts of enthalpy, entropy, chemical potential, fugacity*	2	80	70	H	M	H	H	M	M	M	H	M	H	L	M	M	M	M
CLO-3 :	*Describe the postulates of statistical mechanics*	2	75	70	M	M	H	M	H	H	L	M	H	M	M	H	H	H	H
CLO-4 :	*Enumerate on Bose-Einstein condensation and Fermi gas*	2	80	75	M	H	M	H	H	M	M	H	M	H	L	M	H	H	H
CLO-5 :	*Describe the concept of Hill's nanothermodynamics*	2	80	70	H	H	H	H	M	H	L	M	H	H	M	H	H	H	H
CLO-6 :	*Analyze the fluctuations in small systems*	2	80	75	M	H	H	H	M	M	L	M	M	H	L	H	H	H	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Properties of a thermodynamic system-concept of system and boundaries*	*Thermodynamic properties of pure substances in solid, liquid, vapor phases*	*Fundamentals of statistical physics-microscopic approach*	*Quantum statistics for identical particles*	*Thermodynamics of small systems and Gibbs equation for nanosystems*
	SLO-2	*Concept of continuum*	*Phase diagrams of a pure substance*	*Concept of phase space*	*Distinguishable and indistinguishable particles*	*Features of Hill's nanothermodynamics*
S-2	SLO-1	*Thermodynamic equilibrium*	*Gibb's phase rule*	*Concept of gamma space and μ space*	*Grand canonical ensemble*	*Comparison with classical equilibrium thermodynamics*
	SLO-2	*Path and point functions*	*Different kinds of equilibrium*	*Volumes in phase space*	*Determination of Gibbs factor*	*Nanoensemble and its thermodynamic parameters*
S-3	SLO-1	*Extensive and intensive properties*	*Entropy and energy criteria for equilibrium*	*Difference between microstate and macrostate*	*Photons in an oven*	*Gibbs energy of single-component nanoparticles*
	SLO-2	*Zeroth law of thermodynamics and concept of temperature*	*Ideal gas equation of a state*	*Most probable distribution*	*Principle of detailed balance*	*Fluctuations in small systems*
S-4	SLO-1	*Energy transfer by heat and work*	*Deviation from ideal gas behavior*	*Equal apriori probability and ergodicity*	*Energy flux*	*Jarzyanki's inequality*
	SLO-2	*Isothermal process*	*VanderWaal's equation of state*	*Ensemble averages*	*Bose gas*	*Classical nucleation thermodynamics*
S-5	SLO-1	*Adiabatic process*	*Law of corresponding states*	*Derivation of Boltzmann equation S=KlnW*	*Structureless Bose gas*	*Phase diagrams of small systems*
	SLO-2	*Isochoric process*	*Determination of critical constants*	*Thermodynamics of Ensembles*	*Bose Einstein distribution law for bosons*	*Thermodynamics of metastable phase nucleation at the nanoscale*
S-6	SLO-1	*Isobaric process*	*Temperature and entropy (T-dS) relations*	*Canonical Ensemble and its thermodynamic parameters*	*Bose-Einstein condensation*	*Nanoscale thermodynamic approach in CVD diamond*
	SLO-2	*First law of thermodynamics*	*Helmholtz Function Gibbs Function*	*Microcanonical Ensemble and its thermodynamic parameters*	*Observation of BECs of cold atoms*	*Nucleation thermodynamics of cubic boron nitride*

S-7	SLO-1	*Specific Heat at constant Pressure and constant volume*	*General Thermodynamic equations*	*Stirling Approximation*	*Superfluid liquid helium*	*Nonextensivity of nanosystems*
	SLO-2	*Second law of thermodynamics*	*Joule-Thomson coefficient*	*Classification of statistical distributions*	*Fermi gases for electrons*	*Nonintensivity of nanosystems*
S-8	SLO-1	*Reversibility, irreversibility and Carnot cycle*	*Co-efficient of volume expansion*	*Maxwell-Boltzmann distribution for classical particles*	*Structureless degenerate Fermi gas*	*Principles of non-equilibrium thermodynamics*
	SLO-2	*Reversed Carnot Cycle as a refrigeration cycle*	*Adiabatic and isothermal compressibility*	*Concept of degrees of freedom*	*Fermi Dirac distribution law for fermions*	*Concept of Pseudo equilibrium and benard cells*
S-9	SLO-1	*Third law of thermodynamics*	*Clapeyron equations*	*Law of equipartition of energy*	*Fermions at low temperatures*	*Out of equilibrium nanosystems*
	SLO-2	*Unattainability of absolute zero*	*Clapeyron-Clausius equations*	*Specific heat capacities of gases*	*Fermi temperature and degenerate pressure*	*Cooling by heating in nonequilibrium nanosystems*

Learning Resources	1. *Keith Stowe, An Introduction to Thermodynamics and Statistical Mechanics, Cambridge University, 2007* 2. *Richard E.Sonntag, Gordon J.VanWylen, Introduction to Thermodynamics, Classical and Statistical, Wiley Publishing, 2010*	3. *Yunus, A.Cengel, Michael Boles, Thermodynamics-An Engineering Approach, Tata McGraw Hill,2008* 4. *Pathria, R. K., Statistical Mechanics, Oxford: Pergamon Press, 1972*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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2. Dr. Vinay Kumar Gupta, National Physical Laboratory, New Delhi, guptavinay@nplindia.org	*2. Dr. R.Gnanamoorthy,IITM,Chennai, gmoorthy@iitm.ac.in*	*2. Dr. BibhuRanjanSarangi, SRMIST*

Course Code	18NTC105T	Course Name	BIOLOGICAL PRINCIPLES FOR NANOSCALE SCIENCE	Course Category	C	*Professional Core*	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Nanotechnology*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Know about various biological molecules*
CLR-2 :	*Understand the structure and functions of various biological membranes and transportation across membrane*
CLR-3 :	*Know about various molecular biology principles*
CLR-4 :	*Acquire insight into bioenergetic cycles*
CLR-5 :	*Gain knowledge about various gene transfer technologies*
CLR-6 :	*Understand the basic biological principles and mechanisms*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO - 3
CLO-1 :	*Describe importance of biological molecules*	2	80	75	H	H	H	H	H	M	H	H	H	H	M	H	H	H	M
CLO-2 :	*Analyze the various biological membranes and transportation process across membrane.*	2	80	70	H	M	H	H	M	M	M	H	M	H	M	H	M	M	M
CLO-3 :	*Describe the obtained knowledge on molecular biology*	2	75	70	H	M	M	H	H	H	H	H	H	H	M	M	H	H	H
CLO-4 :	*Analyze the techniques of Bio energetics*	2	80	75	H	H	H	H	H	H	H	H	M	H	H	H	H	H	H
CLO-5 :	*Apply measuring the concept of gene transfer technology*	2	80	70	H	H	H	H	H	H	H	H	H	H	H	H	H	H	M
CLO-6 :	*Describe various biological principles and mechanisms*	2	80	75	H	H	H	H	H	M	H	H	H	H	M	H	H	H	M

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Carbohydrates: classification*	*Models of membrane*	*DNA replication*	*Principles of bioenergetics*	*Introduction of foreign genes into animal cells*
	SLO-2	*Configurations and conformations*	*Membrane structure*	*Enzymology of DNA replication*	*Biological Oxidation reduction reactions*	*Transgenic technology*
S-2	SLO-1	*Sugar derivatives – structural polysaccharides*	*Erythrocytes*	*Transcription*	*Carbohydrate metabolism*	*Transgene transfer techniques*
	SLO-2	*Storage polysaccharides*	*Erythrocytes membrane*	*Types of RNA molecules*	*Glycolysis*	*DNA Microinjection*
S-3	SLO-1	*Amino acids: general properties*	*Plant cell*	*RNA splicing*	*Glucogenesis*	*Embryonic stem cell mediated gene transfer*
	SLO-2	*Peptide bonds*	*Cell membrane*	*Splicing mechanism*	*Gluconeogenesis*	*Retrovirus mediated gene transfer*
S-4	SLO-1	*Essential amino acids*	*Bacterial cell*	*Translation*	*Glycogenolysis*	*Plant tissue culture*
	SLO-2	*Non-essential amino acids*	*Bacterial cell wall*	*Genetic code*	*Pentose-phosphate pathway*	*Totipotency*
S-5	SLO-1	*Lipids: classification*	*Membrane lipids*	*Codon-Anticodon*	*Coordinated regulation of glycolysis and gluconeogenesis*	*Transgenic plants*
	SLO-2	*Fatty acids*	*Structure and function*	*Codon-Anticodon interaction*	*Citric acid cycle*	*Agrobacterium mediated gene transfer*
S-6	SLO-1	*Biological significance of lipids*	*Membrane proteins*	*Ribosomes*	*Reactions of the citric acid cycle*	*Ti plasmid*
	SLO-2	*Functions of lipids*	*Membrane carbohydrates*	*Protein synthesis*	*Glyoxylate cycle*	*Vectors*

S-7	SLO-1	*Nucleic acid*	*Thermodynamics of transport*	*Posttranslational Modification of Proteins*	*Electron transport chain*	*Animal cell culture*
	SLO-2	*Chemical structure and base composition*	*Kinetics of transport*	*Difference between protein synthesis in eukaryotic and prokaryotic cells*	*Oxidative phosphorylation*	*Basic tissue culture techniques*
S-8	SLO-1	*Double helical structures*	*Mechanism of transport*	*Protein structures*	*Electron-Transfer Reactions in mitochondria*	*Concepts of transgenic animal technology*
	SLO-2	*Supercoiled DNA*	*Active and passive transport*	*Primary, secondary, tertiary and quaternary structures of protein*	*Proton pumping*	*Strategies for the production of transgenic animals and their importance*
S-9	SLO-1	*Vitamins, water and fat soluble vitamins*	*ATP-driven active transport*	*Gene regulation*	*ATP molecule*	*Gene therapy*
	SLO-2	*Deficiency and diseases*	*Ion gradient driven active transport*	*Concept of operon*	*ATP synthesis mechanism*	*Clinical significance*

Learning Resources	1. *David L Nelson, Michael M. Cox, Lehninger Principles of Biochemistry, 7th ed., WH Freeman & Co, 2012* 2. *Donald Voet, Judith G. Voet, Biochemistry, Wiley, 2003* 3. *David Freifelder, Molecular Biology, 2nd ed., Narosa, 2004*	4. *George M Malacinski, Freifelders Essentials of Molecular Biology, 4th ed., Jones & Bartlett, 2015* 5. *S.B. Primrose and R.M. Twyman, Principles of Gene Manipulation and Genomics, 7th ed., Wiley, 2006*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. K. Chandru, Trivitron Healthcare Pvt. Ltd. Chennai, chandru.k@trivitron.com	*1. Prof. K. Chandraraj, IITM, Chennai, kcraj@iitm.ac.in*	*1. Dr. G. Devanand Venkatasubbu, SRMIST*
2. Dr. Achuth Padmanaban, Baylor College of Medicine, USA, achuthz@gmail.com	*2. Dr. P. Balasubramanian, NIT Rourkela, biobala@nitrkl.ac.in*	*2. Mrs. J. Jositta Sherine, SRMIST*

Course Code	18NTC106T	Course Name	DESIGN AND SYNTHESIS OF NANOMATERIALS	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Nanotechnology	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Gain insight into fundamental principles involved in the growth of nanomaterials
CLR-2 :	Familiarize with zero dimensional materials and their synthesis techniques
CLR-3 :	Know the concept of one dimensional materials and fabrication procedures
CLR-4 :	Understand the fundamentals of thin films growth
CLR-5 :	Acquire knowledge on special nanomaterials and their fabrication methods
CLR-6 :	Evaluate the potential of various growth approaches in designing nanomaterials

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO - 3
CLO-1 :	Describe the fundamental concepts involved in nanoparticle synthesis	2	80	75	M	H	H	M	M	M	M	H	M	H	L	H	H	H	M
CLO-2 :	Identify various synthesis techniques involved in synthesis of quantum dots and nanoparticles	2	80	70	H	M	H	H	M	M	M	H	H	H	M	H	M	M	M
CLO-3 :	Distinguish nanowires, nanorods and nanotubes from bulk materials and 1D nanostructures	2	75	70	M	H	H	M	H	H	H	M	M	H	L	M	H	H	H
CLO-4 :	Apply the knowledge of thin films growth using PVD and CVD techniques	2	80	75	H	M	H	H	M	H	M	H	M	M	M	H	H	H	H
CLO-5 :	Describe the concept of self-assembly, biosynthesis and green synthesis of nanomaterials	2	80	70	M	H	H	M	H	M	H	H	M	H	L	H	H	H	H
CLO-6 :	Design experiments on the growth of nanomaterials	2	80	75	M	H	H	M	M	M	M	H	M	H	L	H	H	H	M

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Introduction to nanomaterials	Classification of nanoparticle synthesis techniques	1-Dimensional nanostructures: introduction	Fundamentals of thin film growth	Self assembly
	SLO-2	Nanomaterials classification based on dimension	Top down and bottom up approach of nanoparticles synthesis	Various examples of 1D nanostructures	Fundamentals of thinfilm growth (Quantitative approach)	Self-assembled monolayers
S-2	SLO-1	Surface energy	Nanoparticle synthesis by mechanical alloying	Spontaneous growth of 1D nanostructures	Physical vapor deposition	Monolayers of organosilicon
	SLO-2	Surface energies of different surfaces of FCC structure	Nanoparticle synthesis by mechanical milling	Evaporation (dissolution) condensation growth	Evaporation	Monolayers of alkanethiols and sulfides
S-3	SLO-1	Chemical potential as a function of surface curvature	Vapor-phase synthesis of nanoparticles	Fundamentals of evaporation (dissolution) condensation growth	Molecular beam epitaxy (MBE) - principle	Langmuir-Blodgett (LB) technique
	SLO-2	Gibbs-Thompson relation	Inert gas condensation of nanoparticles	quantitative approach	Epitaxial growth of thin films using MBE	Monolayer thin film formation using LB technique
S-4	SLO-1	Concept of Ostwald ripening	Plasma-based synthesis of nanoparticles	Fundamental aspects of (vapour-liquid-solid) VLS growth	Sputtering and Sputtering targets	Graphene preparation methods
	SLO-2	Role of Ostwald ripening in nanoparticle synthesis	Spark plasma method for nanoparticles synthesis	Fundamental aspects of SLS growth	DC and RF sputtering	Mechanical exfoliation
S-5	SLO-1	Fundamentals of homogeneous nucleation	Flame-based synthesis of particles	Au-Si phase diagram	Chemical vapor deposition (CVD)	Liquid phase exfoliation
	SLO-2	Critical radius and critical energy	Combustion synthesis of nanoparticles	VLS growth of various nanowires	Basic chemical reactions in CVD	Role of intercalation in graphene exfoliation
S-6	SLO-1	Effect of temperature on critical size and critical free energy	Spray pyrolysis based synthesis of nanoparticles	Control of the size of the nanowires	Reaction kinetics in CVD	Large area synthesis of graphene
	SLO-2	Process of nucleation and subsequent growth	Nanoparticle nucleation and growth in spray pyrolysis	Catalyst size dependent nanowires growth	Transport phenomena	CVD synthesis of graphene

S-7	SLO-1	*Growth controlled by diffusion*	*Solution processing of nanoparticles*	*Various precursor sand catalysts used for nanowires growth*	*Atomic layer deposition (ALD)*	*Biological synthesis of nanoparticles*
	SLO-2	*Growth controlled by diffusion (quantitative approach)*	*Sol-gel processing*	*SLS growth of various nanowires*	*Self-limiting growth using ALD*	*Nanoparticles synthesis using viruses*
S-8	SLO-1	*Growth controlled by surface process*	*Kinetically confined synthesis of nanoparticles*	*Stress induced recrystallization growth*	*Electrochemical deposition*	*Nanoparticles synthesis using bacteria*
	SLO-2	*Growth controlled by surface process (quantitative approach)*	*Nanoparticle synthesis using micelles*	*Template based synthesis of NWs,*	*Electrochemical deposition – Nernst equation and film growth*	*Role of bacteria in nanoparticle synthesis*
S-9	SLO-1	*Fundamentals of heterogeneous nucleation*	*Nanoparticle synthesis using microemulsion*	*Template filling*	*Sol-Gel Films - spin coating*	*Green chemistry of nanoparticles*
	SLO-2	*Fundamentals of heterogeneous nucleation (Quantitative approach)*	*Aerosol synthesis of nanoparticles*	*Nanofibres producion using Electrospinning*	*Dip coating, Electrophoretic deposition*	*Nanoparticles synthesis using plant extract*

Learning Resources	1. *C. Cao, Nanostructures & Nanomaterials –Synthesis, Properties & Applications, Imperial College Press, 2004* 2. *Abdullaeva Zhypargul, Synthesis of Nanoparticles and Nanomaterials -Biological Approaches, Springer, 2017*	3. *Rai M and Poston C, Green biosynthesis of nanoparticles: mechanisms and applications, Cabi, 2013.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. M. Krishna Surendra, Saint-Gobain Research, Chennai, krishna.muvvala@saint-gobain.com	*1. Prof. S. Balakumar, University of Madras, balakumar@unom.ac.in*	*1. Dr. E. Senthil Kumar, SRMIST*
2. Dr. M. Sathish, CSIR-CECRI, Karaikudi, msathish@cecri.res.in	2. Prof. S. Ramaprabhu, *IIT Madras, ramp@iitm.ac.in*	*2. Dr. S. Chandramohan, SRMIST*

Course Code	18NTC107J	Course Name	ADVANCED CHARACTERIZATION OF NANOMATERIALS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Nanotechnology	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Utilize the concepts of SEM, TEM, SPM, XPS, AES and SIMS to characterize nanomaterials
CLR-2 :	Utilize materials characterization techniques at the morphological, structural and chemical level
CLR-3 :	Analyze different types of nanostructures
CLR-4 :	Asses the performance of broad range of advanced characterization techniques used in nanotechnology
CLR-5 :	Apply the advanced techniques for solving problems in materials science and engineering
CLR-6 :	Demonstrate skills in the use of advanced experimental techniques

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO - 3
CLO-1 :	Explain the principles of optical, electron and scanning probe microscopies and photoelectron, Auger electron spectroscopic and secondary ion mass spectrometric techniques.	1	80	75	H	M	H	H	H	H	H	H	M	H	L	H	H	H	H
CLO-2 :	Describe the construction and operation of different characterization techniques.	1	80	70	H	M	H	H	M	M	M	H	M	H	L	H	M	M	M
CLO-3 :	Perform experiments using SEM, TEM, SPM, XPS, AES, SIMS and optical microscopies.	2	75	70	H	H	H	H	H	H	H	H	M	H	L	H	H	H	H
CLO-4 :	Apply suitable techniques for characterizing nanomaterials and devices.	2	80	75	H	H	H	H	H	H	H	H	M	H	M	H	H	H	H
CLO-5 :	Analyze the morphology, structure, elemental composition and chemical state of the given /synthesized nanomaterials using advanced techniques,	2	80	80	H	H	H	H	H	H	H	H	M	H	L	H	H	H	H
CLO-6 :	Apply skills acquired for advanced experimental characterization	2	80	80	H	H	H	H	H	M	H	H	H	H	M	H	H	H	H

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Image formation, numerical aperture resolution, effective magnification	Scanning electron microscopy; electron optics; imaging with electrons	TEM imaging system	Scanning probe microscopy	Basic principles: X-ray photoelectron spectroscopy(XPS)
	SLO-2	Brightness and contrast, depth of field, aberrations	Magnetic and electrostatic lenses	Instrumentation of TEM	Scanning probe microscopy: Instrumentation	Auger electron spectroscopy(AES)
S-2	SLO-1	Instrumentation: illumination system, objective lens and eyepiece	Signal detection	Electron sources	Scanning tunneling microscopy, tunneling current	Instrumentation: XPS
	SLO-2	Steps for optimum resolution, steps to improve depth of field	Detector	Specimen stage and specimen preparation	Probe tips and working environments	Instrumentation: AES
S-3	SLO-1	Imaging modes bright-field and dark-field imaging	Probe size and current	Kinematics of scattering by nucleus	Atomic force microscopy	Photoelectron spectra
	SLO-2	Kohler illumination	Electron–specimen interactions	Electron – electron scattering	Cantilevers and deflection measurements	Auger electron spectra
S 4-5	SLO-1 SLO-2	Lab 1:Introduction to the basics of laboratory	Lab 4: Morphological study of nanostructured material using SEM	Lab 7: Imaging and analysis using transmission electron microscope	Lab 10: Tunneling measurements using scanning tunneling microscope (STM)	Lab 13: Interpretation of XPS spectra
S-6	SLO-1	Phase-contrast microscopy	Topographic contrast	Image modes: Mass–density contrast	Contact AFM	Qualitative analysis
	SLO-2	The behavior of waves from phase objects in brightfield microscopy	Compositional contrast	Diffraction contrast, phase contrast	Non-contact AFM	Peak identification, chemical shifts, composition imaging
S-7	SLO-1	Properties of polarized light	Working distance and aperture size	Selected-area diffraction (SAD) and characteristics	Dynamic contact AFM	Quantitative analysis: peaks and sensitivity factors
	SLO-2	Polarized-light microscopy	Acceleration voltage and probe current	Single-crystal diffraction, polycrystalline diffraction	Taping AFM	Composition depth profiling

S-8	SLO-1	*Differential interference contrast microscopy and modulation contrast microscopy: DIC optical system*	*Astigmatism*	*Dark field images*	*Force modulation*	*Secondary ion mass spectrometry (SIMS): Basic principles*
	SLO-2	*Modulation contrast microscopy*	*Specimen preparation*	*Phase control*	*Manipulation of atoms*	*Secondary ion generation*
S 9-10	SLO-1 SLO-2	*Lab 2: Optical microscope based investigation of microfabricated structures*	*Lab 5: SE and BSE imaging with SEM*	*Lab 8: Selected area electron diffraction using TEM (SAED)*	*Lab 11: Nanoparticle size determination using atomic force microcopy (AFM)*	*Lab 14: Peak identification of in AES spectra, analysis of the AES depth profile*
S-11	SLO-1	*Physical basis of fluorescence*	*Elemental imaging using EDS*	*High resolution images*	*Advanced SPM techniques*	*Dynamic and static SIMS*
	SLO-2	*Fluorescence microscopy*	*Applications of elemental imaging*	*Interpretation of high resolution images*	*Kelvin probe force microscopy*	*SIMS -instrumentation*
S-12	SLO-1	*Confocal laser scanning microscopy: the optical principle of confocal imaging*	*Field emission SEM*	*Ultrahigh resolution TEM*	*Scanning capacitance microscopy*	*Sample handling*
	SLO-2	*Techniques for improving imaging of nanoscale materials*	*Environmental SEM*	*Dynamic TEM*	*Scanning thermal microscopy*	*Spectrum interpretation*
S-13	SLO-1	*Diffraction limit*	*Time resolved microscopy*	*z-contrast imaging*	*Magnetic force microscopy*	*Element identification*
	SLO-2	*Breaking the diffraction limit*	*Time resolved microscopy:Applications*	*Coherent and incoherent imaging*	*Piezoelectric force microscopy*	*SIMS depth profiling*
S 14-15	SLO-1 SLO-2	*Lab 3: Bioimaging using fluorescence microscopy*	*Lab 6: EDS for chemical identification*	*Lab 9: Repeat/Revision of the experiments*	*Lab 12: Surface morphology by STM and roughness determination by AFM*	*Lab 15: Analysis of SIMS profile spectra*

Learning Resources	1. *Douglas B. Murphy, Michael W. Davidson, Fundamentals of light microscopy and electronic imaging, 2nd ed., John Wiley & Sons, 2013* 2. *Yang Leng, Materials characterization, introduction to microscopic and spectroscopic methods, 2nd ed., Wiley, 2013* 3. *Guy Cox, Optical imaging techniques in cell biology, CRC press, 2012*	4. *Ray, F. Egerton, Physical principles of electron microscopy, Springer, 2005* 5. *Bharat Bhusan, Scanning probe microscopy in nano-science and nanotechnology, Springer, 2013* 6. *Nan Yao, Zhong Lin Wang, Handbook of microscopy for nanotechnology, Kluwer Academic Publisher, 2005*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. N. Vijayan, CSIR-NPL, nvijayan@nplindia.org	*1. Prof. S. Balakumar, University of Madras, balakumar@unom.ac.in*	*1. Dr. C. M. Navaneethan, SRMIST*
2. Mr.K.R. Navaneethakrishnan, GLR Laboratories Pvt Ltd	*2. Dr. N. Vijayan, CSIR-NPL, nvijayan@nplindia.org*	*2. Dr. A. Karthigeyan,SRMIST*

Course Code	18NTC108T	Course Name	MODELING AND COMPUTATIONAL TOOLS	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Nanotechnology*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Know the basics of MATLAB and C++*
CLR-2 :	*Acquire detailed knowledge of Density Functional Theory*
CLR-3 :	*Utilize and gain knowledge of Molecular Dynamics*
CLR-4 :	*Solve in detail the Monte Carlo Method and problems*
CLR-5 :	*Understand the basics of modeling and computational tools*
CLR-6 :	*Know the materials modeling and to determine the desired properties*

		Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Execute and solve problems with the basics of computational tools*	2	80	75	M	M	H	H	H	M	M	H	H	H	M	H	H	H	H
CLO-2 :	*Utilize the principles of DFT*	2	80	70	H	M	H	M	M	M	M	H	M	M	M	H	M	M	M
CLO-3 :	*Apply the knowledge of molecular dynamics to solve problems*	2	75	70	M	M	H	H	H	H	H	M	M	H	M	H	H	H	H
CLO-4 :	*Solve and perform modeling with Monte Carlo method*	2	80	75	H	H	M	H	H	M	H	H	H	M	H	M	H	H	H
CLO-5 :	*Execute the computational codes and tools*	2	80	70	M	M	H	H	H	H	M	H	H	H	M	H	H	H	H
CLO-6 :	*Predict the physical properties from modeling and simulation*	2	80	70	M	H	H	H	H	M	M	M	H	H	M	H	H	H	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Introduction to MATLAB-Arrays and Matrices-Matrix operation*	*Introduction to MATLAB*	*Schrodinger equation*	*Classical molecular dynamics*	*Monte-Carlo method: Introductory examples*
	SLO-2	*Eigen value problem*	*Arrays*	*Schrodinger equation for Many Body problem*	*Discussions on Classical molecular dynamics*	*Brief history*
S-2	SLO-1	*Solution of simultaneous equation*	*Matrices-Matrix operation*	*Born-Oppenheimer approximation*	*Tight bindingmolecular dynamics*	*Fundamental key concepts*
	SLO-2	*Arithmetic operations*	*Inverse of a Matrix*	*Introduction to DFT*	*Discussions on Tight bindingmolecular dynamics*	*Transformation methods*
S-3	SLO-1	*Logical operations*	*Eigen value problem*	*Hohenberg-Kohn Theorem 1*	*The basics of molecular dynamics (MD) algorithm*	*Rejection sampling*
	SLO-2	*If-else clause*	*Problems on Eigen value problem*	*Discussions on Hohenberg-Kohn theorem 1*	*Discussions with examples on MD algorithim*	*Discussions of Rejection sampling*
S-4	SLO-1	*Loop control structure and statements*	*Arithmetic operations*	*Hohenberg-Kohn Theorem 2*	*Verlet algorithms*	*Importance sampling*
	SLO-2	*Break statement, Switch statement*	*Logical operations*	*Discussions on Hohenberg-Kohn theorem 2*	*Discussions Verlet algorithms*	*Discussions on Importance sampling*
S-5	SLO-1	*Self-consistent method*	*Loop control structure and statements*	*Kohn-Sham Equation*	*Predictor - Corrector algorithm*	*Integration by importance sampling-theory*
	SLO-2	*Functions-data visualization in 2D and 3D*	*Break statement*	*Discussion on Kohn-Sham Equation*	*Discussions on - Corrector algorithm*	*Integration by importance sampling-example*
S-6	SLO-1	*Introduction to C++*	*Switch statement*	*Exchange-correlation functions LDA (Basic Concept)*	*MD in different ensembles*	*Metropolis algorithm*
	SLO-2	*Algorithms*	*If and else if statements*	*LDA (explanation of the equation)*	*Discussions MD in different ensembles*	*Discussions on Metropolis algorithm*

S-7	SLO-1	*Structured-programing*	*Functions-data visualization in 2D*	*Exchange-correlation functions GGA (Basic Concept)*	*Examples of MD simulation*	*Introduction to Kinetic Monte Carlo (KMC)*
	SLO-2	*I/O statements*	*Examples on data visualization in 2D*	*GGA (explanation of the equation)*	*Discussions on qualitative results*	*Qualitative discussions and basic concept*
S-8	SLO-1	*Controlstatements*	*Functions-data visualization in 3D*	*Basis set*	*Temperature variation effects in MD*	*Introduction to Quantum Monte Carlo (QMC)*
	SLO-2	*Looping (loop statement)*	*Examples on data visualization in 3D*	*Types of basis set (basic level)*	*Examples on Temperature variation effects in MD*	*Qualitative discussions and basic concept*
S-9	SLO-1	*Matrix: Basic matrix operations*	*Basic concept of Computer clusters, Master Node, Working Node*	*Flow chart of DFT scfprocedure*	*Limitations of MD*	*Merits and demerits of KMC and QMC*
	SLO-2	*Basic idea of parallel programing*	*Bewolf and Shared memory clusters in introductory level*	*Discussions on Flow chart*	*Case study examples*	*Case study examples*

Learning Resources

1. *Jörg-Rüdiger Hill, Lalitha Subramanian, AmiteshMaiti, Molecular modeling techniques inmaterial sciences, Taylor & Francis 2005*
2. *J.M. Thijssen, Computational Physics, Cambridge University Press, 2007*
3. *Andrew R. Leach, Molecular modelling: principles and application, Pearson Education, 2001*
4. *Rizwann Butt, Introduction to Numerical Analysis using MATLAB, Jones and Bartlett Publishers, 2008*
5. *Daan Frenkel and BerendSmit, Understanding molecular simulation: from algorithms to applications, Academic Press, 2001*
6. *Feliciano Giustino, Materials Modelling using Density Functional Theory: Properties and Predictions, Oxford University Press, 2014*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Hemant Dixit, GlobalFoundaries,USA, aplahemant@gmail.com	*1. Dr. Ranjit Kumar Nanda, IIT Madras, nandab@iitm.ac.in*	*1. Dr. RanjitThapa, SRMIST*
2. Dr. Murali Kota, Global Foundaries,USA, kvrmmurali@gmail.com	*2. Dr. Biswarup Pathak, IIT Indore, biswarup@iiti.ac.in*	*2. Dr. Saurabh Ghosh, SRMIST*

Course Code	18NTC109T	Course Name	SOLID STATE ENGINEERING	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Nanotechnology*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Acquire knowledge on various chemical bonding in solids*
CLR-2 :	*Understand theory of crystal diffraction, vibrations and heat capacity*
CLR-3 :	*Describe the concept of free electron Fermi gas and transport properties*
CLR-4 :	*Classify semiconductors, metals and insulators via band theory*
CLR-5 :	*Gain knowledge on excitons, plasmons, polarons and polaritons*
CLR-6 :	*Understand the principles of Raman and optical spectroscopy*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO - 3
CLO-1 :	*Apply the principles of chemical bonding to understand elastic properties of solids*	2	80	75	H	M	H	H	H	M	M	H	H	H	M	H	H	H	H
CLO-2 :	*Analyze crystalline materials and their thermal properties using the concept of phonons*	2	80	70	H	M	M	H	M	M	M	H	M	H	M	H	M	M	M
CLO-3 :	*Utilize the Fermi-Dirac distribution function for electrical transport properties of solids*	2	75	70	H	M	H	H	H	H	H	M	H	H	H	H	H	H	H
CLO-4 :	*Calculate carrier concentration and mobility of metals and intrinsic and extrinsic semiconductors*	2	80	75	M	H	H	M	H	H	H	H	H	H	M	H	H	H	H
CLO-5 :	*Apply the concept of quasi-particles to understand the optical properties of solids*	2	80	70	H	M	H	H	H	M	M	H	M	H	M	H	H	H	H
CLO-6 :	*Utilize the spectroscopic concepts to analyze the properties of materials*	2	80	75	H	M	M	H	H	M	M	H	H	H	M	H	H	M	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Interatomic forces: Understanding of crystal binding*	*Crystal diffraction*	*Free electron gas*	*Nearly free electron model*	*Electronic interband transitions*
	SLO-2	*Bonding in solids*	*Bragg's law*	*Energy levels of free electron gas in one dimension*	*Nearly free electron model (Quantitative approach)*	*Direct and indirect transitions*
S-2	SLO-1	*Van der Waals interaction*	*Reciprocal lattice vectors and Brillouin Zones (BZ)*	*Fermi- Dirac distribution*	*Origin and magnitude of the energy gap*	*Concept of excitons*
	SLO-2	*Quantitative approach of London interaction*	*BZ of square lattice and oblique lattice*	*Effect of temperature on the Fermi – Dirac distribution function*	*Bloch function*	*Energy level diagram of excitons*
S-3	SLO-1	*Equilibrium lattice constants*	*Vibration of crystals with monoatomic basis*	*Free electron gas in three dimensions (Quantitative approach)*	*Classification of solids using band gap*	*Frenkelexcitons*
	SLO-2	*Cohesive energy*	*Dispersion relation*	*Fermi energy, density of states*	*Metals, semiconductors and insulators*	*Frenkelexcitons in alkali halides and molecular crystals*
S-4	SLO-1	*Nature of bonding in ionic crystals*	*Group velocity*	*Heat capacity of the free electron gas*	*Direct and indirect band gap semiconductors*	*Mott-Wannierexcitons*
	SLO-2	*Madelung constant*	*Quantization of elastic waves (concept of phonon)*	*Heat capacity of the free electron gas (Quantitative approach)*	*Relation between bandgap energy, photon and phonon energy*	*Modified Rydberg's equation*
S-5	SLO-1	*Madelung energy*	*Phonon heat capacity-Planck's distribution*	*Electrical conductivity*	*Concept of holes in semiconductors*	*Quantitative approach for Raman effect*
	SLO-2	*Evaluation of Madelung constant*	*Normal modes*	*Ohm's law*	*Effective mass*	*Application: Raman effect in solids*
S-6	SLO-1	*Covalent bonding*	*Phonon -density of states (modes) in one dimensions*	*Electrical resistivity*	*Intrinsic carrier concentration*	*Concept of plasmons in metals*
	SLO-2	*Metallic and hydrogen bonding*	*Phonon- density of states (modes) in three dimensions*	*Matthiessen's rule*	*Intrinsic carrier concentration – quantitative approach*	*Plasma frequency*

S-7	SLO-1	*Hooke's law in solids*	*Debye model for density of states (modes)*	*Motion of electron in magnetic field*	*Impurity conductivity: doping*	*Concept of polarons*
	SLO-2	*Elastic strain components (Quantitative treatment)*	*Cutoff frequency in Debye solids*	*Cyclotron frequency*	*Donor and acceptor states*	*Concept of polaritons*
S-8	SLO-1	*Dilation in solids*	*Debye – T^3 law*	*Hall effect: quantitative approach*	*Zener tunneling, Zener breakdown and Zener diodes*	*Defects in solids – lattice vacancies*
	SLO-2	*Elastic stress components*	*Debye – T^3 law (Quantitative approach)*	*Hall coefficient*	*Avalanche bvreakdown and Avalanche diodes*	*Schottky and Frenkel defects*
S-9	SLO-1	*Elastic compliance components*	*Einstein model for density of states*	*Thermal conductivity of metals: Wiedemann-Franz law*	*Super lattices and quantum wells*	*Color centers: F centers*
	SLO-2	*Elastic stiffness components*	*Einstein model for density of states – quantitative approach*	*Lorentz number*	*Multi Quantun well light emitting diodes (MQW-LEDs)*	*Other centers in alkali halides*

Learning Resources	1. *C. Kittel, Introduction to Solid State Physics, 8th ed., Wiley, 2015* 2. *Fundamentals of Solid State Engineering, ManijehRazeghi, Kluwer Academic Publishers, 2002*	3. *Solid State Electronic Devices, Ben. G. Streetman amd Sanjay Banerjee, 7thEdison, Pearson, 2006*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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2. Dr. Krishna Surendra Muvvala, Saint Gobain Research, India, Krishna.muvvala@saintgobain.com	*2. Dr. M. S. Ramachandra Rao, IIT Madras, msrrao@iitm.ac.in*	*2. Dr. Kamala Bharathi, SRMIST*

ACADEMIC CURRICULA

Professional Elective Courses

ELECTRONICS AND COMMUNICATION ENGINEERING

Regulations - 2018

SRM
INSTITUTE OF SCIENCE & TECHNOLOGY
(Deemed to be University u/s 3 of UGC Act, 1956)

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Kancheepuram, Tamil Nadu, India

Course Code	18ECE203T	Course Name	SEMICONDUCTOR DEVICE MODELING	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*18ECC102J*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Electronics and Communication Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Utilize the properties of semiconductor materials*
CLR-2 :	*Utilize the mechanisms that occur in a PN junction*
CLR-3 :	*Utilize the characteristics and modeling of BJT*
CLR-4 :	*Utilize the modeling aspects of MOSFET*
CLR-5 :	*Identify the effects of MOSFET scaling and special MOSFETs*
CLR-6 :	*Understand the fundamental physical processes of semiconductor devices to meet the challenge of these dynamic fields.*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1 Level of Thinking (Bloom)	Learning 2 Expected Proficiency (%)	Learning 3 Expected Attainment (%)	PLO 1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	13 PSO - 1	14 PSO - 2	15 PSO - 3
CLO-1 :	*Identify and Choose semiconductor materials for various applications*	2	80	70	H	H	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	*Interpret the characteristics of Junction devices*	3	85	75	H	H	-	H	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	*Modify and model the BJT parameters for better performance*	3	75	70	H	H	-	H	-	-	-	-	-	-	-	-	-	-	H
CLO-4 :	*Evaluate and optimize the performance of MOSFET*	3	85	80	H	H	-	H	-	-	-	-	-	-	-	-	-	-	H
CLO-5 :	*Build new devices with small channel*	3	85	75	H	-	-	H	-	-	-	-	-	-	-	-	-	-	H
CLO-6 :	*Explain the equations, approximations and techniques available for deriving a model with specified properties, for a general device characteristic with known qualitative theory*	3	80	70	H	H	-	H	-	-	-	-	-	-	-	-	-	-	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Electron, Hole Densities In Equilibrium: Distribution of quantum states in energy band*	*PN Junction under thermal equilibrium: Built in potential, concept of space charge layer*	*Current components, Basic BJT parameters,*	*MOS diode*	*Scaling of MOSFETS*
	SLO-2	*Fermi – Dirac Statistics*	*Problem Solving*	*Limitations on the junction voltage*	*Operation of Ideal MOS diode (at VGB >0)*	*Effect of Gate voltage on carrier mobility*
S-2	SLO-1	*Electron concentration conduction band*	*Distribution of electric filed and potential within the space charge layer for abrupt junctions at Zero bias*	*Capacitances in a BJT,*	*Operation of ideal MOS diode (at VGB <0)*	*Effect of Drain voltage on carrier mobility*
	SLO-2	*Hole concentration Valence band*	*Distribution of electric filed and potential within the space charge layer for abrupt junctions at Zero bias*	*Switching of BJT*	*Operation of ideal MOS diode with and without oxide charge*	*Effect of Drain voltage on carrier mobility*
S-3	SLO-1	*Carrier concentration in intrinsic semiconductors*	*Distribution of electric filed and potential within the space charge layer for linearly graded junctions at Zero bias*	*Ebers-Moll model*	*Effects of mobile Ionic charges*	*Channel length modulation*
	SLO-2	*Position of Fermi level in extrinsic semiconductors*	*Distribution of electric filed and potential within the space charge layer for linearly graded junctions at Zero bias*	*Problem Solving*	*Problem Solving*	*Breakdown and punch through*
S-4	SLO-1	*Ionization of impurities, Equilibrium electron and hole concentration*	*PN Junction under applied bias: Depletion layer capacitance in an abrupt PN junctions*	*Early effect (CB & CE)*	*Oxide charges and Interface states*	*Sub threshold current*
	SLO-2	*Problem Solving*	*Problem Solving*	*Operation of BJT at high frequencies: Charge control model*	*C-V Characteristics*	*Sub threshold current*
S-5	SLO-1	*Fermi level at thermal equilibrium*	*Depletion layer capacitance with arbitrary doping profiles*	*Small signal equivalent circuit,*	*Problem Solving*	*Short channel effects*

	SLO-2	*Problem Solving*	*Static current voltage characteristics of PN junction,*	*Problem Solving*	*Threshold voltage of MOSFET*	*Short channel effects*
S-6	SLO-1	*Excess Carriers: Generation and recombination of carriers*	*Current-voltage relationship in an infinitely long diode,*	*Design of high frequency transistors*	*Bulk charge model*	*Meyer's model*
	SLO-2	*Mobility of carriers*	*Quasi Fermi level under bias condition*	*Problem Solving*	*Problem Solving*	*Small signal model*
S-7	SLO-1	*Charge transport in semiconductors: Drift current*	*Current –voltage relation in practical diodes having finite lengths*	*Second order effects in BJT: Non-uniform doping in the base*	*square law method (Level 1 in SPICE*	*MOSFET scaling*
	SLO-2	*Hall effect*	*Ideality factor*	*Non-uniform doping in the base*	*square law method (Level 1 in SPICE*	*Non-uniform doping in channel*
S-8	SLO-1	*Diffusion current*	*Transient analysis: Time variation of stored charge*	*Variation of β with collector current*	*Level 3 model in SPICE*	*SOI MOSFET*
	SLO-2	*Problem Solving*	*Problem Solving*	*High injection in collector*	*BSIM Models*	*SOI MOSFET*
S-9	SLO-1	*Current density equations*	*Reverse recovery of a diode, charge storage capacitance*	*Heavy doping effects in the emitter*	*Comparison of Models*	*Buried channel MOSFET*
	SLO-2	*Current density equations*	*Problem Solving*	*emitter crowding in bipolar transistors*	*Comparison of Models*	*Fin FET*

Learning Resources	1. *Nandita Das Gupta, Amitava Das Gupta, Semiconductor devices, modeling and Technology, Prentice Hall of India, 2004* 2. *Philip. E. Allen Douglas, R. Hoberg, CMOS Analog circuit Design, 2nd ed., Oxford Press, 2002*	3. *S.M. Sze, Semiconductor Devices-Physics and Technology, John Wiley and Sons, 1985.* 4. *Kiat Seng Yeo, Samir R.Rofail, Wang-Ling Gob, CMOS/BiCMOS VLSI-Low Voltage, Low Power, Pearson 2003*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*1. Dr. P. Aruna Priya, SRMIST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	*2. Dr. J. Manjula, SRMIST*

Course Code	18ECE206J	Course Name	ADVANCED DIGITAL SYSTEM DESIGN	Course Category	E	Professional Elective	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Understand advanced Boolean theorems for logic simplification and implementation*
CLR-2 :	*Understand the formal procedures for the analysis and design of synchronous and asynchronous sequential circuits*
CLR-3 :	*Understand concept of Programmable Devices (PROM, PLA, PAL, CPLD and FPGA) and implement combinational and sequential logic circuits using them.*
CLR-4 :	*Adopt systematic approach with the use of ASM chart ASMD chart, RTL representation for the design of digita circuits and systems*
CLR-5 :	*Use VHDL as a design-entry language for FPGA in electronic design automation of digital circuits*
CLR-6 :	*Develop the ability to simulate circuits for more advanced design projects.*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1	Learning 2	Learning 3	Program Learning Outcomes (PLO) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Apply advanced theorems to simplify the design aspects of various practical circuits*	3	80	75	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	*Analyze and design synchronous sequential circuits*	3	80	70	-	M	M	-	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	*Identify methods to analyze and design Asynchronous sequential circuits*	3	75	70	-	M	M	-	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	*Implement various digital circuits using Programmable Logic Devices*	3	80	75	-	M	M	-	-	-	-	-	-	-	-	-	-	-	-
CLO-5 :	*Design and implement digital circuits using VHDL.*	3	80	70	-	H	H	H	H	-	-	L	H	M	-	-	-	-	L
CLO-6 :	*Perform experiments in the laboratory with hardware and as well with software (VHDL) to simulate and verify the design*	3	80	70	-	-	-	-	-	-	-	-	-	-	-	H	H	-	L

Duration (hour)		12	12	12	12	12
S-1	SLO-1	*Shannon's Expansion theorem*	*state reduction*	*Analyze asynchronous sequential circuit*	*Dynamic hazards*	*Xilinx 3000 series FPGA*
	SLO-2	*Shannon's Expansion theorem application*	*state reduction*	*flow table reduction*	*Essential hazards*	*Xilinx 3000 series FPGA*
S-2	SLO-1	*Shannon's Expansion theorem and its application*	*state assignment*	*races-state assignment*	*Programming logic device families*	*Xilinx 4000 series FPGA*
	SLO-2	*Consensus theorem*	*state assignment*	*Variables Signals, Constants, Sequential statements VHDL processes*	*Designing synchronous sequential circuit using PROM*	*Xilinx 4000 series FPGA*
S 3-4	SLO-1 SLO-2	*Lab 1: Implement six-variable function using four-variable function generators*	*Lab 4: Implement hazard-free circuits*	*Lab 7: VHDL Programming Practice*	*Lab 10: Construct multiplexers, de-multiplexers in VHDL*	*Lab13: Implement BCD adder, comparator in VHDL*
S-5	SLO-1	*Reed-Muller Expansion technique*	*Design of synchronous sequential circuits*	*races-state assignment*	*Designing synchronous sequential circuit using PROM*	*Design of sequential circuits (using VHDL)*
	SLO-2	*Reed-Muller Expansion technique*	*Design of synchronous sequential circuits*	*Transition table and problems in transition table*	*Designing synchronous sequential circuit using PROM*	*Design of sequential circuits (using VHDL)*
S-6	SLO-1	*Multiplexer logic as function generators*	*Introduction to VHDL, Entity and Architecture description*	*Transition table and problems in transition table*	*Programmable Array Logic (PAL)*	*Design of sequential circuits (using VHDL)*
	SLO-2	*Implementation of Multiple output logic functions*	*VHDL Data types and Operators*	*Design of asynchronous sequential circuit*	*Programmable Array Logic (PAL)*	*Design of sequential circuits (using VHDL)*
S 7-8	SLO-1 SLO-2	*Lab 2: Implement Reed-Muller expressions using logic gates.*	*Lab 5: Demo of VHDL programmes, Simple programmes*	*Lab 8: Combinational Circuit Design using Structural, behavioral, data flow modeling*	*Lab 11: Construct code converters, 4-bit binary adders in VHDL*	*Lab 14: Mini Project Work*
S-9	SLO-1	*Mealy and Moore machines*	*ASM chart and realization using ASM*	*Design of asynchronous sequential circuit*	*Programmable Logic Array (PLA)*	*Additional circuit designs using VHDL*

	SLO-2	*Clocked synchronous sequential circuit design procedure*	*ASM chart and realization using ASM*	*Design of asynchronous sequential circuit*	*Programmable Logic Array (PLA)*	*Additional circuit designs using VHDL*
S-10	SLO-1	*State diagrams*	*Concurrent, Sequential Assignment Statements, Types of Modeling in VHDL*	*Static hazards*	*FPGA-Xilinx FPGA*	*Additional system designs using VHDL*
	SLO-2	*State table*	*Behavioral, dataflow and structural modeling*	*Static hazards*	*FPGA-Xilinx FPGA*	*Additional system designs using VHDL*
S 11-12	SLO-1	*Lab 3: Implementation of Sequence detector circuit.*	*Lab 6: VHDL Programming Practice*	*Lab 9: Implement Combinational Circuits using Structural, behavioral and data flow modeling- Arithmetic circuits, decoders, encoders.*	*Lab 12: BCD adder, comparator, Design of Sequential circuits (using VHDL)*	*Lab 15: End-Semester Practical Examinations*
	SLO-2					

Learning Resources	1. *Charles H. Roth, Jr. University of Texas at Austin. Larry L. Kinney, Fundamentals of Logic Design, 7th ed., Cengage Learning, 2012* 2. *Richard S. Sandige, Michal L. Sandige, Fundamentals of digital and computer design with VHDL, Mc Graw Hil, 2014*	3. *Jayaram Bhasker, A VHDL Primer, 3rd ed., Prentice Hall, 2011* 4. *Charles. H. Roth, Jr, Digital Systems Design using VHDL, CENGAGE Learning, 2010* 5. *Morris Mano M, Michael D. Ciletti, Digital Design with an Introduction to the Verilog HDL, 5th ed., Pearson, 2014*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100%	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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Course Code	18ECE222T	Course Name	ADHOC AND SENSOR NETWORKS	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Utilize the Ad hoc Networks and its various routing protocols
CLR-2 :	Learn the MAC Layer and the concept of Quality of Service
CLR-3 :	Analyze energy management in Ad hoc Networks
CLR-4 :	Identify insights of Sensor network
CLR-5 :	Analyze various aspects Hybrid networks and routing configuration
CLR-6 :	Expose to the different types of adhoc network routing protocols and sensor networks

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO–1: Professional Achievement	14: PSO – 2: Project Management Techniques	15: PSO – 3: Analyze & Research
CLO-1 :	Acquire knowledge about Ad hoc Networks and various routing protocols used in Ad hoc networks	3	80	75	H	M	L	M	-	-	H	-	-	-	-	M	-	-	H
CLO-2 :	Analyze the various functional areas such as MAC Layer and QOS	3	80	70	H	M	-	M	-	-	H	-	-	-	-	M	M	-	H
CLO-3 :	Identify energy management in Ad hoc Networks	3	75	70	L	H	-	M	-	-	M	-	-	-	-	H	-	-	L
CLO-4 :	Analyze the Sensor network	3	80	75	H	L	-	M	-	-	-	-	-	-	-	-	-	M	H
CLO-5 :	Identify Hybrid networks and routing configuration	3	80	70	-	-	H	M	-	-	M	-	-	-	-	-	-	-	-
CLO-6 :	Understand the various types of adhoc networks and sensor networks	3	80	70	H	M	-	L	-	-	H	-	-	-	-	M	-	-	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Cellular and Ad hoc Wireless Networks	Quality of service in Ad hoc wireless networks, Real-Time Traffic support	Energy Management-Needs	Sensor Networks, Applications. Comparison with Ad hoc network,	Hybrid wireless network, Introduction, classification
	SLO-2	Applications of Ad hoc Wireless Networks	Issues and challenges in providing QoS	Classifications of Energy Management Schemes	Issues, challenges in designing sensor network Sensor Network Architecture	Multi-hop cellular network (MCN) Architecture
S-2	SLO-1	Issues in Ad hoc Wireless Networks	Classifications of QoS solutions	Battery Management Scheme-Overview,	Layered Architecture, Clustered Architecture	Mobile assisted data forwarding (MADF) Architecture
	SLO-2	MAC Protocol for Ad hoc Networks Issues in Designing and Design Goals	MAC Layer solution-cluster TDMA, IEEE 802.11e, DBASE	Data link layer solution-Lazy packet scheduling scheme,	Data Dissemination, Flooding, Gossiping, Rumor Routing, Sequential Assignment Routing	Hybrid wireless Network (HWN) Architecture
S-3	SLO-1	Classifications of MAC protocols-Floor Acquition Multiple Access protocols	Network Layer solution-QOS routing protocols,	Battery Aware MAC protocol	Cost field approach	Routing in Hybrid wireless network Base assisted ad hoc routing (BAAR)
	SLO-2	Collision Avoidance Time Allocated Protocol	Ticket Based QOS Routing protocols,	Network Layer solution	Data Gathering, Direct Transmission, Binary scheme	Operation of BAAR protocol
S-4	SLO-1	Routing Protocol for Ad hoc wireless network-Classification	Predictive location based QOS routing	Transmission Power Management Schemes-Data link layer solution	Chain Based Three level scheme	Base driven multi-hop bridging protocol(BMBP)-Message used
	SLO-2	Table driven Routing Protocols-Wireless Routing Protocol	QOS frame work	Dynamic power adjustments policies, Distribute topology control Algorithm	MAC protocols for sensor Networks-Self organizing MAC, CSMA Based MAC	BMBP procedure
S-5	SLO-1	On demand routing protocols-Dynamic Source Routing protocol	QOS models	Construct distributed power control loop, Centralized Topology control Algorithm	Location discovery-Indoor and sensor network localization	Issues in pricing Multi-Hop wireless networks
	SLO-2	Multicast Routing Architecture Reference model	QOS Resource Reservation Signaling	Network layer solution-common power protocol	Quality of Sensor Networks-coverage,	Pricing in Multi-Hop wireless WANs
S-6	SLO-1	Tree Based Routing	INSIGNIA-QOS framework	Minimum power consumption Technique	Exposure	Pricing in Ad hoc Wireless Networks

	SLO-2	*Mesh Based Routing*	*Operation of INSIGNIA framework, Advantages and disadvantages*	*Minimum battery cost Routing*	*Recent Trends in Sensor Networks-Energy Efficient Design, synchronization*	*Power control scheme in Hybrid Wireless Networks, Issues in using variable power in IEEE 802.11*
S-7	SLO-1	*Energy Efficient Multicasting-Routing protocols*	*INORA-Coarse feedback scheme,*	*Higher Layer solution*	*Transport Layer Issue*	*Power optimization scheme*
	SLO-2	*Cluster Adaptation of Multicast protocols*	*Class based fine feedback scheme*	*System power management scheme, Processor power management*	*Security-Localized Encryption and Authentication protocols (LEAP)*	*Load Balancing in Hybrid Wireless Networks*
S-8	SLO-1	*Multicast with QOS Guarantees-Real Time Multicasting Protocols*	*SWAN-Model*	*Power saving Mode Power Aware Multi-Access Signaling*	*Intrusion Tolerant Routing in Wireless Sensor Network (INSENS)*	*Preferred Ring Based Routing Scheme*
	SLO-2	*Priority Scheduling Protocols*	*Advantages and Disadvantages*	*Addition of separate signaling scheme*	*Real –Time communication*	*Preferred inner Routing Scheme(PIRS)*
S-9	SLO-1	*Application Dependent Multi Cast Routing-Role Based,*	*Proactive RTMAC framework*	*Device power Management Scheme-Low Power Design of Hardware*	*SPEED Protocol*	*Preferred outer Ring Routing Scheme (PORS)*
	SLO-2	*Content Based, Location Based*	*Advantages and Disadvantages*	*Hard Disk Drive (HDD) power consumption*	*RAP protocols*	*Preferred Destination/Source Ring Based Routing Scheme*

Learning Resources	1. *Siva Ram Murthy C., Manoj B.S, Ad hoc Wireless Networks – Architectures and Protocols, 2nd ed., Pearson, 2004* 2. *Feng Zhao, LeonidasGuibas,Wireless Sensor Networks, 1st ed., Morgan Kaufman Publishers, 2004*	3. *C.K.Toh, Ad hoc Mobile Wireless Networks, 7th ed., Pearson, 2002* 4. *Thomas Brag, Sebastin Buettrich, Wireless Mesh Networking, 3rd ed., O'Reilly Publishers, 2007*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Mr. Anuj Kumar, Bombard*ier Transportation, Ahmedabad, *kumaranuj.anii@gmail.com*	1. *Dr. Meenakshi, Professo*r of ECE, CEG, Anna University, *meena68@annauniv.edu*	*1. Mrs. S. T. Aarthy, SRM IST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECE224T	Course Name	CRYPTOGRAPHY AND NETWORK SECURITY	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Utilize classical and modern encryption methods
CLR-2 :	Utilize the different key generation standards
CLR-3 :	Utilize the various techniques in authentication of information
CLR-4 :	Analyze the aspects in network security
CLR-5 :	Identify the effect of various malwares and counter measures
CLR-6 :	Understand various conventional and modern cryptography techniques with its added security features

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO–1: Professional Achievement	PLO 14: PSO – 2: Project Management Techniques	PLO 15: PSO – 3: Analyze & Research
CLO-1 :	Identify the methods of classical and modern Encryption	3	80	75	-	-	M	L	-	-	-	-	-	-	-	H	-	-	H
CLO-2 :	Identify the concepts of Number theory, Key generation and distribution standards	3	80	70	L	H	M	-	-	-	-	-	-	-	-	-	-	H	-
CLO-3 :	Analyze Message authentication and Digital Signature algorithm.	3	75	70	-	M	L	-	-	-	-	-	-	-	-	H	-	-	M
CLO-4 :	Obtain information about various forms of network security	3	80	75	H	M	L	-	-	-	-	-	-	-	-	-	-	-	M
CLO-5 :	Analyze the effects of intrusion, viruses, firewalls and various levels of system security	3	80	70	L	-	-	-	-	-	-	-	-	-	-	M	-	M	-
CLO-6 :	Obtain the knowledge about various encryption techniques, standards and security aspects	3	80	70	M	-	-	L	-	-	-	-	-	-	-	-	-	-	M

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Security Services Mechanisms	Number Theory	Basics of Message authentication codes	IP Security	Intruders
	SLO-2	Attacks	Basics of Modulo operations, additive and multiplicative inverse	Basics of Message authentication codes	Overview of techniques	Intrusion
S-2	SLO-1	Network Security Model	Euclidean algorithm	Requirements of MAC	Architecture	Intrusion Detection
	SLO-2	Block cipher, stream cipher, symmetric and Assymetric	Extended Euclidean algorithm	MAC logic	Authentication Header	Techniques
S-3	SLO-1	Conventional Encryption techniques	Fermet's theorem	MD5 Logic, MD5 Compression Function,	Authentication Protocols	Password Management
	SLO-2	Substitution and transposition techniques	Euler's theorem	MD4, Strength of MD5	Mututal authentication, one way authentication	Techniques
S-4	SLO-1	Steganography	Key cryptography	Requirements for a Hash Function, simple Hash Function,	Encapsulating Security Payload	Viruses
	SLO-2	Basics of LSB, Histogram,DE techniques	Key cryptography	Birthday Attacks, Block Chaining Techniques	Encapsulating Security Payload	Worms
S-5	SLO-1	DES	RSA	Securities	Security Associations	Advanced Security
	SLO-2	Algorithm and examples	Algorithms and examples	HASH - MAC	Techniques overview	OS Security
S-6	SLO-1	SDES	Key distribution	Birthday Attack	Kerbros V4, V5 certificate	WLAN Security
	SLO-2	Block cipher modes operation	Algorithms	SHA	Authentication Procedure	Ad hoc Network Security

S-7	SLO-1	*Overview of IDEA*	*Key Management*	*Digital Signature standard*	*PGP*	*GSM Security*
	SLO-2	*Overview of Blowfish*	*Algorithms*	*Overview of blocks*	*Email Security*	*E-commerce Security*
S-8	SLO-1	*Overview of RC5*	*Diffie Hellman key exchange*	*Digital Signature Algorithms*	*Web security requirements*	*Cloud Computing Security*
	SLO-2	*Overview of CAST-128*	*Diffie Hellman key exchange*	*Examples*	*SSL -TLS - SET*	*Introduction to Firewall*
S-9	SLO-1	*Characteristics of advanced symmetric Block ciphers*	*Elliptic curve cryptography*	*Basics of proof*	*Port Scanning*	*Firewall-Types, configurations*
	SLO-2	*Characteristics of advanced symmetric Block ciphers*	*Elliptic curve cryptography*	*Proof of DSS Message Authentication Codes.*	*Port Knocking*	*Trusted System*

Learning Resources	1. *William Stallings, Cryptography & Network Security,6th ed., Pearson, 2014* 2. *Bruce Schneier, Applied Cryptography, 2nd ed., 2015* 3. *Eric Maiwald,Fundamentals of Network Security, Tata McGraw Hill, 2011*	4. *BehrouzA.Forouzan, Debdeep Mukhopadhyay, Cryptography and Network Security, 2nd ed., Tata McGraw Hill, 2010* 5. *Bernard Menezes, Network Security and Cryptography, Cengage Learning, 2010*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,\

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2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECE321T	Course Name	RF AND MICROWAVE SEMICONDUCTOR DEVICES	Course Category	E	*Professional Elective*	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*18ECC102J*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Electronics and Communication Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Study microwave semiconductor materials and to understand the fundamental of electronic components under microwave signal*
CLR-2 :	*Learn about microwave components and devices that are used in modern microwave radar and communication systems*
CLR-3 :	*Know the characteristics and operation of microwave transistor.*
CLR-4 :	*Know the fundamentals of RF power transistors and challenges*
CLR-5 :	*Discuss the main issues and challenges encountered in developing the products at microwave frequencies*
CLR-6 :	*Acquire deep understanding of development of RF and modern semiconductor devices*

		Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	*Understand the properties of Semiconductor Junction Diodes under microwave signals*	*3*	*80*	*75*	*H*	-	-	*H*	-	-	-	-	-	-	-	-	*H*	-	-
CLO-2 :	*Analyze the development of negative resistance characteristics in tunnel diode and transit time devices*	*3*	*80*	*70*	*H*	-	-	*M*	-	-	-	-	-	-	-	-	*H*	-	-
CLO-3 :	*Characterize the microwave components and circuits in terms of their performance parameters*	*3*	*75*	*70*	*H*	-	-	*H*	-	-	-	-	-	-	-	-	*H*	-	*H*
CLO-4 :	*Compare the characteristics of RF power transistors*	*3*	*80*	*75*	*H*	-	-	*M*	-	-	-	-	-	-	-	-	*M*	-	-
CLO-5 :	*Appreciate IC packaging issues and challenges involved at microwave frequencies*	*3*	*80*	*70*	*H*	-	*H*	-	-	-	-	-	-	-	-	-	*H*	-	*M*
CLO-6 :	*Understand the concepts of RF and semiconductor devices and apply in the design of electronic systems.*	*3*	*80*	*70*	*H*	*H*	-	-	-	-	-	-	-	-	-		*H*	-	*H*

		Semiconductor P-N Junction	**Negative Resistance and Transit Time Devices**	**Microwave BJT Transistors**	**HEMT Transistors and RF Power Transistor**	**RF Package Design and Development**
Duration (hour)		**9**	**9**	**9**	**9**	**9**
S-1	SLO-1	*Review of properties of semiconductors*	*Negative Resistance Devices*	*Microwave Transistor*	*Introduction to HEMT*	*Introduction to RF Package*
	SLO-2	*Review of properties of semiconductors*	*Negative Resistance Devices*	*High frequency limitations of BJT*	*Short channel effects*	*Introduction to RF Package*
S-2	SLO-1	*Transient and ac behavior of p-n junctions*	*Tunnel Diode, Tunneling process in p-n junction*	*Microwave bipolar transistors – introduction*	*Device operation*	*Thermal Management*
	SLO-2	*Transient and ac behavior of p-n junctions*	*V-I characteristics and device performance*	*Microwave bipolar transistors – operation*	*Device operation*	*Thermal Management*
S-3	SLO-1	*Effect of doping profile on the capacitance of p-n junctions*	*MIS tunnel diodes*	*Hetero junction bipolar transistors*	*Device design*	*Mechanical Design*
	SLO-2	*Effect of doping profile on the capacitance of p-n junctions*	*V-I characteristics and device performance*	*Basic principle of operation*	*Scaling issues*	*Mechanical Design*
S-4	SLO-1	*Noise in p-n junctions*	*Backward Diode*	*Kirk effect*	*Material Systems for HEMT Devices*	*Package electrical and electromagnetic Modeling*
	SLO-2	*Noise in p-n junctions*	*V-I Characteristics*	*High frequency response*	*GaAs HEMT*	*Package electrical and electromagnetic Modeling*
S-5	SLO-1	*Varactor diode*	*Transferred Electron Devices*	*MESFET*	*InP HEMT*	*Design verification*
	SLO-2	*Construction and Operation of Varactor Diode*	*Impact ionization*	*Principle of operation*	*Technology comparisons*	*Design verification*
S-6	SLO-1	*Applications of Varactor Diode*	*IMPATT*	*Properties of semiconductor materials used in MESFET*	*Technology comparisons*	*Materials testing*

	SLO-2	*Schottky effect*	*Small-signal analysis of IMPATT diodes*	*MESFET Technology*	*Introduction of RF power transistor*	*Reliability testing*
S-7	SLO-1	*Schottky barrier diode*	*TRAPATT, BARITT Diodes*	*MESFET Modeling*	*Figure of Merit for RF Power Transistor*	*computer integrated Manufacturing*
	SLO-2	*Applications of Schottky Diode*	*Two-valley model of compound semiconductors*	*I-V Characteristics*	*Common RF power devices*	*computer integrated Manufacturing*
S-8	SLO-1	*Hetero junctions*	*vd-E characteristics*	*High frequency performance*	*Material properties*	*Thermal modeling*
	SLO-2	*Hetero junctions*	*Gunn Effect, modes of operation*	*MISFET-Introduction*	*State-of-the-art-wide bandgap microwave transistor data*	*Thermal analysis of resistance networks*
S-9	SLO-1	*Construction and operation of microwave PIN diode*	*small-signal analysis of Gunn diode*	*Operating characteristics of MISFET*	*Challenges to production*	*Introduction to computer aided design*
	SLO-2	*Applications*	*Power-frequency limit.*	*Operating characteristics of MISFET*	*Challenges to production*	*Benefits, limitations and applications of CAD*

Learning Resources	*1. Golio, M., "RF and Microwave Semiconductor Devices Handbook", CRC Press (2002).* *2 Sze, S.M., and Ng, K.K., "Physics of Semiconductor Devices", 3rd Ed., Wiley-Interscience (2006).*	*3. Glover, I.A., Pennoek, S.R. and Shepherd P.R., "Microwave Devices, Circuits and Sub-Systems", 4th Ed., John Wiley & Sons (2005)* *4. Liao, S.Y., "Microwave Devices and Circuits", 4th Ed., Pearson Education (2002).*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECE240T	Course Name	WAVELETS AND SIGNAL PROCESSING	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	18ECC104T	Co-requisite Courses	Nil	Progressive Courses	18ECE341T
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Learn about multiresolution analysis and wavelet signal processing
CLR-2 :	Identify the families of wavelets required to apply the transformation to various real time applications
CLR-3 :	Study the of discrete systems that employs wavelet transformation
CLR-4 :	Study various filter banks of discrete systems used in wavelet transformation
CLR-5 :	Analyze various real time applications that employs filter banks
CLR-6 :	Acquire knowledge about wavelet transforms, types and applications of multiresolution analysis

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO–1: Professional Achievement	14: PSO – 2: Project Management Techniques	15: PSO – 3: Analyze & Research
CLO-1 :	Understand multi resolution analysis for discrete signals	3	80	75	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-2 :	Know the families of wavelets	3	80	70	H	-	M	-	-	-	-	-	-	-	-	-	-	-	M
CLO-3 :	Identify Discrete wavelet transform	3	75	70	M	M	M	-	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	Analyze and design filter banks	3	80	75	H	-	M	-	-	-	-	-	-	-	-	-	-	-	-
CLO-5 :	Utilize wavelet transformations on various applications	3	80	70	H	-	M	L	-	-	-	-	-	-	-	-	-	M	H
CLO-6 :	Know about wavelet transforms, types and applications of multiresolution analysis	3	80	70	M	H	-	-	-	-	-	-	-	-	-	-	-	-	-

		Multiresolution Analysis (MRA)	Families of wavelets	Discrete Wavelet Transform (DWT)	Filter banks	Applications
Duration (hour)		9	9	9	9	9
S-1	SLO-1	Introduction to multiresolution/ multiscale analysis	Orthogonal	Discretization in steps	Introduction to Variants of the wavelet transform	Transient analysis
	SLO-2	Introduction to multiresolution/ multiscale analysis	Orthogonal	Discretization in steps	Introduction to Variants of the wavelet transform	Transient analysis
S-2	SLO-1	Time-frequency analysis and wavelets	Biorthogonal wavelets	Discretization of scale	Implementational structures	Singularity detection
	SLO-2	Time-frequency analysis and wavelets	Biorthogonal wavelets	Discretization of scale	Implementational structures	Singularity detection
S-3	SLO-1	Piecewise constant approximation	Daubechies' family of wavelets	Generalized filter bank	The wavepacket transform	Biomedical signal processing applications
	SLO-2	Piecewise constant approximation	Daubechies' family of wavelets	Generalized filter bank	The wavepacket transform	Biomedical signal processing applications
S-4	SLO-1	Haar wavelet	Daubechies' family of wavelets	Discretization of translation	Computational efficiency in realizing filter banks	Efficient signal design and realization
	SLO-2	Haar wavelet	Conjugate Quadrature Filter Banks (CQF) and their design	Discretization of translation	Computational efficiency in realizing filter banks	Efficient signal design and realization
S-5	SLO-1	Building up the concept of dyadic Multiresolution Analysis (MRA)	Conjugate Quadrature Filter Banks (CQF) and their design	Generalized output sampling	Computational efficiency in realizing filter banks	Wavelet based modulation and demodulation
	SLO-2	Building up the concept of dyadic Multiresolution Analysis (MRA)	Conjugate Quadrature Filter Banks (CQF) and their design	Generalized output sampling	Polyphase components	Wavelet based modulation and demodulation
S-6	SLO-1	Relating dyadic MRA to filter banks	Data compression	Discretization of time/ space (independent variable)	Polyphase components	Applications in mathematical approximation
	SLO-2	Relating dyadic MRA to filter banks	Data compression	Discretization of time/ space (independent variable)	Polyphase components	Applications in mathematical approximation

S-7	SLO-1	*A review of discrete signal processing*	*Fingerprint compression standards*	*Going from piecewise linear to piecewise polynomial*	*The lattice structure*	*Applications to the solution of some differential equations.*
	SLO-2	*A review of discrete signal processing*	*Fingerprint compression standards*	*Going from piecewise linear to piecewise polynomial*	*The lattice structure*	*Applications to the solution of some differential equations.*
S-8	SLO-1	*Elements of multirate systems*	*JPEG-2000 standards*	*The class of spline wavelets*	*Solving Problems*	*Solving Problems*
	SLO-2	*Elements of multirate systems*	*JPEG-2000 standards*	*The class of spline wavelets*	*Solving Problems*	*Solving Problems*
S-9	SLO-1	*Two-band filter bank design for dyadic wavelets.*	*Solving problems*	*A case for infinite impulse response (IIR) filter banks*	*The lifting scheme.*	*Solving Problems*
	SLO-2	*Two-band filter bank design for dyadic wavelets.*	*Solving problems*	*A case for infinite impulse response (IIR) filter banks*	*The lifting scheme.*	*Solving Problems*

Learning Resources	1. *M. Vetterli, J. Kovacevic, Wavelets and Subband Coding, Prentice Hall, 1995* 2. *S. Mallat, A Wavelet Tour of Signal Processing, 2nd ed., Academic Press, 1999* 3. *P.P. Vaidyanathan, Multirate Systems and Filter Banks, Pearson Education, 1993* 4. *C.S.Burrus, Ramesh A. Gopinath, and Haitao Guo, Introduction to Wavelets and Wavelet Transforms: A Primer, Prentice Hall, 1997*	5. *Gilbert Strang, Truong Nguyen, Wavelets and Filter Banks, 2nd ed., Wellesley-Cambridge Press,1998.* 6. *Ingrid Daubechies, Ten Lectures on Wavelets, SIAM, 1992* 7. *Howard L. Resnikoff, Raymond O. Wells, "Wavelet Analysis: The Scalable Structure of Information", Springer, 1998*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Mr. Anuj Kumar, Bombard*ier Transportation, Ahmedabad, *kumaranuj.anii@gmail.com*	1. *Dr. Meenakshi, Professo*r of ECE, CEG, Anna University, *meena68@annauniv.edu*	*1. Dr. Sabitha Gauni, SRM IST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECE241J	Course Name	SIGNAL PROCESSING FOR AUDITORY SYSTEMS	Course Category	E	Professional Elective	L	T	P	C
							2	0	2	3

Pre-requisite Courses	*18ECC104T*	Co-requisite Courses	*Nil*	Progressive Courses	*18ECE343T*
Course Offering Department	*Electronics and Communication Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Learn basics of signal processing*
CLR-2 :	*Know Feature Extraction technique used in Speech Processing*
CLR-3 :	*Identify Frequency characteristics of Speech signal*
CLR-4 :	*Construct the Digital model of speech signal*
CLR-5 :	*Identify the Ethical issues of elements of music*
CLR-6 :	*Learn the basic of speech signal processing and its model*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO–1: Professional Achievement	PLO 14: PSO – 2: Project Management Techniques	PLO 15: PSO – 3: Analyze & Research
CLO-1 :	*Appreciate the functioning of the human vocal and auditory systems*	3	80	75	H	-	H	-	H	-	-	-	-	-	-	-	M	-	H
CLO-2 :	*Analyze the function of feature extraction in speech and audio signal processing using Time Domain Characteristics*	3	80	70	H	-	H	-	-	M	-	M	-	-	-	-	M	-	H
CLO-3 :	*Explore the frequency characteristics of speech signal*	3	75	70	H	-	H	H	-	-	-	-	-	-	-	-	M	-	H
CLO-4 :	*Apply appropriate Digital models for speech signal*	3	80	75	H	-	-	-	H	-	-	-	-	-	-	-	H	M	M
CLO-5 :	*Analyze the elements of music*	3	80	70	-	-	-	M	-	-	-	-	-	-	-	-	M	-	H
CLO-6 :	*Know about speech signal processing and its model*	3	80	70	H	-	H	-	H	-	-	-	-	-	-	-	H	-	M

		Basic Audio Processing using MATLAB	**Speech Signal Analysis in Time Domain**	**Speech Signal Analysis in Frequency Domain**	**Digital Models for Speech Signal**	**Time Elements in Music**
Duration (hour)		**12**	**12**	**12**	**12**	**12**
S-1	SLO-1	*Introduction to Digital audio*	*Speech signal analysis*	*Short Time Fourier analysis*	*Introduction to Acoustic Phonetics*	*Sound vibrations – pure tones and perception of pitch*
	SLO-2	*Capturing and converting sound*	*Segmental analysis*	*Filter bank analysis*	*Introduction to Acoustic Phonetics*	*Sound vibrations – pure tones and perception of pitch*
S-2	SLO-1	*Sampling of sound wave*	*Sub-segmental*	*Formant extraction*	*Acoustic theory of speech production:- Sound propagation*	*Auditory coding in the nervous system*
	SLO-2	*Handling audio in MATLAB*	*Supra segmental levels*	*Pitch Extraction*	*Acoustic theory of speech production:- Sound propagation*	*Auditory coding in the nervous system*
S 3-4	SLO-1 SLO-2	*Lab 1: Read & write a speech signal, Record a speech signal, playback, convert into a wave file, plot the speech signal, and spectrogram plot.*	*Lab 4: Short-term energy of a speech signal*	*Lab 7: Estimation of pitch period using simplified inverse filter tracking (SIFT) algorithm*	*Lab 10: Phoneme-level segmentation of speech*	*Lab 13:Feature Extraction of speech signal*
S-5	SLO-1	*Normalization*	*Time domain parameters of speech signal*	*Homomorphic speech analysis*	*Vocal tract transfer function of vowels*	*Subjective pitch and role of nervous system*
	SLO-2	*Audio processing*	*Time domain parameters of speech signal*	*Homomorphic speech analysis*	*Vocal tract transfer function of vowels*	*Subjective pitch and role of nervous system*
S-6	SLO-1	*Segmentation*	*Methods for extracting the parameters Energy*	*Formant and Pitch Estimation*	*Effect of nasal coupling*	*Acoustical energy –perception of loudness, pitch, timbre*
	SLO-2	*Analysis of window sizing*	*Methods for extracting the parameters Average Magnitude*	*Formant and Pitch Estimation*	*Excitation of sound in vocal tract*	*Pitch contour Musical Structure*
S 7-8	SLO-1 SLO-2	*Lab 2: Convert into a wave file, plot the speech signal, and spectrogram plot*	*Lab 5: Short-time Fourier transform magnitude spectrum*	*Lab 8: Estimation of pitch period using harmonic product spectrum*	*Lab 11: Estimation of sound in vocal tract*	*Lab 14: Speech production mechanism*

S-9	SLO-1	*Visualization*	*Zero crossing Rate*	*Linear Predictive analysis of speech*	*Vocal tract transfer function of vowels*	*Detecting beats, rhythm, meter*
	SLO-2	*Sound generation*	*Zero crossing Rate*	*Linear Predictive analysis of speech*	*Vocal tract transfer function of vowels*	*Recognizing pitch – melody*
S-10	SLO-1	*Speech production mechanism*	*Silence Discrimination using ZCR and energy*	*Autocorrelation method, Covariance method*	*Effect of nasal coupling*	*Auditory streaming*
	SLO-2	*Speech production mechanism*	*Silence Discrimination using ZCR and energy*	*Solution of LPC equations*	*Excitation of sound in vocal tract*	*Tonality and context – algorithms*
S 11-12	SLO-1	*Lab 3: Cepstrum smoothed magnitude spectrum*	*Lab 6: (i)Linear prediction magnitude spectrum (ii) Estimation of formant frequencies using linear prediction*	*Lab 9: Pitch and duration modification using time-domain pitch synchronous overlap and add (TD-PSOLA) method*	*Lab 12: Sound vibrations*	*Lab 15:Study of Feature extraction and SVM classifier*
	SLO-2					

Learning Resources	1. *Ian McLaughlin, Applied Speech and Audio processing, with MATLAB examples, 1st ed., Cambridge University Press, 2009* 2. *Ben Gold, Nelson Morgan, Dan Ellis, Wiley, Speech and Audio Signal Processing: Processing and Perception of Speech and Music, 2nd ed., John Wiley & Sons, 2011*	3. *Lawrence Rabiner,B.H.Juang, Fundamentals of Speech Recognition, 2nd ed., Prentice-hall, 1993* 4. *Ken Pohlmann, Principles of Digital Audio, 6th ed., McGraw-Hill, 2007* 5. *A.R.Jayan, Speech and Audio Signal Processing, PHI Learning Pvt. Ltd,2016*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECE242J	Course Name	PATTERN RECOGNITION AND NEURAL NETWORKS	Course Category	E	Professional Elective	L	T	P	C
							2	0	2	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*18ECE340T*
Course Offering Department	*Electronics and Communication Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Learn the concepts of pattern recognition*
CLR-2 :	*Analyze few parameter estimation methods for pattern recognition*
CLR-3 :	*Acquire knowledge on the fundamental neural networks*
CLR-4 :	*Apply the neural network recurrence for pattern recognition studies*
CLR-5 :	*Utilize the practical applications of neural networks in pattern recognition*
CLR-6 :	*Understand the pattern and apply neural network based learning algorithm to analyze the data from real world applications*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO–1: Professional Achievement	PLO 14: PSO – 2: Project Management Techniques	PLO 15: PSO – 3: Analyze & Research
CLO-1 :	*Identify the fundamentals of recognition of patterns, regularities in data and classifiers*	3	80	75	L	-	L	H	M	-	-	-	-	-	-	-	-	-	-
CLO-2 :	*Classify error estimation, such as definitions, test-set error estimation and training-set error estimation*	3	80	70	M	-	-	H	-	-	-	-	-	-	-	-	-	-	H
CLO-3 :	*Analyze the neuron model and fundamentals on learning algorithms*	3	75	70	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	*Realize the error model and calculate the deviation with back propagation networks*	3	80	75	M	-	M	H	-	-	-	-	-	-	-	-	M	-	H
CLO-5 :	*Identify the applications of neural networks in the area of pattern recognition*	3	80	70	L	-	M	H	-	-	-	-	-	-	-	-	-	-	H
CLO-6 :	*Analyze and compare a variety of pattern classification techniques to real-world problems such as document analysis and recognition.*	3	80	70	M	-	M	H	M	-	-	-	-	-	-	-	L	-	H

		Introduction To Pattern Recognition	Parameter Estimation Methods	Introduction to Neural Networks	ANN for Classification and Regression	ANN for Organization and Recognition
Duration (hour)		12	12	12	12	12
S-1	SLO-1	*Introduction to Statistical Pattern Recognition*	*Introduction to parameter estimation*	*Introduction to neural networks*	*Introduction to Hopfield networks*	*Self-organizing map*
	SLO-2	*Overview of Pattern Classifiers*	*Maximum-Likelihood estimation*	*Neuron model*	*Hop-field network- architecture*	*SOM algorithm*
S-2	SLO-1	*Process of Classifier Design, Decision making theory*	*Maximum a Posteriori estimation*	*Learning methods of ANN, Supervised, Unsupervised and reinforced*	*Recurrent networks*	*Learning vector quantization*
	SLO-2	*Bayesian decision making*	*Bayesian estimation*	*Basic learning rules of ANN-*	*Sample recurrent network structure*	*Kohonen self-organizing map*
S 3-4	SLO-1 SLO-2	*Lab1: Digitization of analog signals*	*Lab4: Programs on Estimation*	*Lab 7: Logic gate function description with Hebb rule*	*Lab 10: Programs on training a Hopfield network*	*Lab 13: programs on orthogonality and evaluating input and output for association*
S-5	SLO-1	*Bayes Classifier*	*Unsupervised learning and clustering*	*McCulloh pitt neuron*	*Associative memories- Introduction:*	*Feature selection*
	SLO-2	*Bayes Classifier for minimizing Risk*	*Clustering vs. Classification-Supervised vs. unsupervised*	*Problems on McCulloh pitt*	*Auto and hetero associative memory*	*Feature map classifier, applications*
S-6	SLO-1	*Estimating Bayes Error*	*Criterion functions for clustering Algorithms for clustering*	*Hebb learning rule*	*Bi directional memories*	*Architecture of Adaptive Resonance Theory*
	SLO-2	*Effect of sample size in estimation*	*K-Means clustering*	*Problems on Hebb learning rule*	*XOR problem*	*ATR1 algorithm*
S 7-8	SLO-1 SLO-2	*Lab 2: Program to count the white pixels from the image*	*Lab 5: Loading a data set and selecting predictive features*	*Lab 8: Evaluating function with different learning rules*	*Lab 11: Programs on Auto and hetero association of memory*	*Lab 14: Character Recognition*
S-9	SLO-1	*Minimax Classifiers*	*Hierarchical methods of clustering*	*Single layer perceptron architecture Training algorithm*	*Back-propagation Algorithm*	*ART2 algorithm - Training*

	SLO-2	*Neymann Classifiers*	*Comparison of methods, cluster distance and validation*	*Multilayer perceptron*	*Counter propagation networks-architecture*	*ART2- network architecture*
S-10	SLO-1	*Pearson Classifiers*	*Sequential Pattern Recognition*	*Adaline architecture*	*Simulated annealing*	*Hand written digit recognition*
	SLO-2	*Applications*	*Sequential Pattern Recognition*	*Madaline architecture*	*Boltzmann machine*	*Character recognition networks*
S 11-12	SLO-1 SLO-2	*Lab3: Analysis of a data set with classifiers*	*Lab 6: Programs on clustering technique*	*Lab 9 : XOR problem with Perceptron network*	*Lab 12: Evaluation of error in BPN*	*Lab 15: Mini Project*

Learning Resources	1. *Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer Verlag, 2016* 2. *Dionisis Cavouras , S.Theodoridis , K. Koutroumbas , A. Pikrakis , An Introduction to Pattern Classification: A Matlab Approach, Elsevier Science Publishing Co Inc, 2010* 3. *Martin T.Hagan, Neural network design, Cengage publications, 2010*	4. *Simon O. Haykin, Neural Network and Learning Machines, 3rd ed., Pearson Education, 2009* 5. *Ke-Lin Du ,M. N. S. Swamy, Neural Networks and Statistical Learning, Publisher Springer, 2014* 6. *Kosko B, Neural Networks and Fuzzy Systems: A dynamical system approach to machine intelligence, Prentice Hall, 2009*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECE260J	Course Name	BIOMEDICAL INSTRUMENTATION	Course Category	*E*	*Professional Elective*	L	T	P	C
							2	0	2	3

Pre-requisite Courses	*18ECC201J*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Electronics and Communication Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-1 :	*Measure and interpret various physiological parameters*																		
CLR-2 :	*Utilize the working of different monitoring equipment's*																		
CLR-3 :	*Utilize the principle and working of different equipment's available for hemodynamic measurements*																		
CLR-4 :	*Utilize the principle and working of different types of pulmonary function analyzers*																		
CLR-5 :	*Utilize the principle and working of clinical laboratory equipment's*																		
CLR-6 :	*The learner gains knowledge in application of various diagnostic medical devices and issues related to device safety*																		
Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Describe the origin of bio potential and its measurements using different type of electrodes*	3	80	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-2 :	*Illustrate working principle of cardiac function monitors and devices used for measurement of parameters such as blood pressure, blood flow, heart rate, cardiac output and blood oxygen content*	3	80	70	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-3 :	*Analyze the components and working principle of pulmonary function measuring devices and patient monitoring systems*	3	75	70	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-4 :	*Interpret the working principle of different clinical laboratory equipment*	3	80	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-5 :	*Predict various electrical hazards and implement safety methods while using biomedical equipment*	3	80	70	-	M	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-6 :	*Summarize the working principles of different diagnostic instruments available for measuring the physiological variables*	3	80	70	M	M	-	-	-	-	-	-	-	-	-	-	M	-	-

		Biopotential Electrodes	**Bio Signals Recording**	**Cardiac Function Measurements**	**Pulmonary Function Measurements and Patient Monitoring System**	**Bioanalytical Equipments and Patient Safety**
Duration (hour)		**12**	**12**	**12**	**12**	**12**
S-1	SLO-1	*Cell structure and its functions, Physiological systems of the body*	*Electrical conduction system of the heart, Cardiac cycle*	*Haemodynamic pressure, Measurement of blood pressure: direct methods*	*Mechanism of respiration*	*Types of blood cells*
	SLO-2	*Cardiovascular system Respiratory system, Nervous system*	*ECG: origin, waveforms, characteristics, Einthoven triangle Lead configurations*	*Indirect methods: Oscillometric method, Auscultatory method, Rheographic method, Ultrasonic method for blood pressure measurement*	*Pulmonary function measurements, Respiratory volumes and capacities*	*Calculation of cell size*
S-2	SLO-1	*Basic Medical Instrumentation system, Sources of Biomedical Signals*	*Electrocardiograph, 12 lead ECG machine block diagram,*	*Blood flow measurement: Electromagnetic blood flow meters, Sine and square wave blood flowmeter*	*Spirometry: Basic spirometer, wedge spirometer, Ultrasonic spirometer*	*Blood cell counters –Microscopic method, Automatic optical method*
	SLO-2	*Resting and Action potential, Nernst equation, Goldman equation, Hodgkin-Huxley model*	*Common mode and interference reduction circuits*	*Ultrasonic blood flow meter: Doppler shift principle, Pulsed Doppler blood flowmeter*	*Pneumotachometers: turbine type Pneumotachometer, Fleisch-type & Venturi type Pneumotachometers*	*Electrical conductivity based method, Coulter counter, Automatic recognition*
S 3-4	SLO-1 SLO-2	*Lab1: Language of Anatomy, Overview of organ system*	*Lab4: Recording and analysis of ECG signal*	*Lab7: Recording and analysis of heart sounds*	*Lab10: Pulmonary function measurement and analysis using spirometer*	*Lab13: Mini project*
S-5	SLO-1	*Recording Electrodes: Electrode tissue interface, Metal electrolyte interface*	*Cardiac arrhythmias*	*NMR blood flow meter*	*Measurement of gas volume: Flow-Volume curve, Area of the flow volume, Nitrogen wash out technique*	*Differential counting of cells, Spectrophotometer Colorimeters*
	SLO-2	*Electrolyte skin interface*	*Characteristics and origin of heart sound, Phonocardiography*	*Laser Doppler blood flowmeter*	*Electro spirometer*	*Flame photometers, Selective ion electrodes, ion analyser*
S-6	SLO-1	*Polarization: polarizable and non-polarizable electrodes, Skin contact impedance*	*EEG : origin, waveforms and their characteristics, 10-20 electrode placement system*	*Cardiac output measuring techniques: dye dilution method, Indicator dilution, thermal dilution method*	*Pulmonary function analyzers*	*Patient safety: Electric shock hazards*

	SLO-2	*Surface Electrodes: Silver-Silver chloride electrodes, Floating and pre-gelled electrodes , Pasteless electrodes*	*Block diagram and working of EEG*	*Measurement of cardiac output from aortic pressure waveform*	*Impedance pneumography*	*Gross shock and effects of electric current on human body*
S 7-8	SLO-1	*Lab2: Study of different types of electrodes*	*Lab5: Recording and analysis of EEG signal*	*Lab8: Measurement of blood pressure using Sphygmomanometer/LabVIEW Biomedical workbench*	*Lab11: Measurement of Heartrate using LabVIEW Biomedical workbench*	*Lab14: Mini project*
	SLO-2					
S-9	SLO-1	*Air jet electrodes, Micro Electrodes*	*Other Biomedical recorders: Vectorcardiograph*	*Impedance technique and bioreactance method*	*Respiratory gas analyzers: Infrared gas analyser, Paramagnetic oxygen analyser*	*Micro current shock*
	SLO-2	*Needle Electrodes, Ion sensitive field effect transistors, Transcutaneous electrodes*	*Apexcardiograph*	*Ultrasound method and CO2 rebreathing method*	*Thermal conductivity analyser, nitrogen gas analyser, Polarographic oxygen analyser*	*Ventricular fibrillation- electrophysiology*
S-10	SLO-1	*Biochemical electrodes: pH*	*Recording and analysis of EMG signal, Biofeedback Instrumentation*	*Oximeters- Invitro, Invivo oximetry and types of oximeters*	*Heart rate measurement, Monitoring of foetal heart rate*	*Leakage current and its types*
	SLO-2	*Biochemical electrodes: pO2, pCO2*	*Measurement of BSR, Measurement of GSR*	*Central monitoring & Bedside monitoring system*	*Measurement of respiration rate: displacement method, thermistor method, CO2 method, Apnoea detector*	*Precautions and safety codes, Electrical safety analyser*
S 11-12	SLO-1	*Lab3: Design of bio amplifier*	*Lab6: Recording and analysis of EMG signal*	*Lab9: Recording and analysis of signals using patient monitoring system*	*Lab12: Mini project*	*Lab15: Model Practical Exam*
	SLO-2					

Learning Resources	*1. R.S. Khandpur, Handbook of Biomedical instrumentation, 3rd ed., Tata McGraw Hill, 2014*	*2. John G. Webster, Medical Instrumentation application and design, 4th ed., Wiley, 2015*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Sathyanarayanan J, Mindray Medical India Pvt Ltd, sathyanarayananjayagopal@mindray.com	*1. Dr. S. Poonguzhali, Anna University, poongs@annauniv.edu*	*1. Dr. A. K. Jayanthy, SRMIST*
2. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*2. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*2. Dr. T. Jayanthi, SRMIST*

Course Code	18ECE261T	Course Name	MEDICAL IMAGING TECHNIQUES	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Electronics and Communication Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Utilize the physics behind x ray imaging and Computed tomography*
CLR-2 :	*Utilize the hardware and techniques involved in nuclear imaging*
CLR-3 :	*Utilize the properties and techniques in ultrasound imaging*
CLR-4 :	*Utilize the physics behind magnetic resonance and techniques in resonance imaging*
CLR-5 :	*Utilize the principle behind modern imaging techniques*
CLR-6 :	*Utilize the imaging techniques for various applications*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	**Learning** 1 Level of Thinking (Bloom)	2 Expected Proficiency (%)	3 Expected Attainment (%)	**Program Learning Outcomes (PLO)** 1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	13 PSO - 1	14 PSO - 2	15 PSO - 3
CLO-1 :	*Analyze the physics behind x ray imaging and Computed tomography*	3	80	75	M	-	-	-	-	-	-	-	-	-	-	-	L	-	L
CLO-2 :	*Illustrate the hardware and techniques involved in nuclear imaging*	3	80	70	L	-	-	-	-	-	-	-	-	-	-	-	L	-	L
CLO-3 :	*Describe the properties and techniques in ultrasound imaging*	3	75	70	L	-	-	-	-	-	-	-	-	-	-	-	L	-	L
CLO-4 :	*Analyze the physics behind magnetic resonance and techniques in resonance imaging*	3	80	75	M	-	-	-	-	-	-	-	-	-	-	-	L	-	L
CLO-5 :	*Identify the principle behind modern imaging techniques*	3	80	70	M	-	-	-	-	-	-	-	-	-	-	-	L	-	L
CLO-6 :	*Apply the imaging modality for interpretation*	3	80	70	M	-	-	-	-	-	-	-	-	-	-	-	L	-	L

		X-ray and Computed Tomography	**Nuclear Imaging**	**Ultrasound Imaging**	**Nuclear Magnetic Resonance Imaging**	**Modern optical imaging**
Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Production of x-ray – Basic principle and its block diagram*	*Nuclear medicine – Radio isotopes in medical diagnosis*	*Diagnostic ultrasound*	*Principles of NMR imaging system*	*Spectroscopy – Introduction*
	SLO-2	*Voltage Generators , Collimators and Grids , Automatic Exposure Control*	*Physics of radioactivity*	*Physics of ultrasound*	*Free induction decay*	*Types of light sources*
S-2	SLO-1	*Visualization of x rays – X ray film and processing, Fluorescent screen*	*Radiation detectors – Ionization chamber*	*Generation and detection of ultrasound*	*NMR signal – Spin echo*	*Optical filters – Types*
	SLO-2	*Image intensifier*	*Scintillation detectors , Semiconductor detectors, Solid state detectors*	*frequency, active element diameter and focusing*	*T1 and T2 relaxation*	*Need for filters*
S-3	SLO-1	*Computed radiography - CR imaging*	*Pulse height analyser*	*Basic pulse echo apparatus*	*Pulse sequence*	*Monochromators - Prism*
	SLO-2	*CR image manipulation*	*Uptake monitoring system*	*System description*	*Repetition time, Echo time*	*Grating monochromators*
S-4	SLO-1	*Digital radiography*	*Rectilinear scanner*	*A scan - Introduction*	*Spin Echo Contrast Weighting – T1 weighting*	*Optical fibers – Need*
	SLO-2	*Flat panel detector*	*Radioisotope rectilinear scanner*	*Applications of A scan*	*T2 weighting , Spin proton density weighting*	*Various configurations using optical fibers*
S-5	SLO-1	*Mammography – Automatic exposure control*	*Gamma camera*	*M Mode principle*	*Localization MR signal -Magnetic field gradients*	*Polarizers – Introduction*
	SLO-2	*Mammography equipment's*	*Multi crystal gamma camera*	*Block diagram of an echocardiograph circuit*	*Slice select gradients*	*Types of polarisers*
S-6	SLO-1	*CT – Principle of CT imaging*	*Emission computed tomography- Principle*	*B scanner - Introduction*	*Frequency encode gradient*	*Fractional Flow Reserve – procedure*
	SLO-2	*Beers law, Hounsfield unit*	*Principle of PET and SPECT scanner*	*Types of B scanner*	*Phase encoded gradient*	*Measurement , Interpretation of results , Advantages*

S-7	SLO-1	*CT scan – Tomographic acquisition*	*SPECT system description*	*Multi element array scanners*	*2D image acquisition*	*Microwave imaging – Need*
	SLO-2	*Generations of CT*	*Various detector configurations*	*Sequential array scanner and phased array scanner*	*Echo planar image acquisition*	*Applications of microwave imaging*
S-8	SLO-1	*Detectors – Scintillation crystal and Photomultiplier*	*PET system description*	*Modern Imaging systems – block diagram description*	*MRI scanner components*	*Optical coherence imaging – Introduction*
	SLO-2	*Xenon , scintillarc*	*Gantry and detector modules*	*Frame grabbers , Digital scan converters*	*Artifacts*	*Types – Time domain and Fourier domain*
S-9	SLO-1	*Data acquisition and Image reconstruction*	*Dual modality imaging – SPECT/CT*	*Doppler ultrasound*	*Functional MRI*	*Thermal imaging in medicine*
	SLO-2	*Filtered back projection and artifacts*	*PET / CT*	*Intravascular ultrasound techniques*	*MR spectroscopy*	*IR detectors , Block diagram of IR imaging*

Learning Resources	1. *Khandpur R.S, Hand-book of Biomedical Instrumentation, 2nd ed., Tata McGraw Hill, 2003* 2. *Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, Biomedical Instrumentation and Measurements, 2nd ed., Prentice-Hall of India, 1997*	3. *William R. hendee, E, Russell Ritenour Medical imaging physics, 4th ed., 2002* 4. *Wolfgang Drexler James G. Fijimoto, Optical coherence tomography technology and applications, 1st ed., Springer, 2008*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	*2. Dr. P. Vinupritha, SRMIST*

Course Code	18ECE262T	Course Name	BIOMATERIALS AND ARTIFICIAL ORGANS	Course Category	E	*Professional Elective*	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Electronics and Communication Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Identify the phenomena occurring between biomaterials and surrounding tissue in living organism*
CLR-2 :	*Acquire the skills on different classes of biomaterials with its degradation process.*
CLR-3 :	*Identify the suitable biomaterials for cardiovascular and orthopedic applications.*
CLR-4 :	*Acquire skills to handle different biomaterials for dental, eye and ear applications*
CLR-5 :	*Proficiency to have an insight on the regulatory approval procedure for artificial organs*
CLR-6 :	*Acquire the skills on suitable burn dressings and skin substitutes*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO - 3
CLO-1 :	*Analyze biocompatibility and testing of biomaterials*	3	80	75	M	-	-	-	-	-	-	-	-	-	-	-	L	-	-
CLO-2 :	*Identify relations between structure and properties of various biomaterials*	3	80	70	M	-	-	-	-	-	-	-	-	-	-	-	L	-	-
CLO-3 :	*Select materials with suitable properties in cardiovascular and orthopedic devices*	3	75	70	M	-	-	-	-	-	-	-	-	-	-	-	-	-	L
CLO-4 :	*Identify biomaterials in dental, vision and auditory devices*	3	80	75	M	-	-	-	-	-	-	-	-	-	-	-	-	-	L
CLO-5 :	*Analyze materials for artificial skin and drug delivery applications*	3	80	70	M	-	-	-	-	-	-	-	M	-	-	-	-	-	-
CLO-6 :	*Analyze the regulatory process for different artificial organs comprising codes, reliability, and device testing*	3	80	70	M	-	-	-	-	-	-	-	-	-	-	-	L	-	-

		Properties of biomaterials	Metals and ceramics	Biomaterials for cardiovascular and orthopedic applications	Biomaterials for eye, ear & dental applications	Biomaterials for artificial skin and drug delivery applications
Duration (hour)		9	9	9	9	9
S-1	SLO-1	*The nature of matter and materials*	*Metals: Basic Principles*	*Substitute Heart Valves*	*Dental implants to support dental prosthesis*	*Burn Dressings and Skin Substitutes: Artificial skin, Soft tissue replacement*
	SLO-2	*Mechanical properties of biomaterials*	*Stainless Steel, Titanium and Co-Cr alloys: Metallurgical and Chemical Considerations*	*Heart Valve Function and Dysfunction*	*Adhesives and Sealants to enhance bond strength and durability*	*Sutures and Alternatives to Suture*
S-2	SLO-1	*Physiochemical properties of biomaterials*	*Mechanical properties*	*Heart Valve Replacement and Repair*	*Ophthalmologic Applications: Overview of Eye Anatomy*	*Drug Delivery Systems: Principles, Origins, Evolution of Controlled Drug Delivery*
	SLO-2	*Biomaterial characterization – Analytical instruments*	*Corrosion behavior*	*Mechanical and Tissue Valve Replacement Devices: Types and Complications*	*Contact Lenses -General Properties and Corneal Requirements*	*Liposomes, Polymeric micelles*
S-3	SLO-1	*Cells: Function and response to Injury*	*Applications of Stainless steel, titanium, Co-Cr alloys*	*Trans catheter Valve Replacement*	*Contact Lens Materials - Surface Modifications*	*Polymeric and Albuminated Drug Nanoparticles, Dendrimers*
	SLO-2	*Tissues, the Extracellular Matrix, and Cell–Biomaterial Interactions*	*Various other types of metals with its biomedical applications*	*Engineered Heart Valves*	*Specialty Lenses - Contact Lens Solutions*	*Injected Depot DDS*
S-4	SLO-1	*Host Reaction to biomaterials and their evaluation*	*Polymers: Basic principle*	*Angioplasty and Stents*	*Intraocular Lens Implants (IOLS): Scientific Perspective*	*Implants and Inserts, Infusion Pumps, Inserts*
	SLO-2	*Inflammation, Wound healing, and the foreign body response*	*Polyacrylate, Polyamide and Polyolefins: Properties of biomaterials*	*Vascular Grafts*	*Optics of the Eye and Cataracts Emerging Functional Variations of IOLS*	*Smart DDS, Environmentally Response systems*
S-5	SLO-1	*Systemic toxicity and hypersensitivity*	*Applications of polymeric biomaterials*	*Stent Grafts*	*Biomaterials for IOLS*	*Transdermal DDS, Passive and Active Transdermal Delivery Systems*
	SLO-2	*In Vitro assays to assess cell and tissue compatibility in biomaterial/medical device*	*Various other types of metals with its biomedical applications*	*Engineered Vascular Grafts*	*IOLS with Variations of Optical Function*	*Oral drug delivery – Controlled release in the GI tract*
S-6	SLO-1	*Evaluation for regulatory purposes*	*Ceramics: Basic Principles, Bioactive Glasses and Glass-Ceramics*	*Cardiovascular Devices: Pacemakers and Icds (For Cardiac Arrhythmias)*	*Corneal Inlays and Onlays*	*Regulatory Overview of Medical Products Using Biomaterials: Global Regulatory Strategy - Design Control, Risk Analysis*

	SLO-2	*Application-Specific In Vitro assays considered in proof of concept testing*	*Calcium Phosphate Ceramics, Natural and Synthetic Hydroxyapatites, Alumina: Synthesis of ceramic materials*	*Cardiac Assist and Replacement Devices (For Heart Failure)*	*Synthetic Biomaterials in the Cornea - Optical Requirements - Biological Requirements - Permeable Intracorneal Lenses*	*Biocompatibility Assessment for Biomaterials in Medical Devices - Manufacturing Controls and Post Market Oversight*
S-7	SLO-1	*Future challenges in In Vitro Assessment of cell and tissue compatibility*	*Mechanical Properties and Porosity*	*Miscellaneous Cardiovascular Devices*	*Impermeable Intracorneal Lenses - Synthetic Materials for Corneal Onlays*	*Premarket Clearance, Premarket Approval (PMA)*
	SLO-2	*Selection of In Vivo tests according to intended use*	*Stability and Biocompatibility*	*Implantable Cardiac Assist Devices and IABPs*	*Glaucoma Drains and Implants*	*Clinical and Animal Trials of Unapproved Devices*
S-8	SLO-1	*Biomaterial and Device perspectives in In Vivo testing*	*Applications of ceramics biomaterials*	*Ventricular Assist Device and Blood-Contacting Materials*	*Retinal Prostheses and concerned biomaterials*	*Sterilization, Shelf-Life, and Aging*
	SLO-2	*Specific biological properties assessed by In Vivo tests*	*Various other types of metals with its biomedical applications*	*Orthopedic applications: Total hip replacement*	*Cochlear Prostheses – Overview of the Auditory System*	*Ethical Issues in Biomaterials and Medical Devices: Protection of Patients*
S-9	SLO-1	*Selection of animal models for In Vivo tests*	*Degradation of metallic and polymeric biomaterials*	*Knee replacement*	*Cochlear Prostheses - Materials and Electrode Arrays*	*Good Laboratory, Manufacturing and Clinical Practice*
	SLO-2	*Future Perspectives on In Vivo medical device testing*	*Degradation of ceramic biomaterials*	*Miscellaneous orthopedic Devices*	*The role of biomaterials in stimulating bioelectrodes- Active chemical processes and Passive chemical processes*	*Protection of Research Subjects - Conflicts of Interest*

Learning Resources	1. *David Williams., Essential biomaterials science, 1st ed., Cambridge University Press, 2014* 2. *Lysaght M, Webster T J., Biomaterials for artificial organs, 1st ed., Woodhead Publishing Limited, 2011*	3. *Buddy Ratner, Allan Hoffman, Frederick Schoen, Jack Lemons., Biomaterials Science - An Introduction to Materials in Medicine, 3rd ed., Academic Press, 2012*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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2. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*2. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*2. Mr. S. Gnanavel, SRMIST*

Course Code	18ECE263T	Course Name	BIOSENSORS	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Electronics and Communication Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Utilize the various concepts and terminologies of measurement system*
CLR-2 :	*Utilize the working principles of transducers*
CLR-3 :	*Analyze the physiology of human sensory systems*
CLR-4 :	*Utilize the working principles of biological sensors*
CLR-5 :	*Analyze the medical applications of biosensors*
CLR-6 :	*Learn the modern sensors for medical diagnosis*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO - 3
CLO-1 :	*Identify the concepts of measurements and the errors associated with measurement*	3	80	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-2 :	*Analyze the working principles of transducers*	3	80	70	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-3 :	*Evaluate the physiological functions of human sensory systems*	3	75	70	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-4 :	*Analyze the principles of various sensors used in medical diagnosis*	3	80	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-5 :	*Describe the various modern biosensors used in medical diagnosis*	3	80	70	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-6 :	*Implement the modern technologies in biosensors*	3	80	70	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-

		Fundamentals of measurement system	Transducers	Biological sensors	Biosensors	Fiber optic sensors
Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Functional elements of an instrumentation system*	*Classification of transducers*	*Study of biological sensors in the human body: neuronal mechanism*	*Biosensors – Introduction*	*Fiber optic sensors: Introduction*
	SLO-2	*Functional elements of an instrumentation system*	*Classification of transducers*	*Study of biological sensors in the human body: neuronal mechanism*	*Biosensors – Introduction*	*Fiber optic sensors: Introduction*
S-2	SLO-1	*Static characteristics*	*Characteristics for selection of transducers*	*pacinian - functions*	*components of Biosensors*	*Fiber optic biosensors: Introduction*
	SLO-2	*Static characteristics*	*Characteristics for selection of transducers*	*pacinian - functions*	*components of Biosensors*	*Working and principle*
S-3	SLO-1	*Static characteristics*	*Resistive transducers: RTD*	*Chemoreceptor*	*Classification of biosensors*	*Optical biosensors for measurement of blood glucose level*
	SLO-2	*Static characteristics*	*Thermistor*	*Chemoreceptor*	*Classification of biosensors*	*Optical biosensors for measurement of blood glucose level*
S-4	SLO-1	*Dynamic characteristics*	*Resistive transducers: Strain gauge*	*hot and cold receptors*	*Biocatalysts based biosensor*	*Smart sensor: Introduction*
	SLO-2	*Dynamic characteristics*	*Resistive transducers: Strain gauge*	*hot and cold receptors*	*Biocatalysts based biosensor*	*Working*
S-5	SLO-1	*Errors in measurements: sources of errors*	*Piezoelectric effect transducer: Construction*	*baro receptors*	*Enzyme immobilisation*	*Applications of smart sensor*
	SLO-2	*Errors in measurements: sources of errors*	*Working*	*baro receptors*	*Enzyme immobilisation*	*Applications of smart sensor*
S-6	SLO-1	*Errors in measurements: types of errors*	*Hall effect transducer: Construction*	*sensors for smell*	*Glucose Biosensor*	*Lab on a chip- Introduction, Need*
	SLO-2	*Errors in measurements: types of errors*	*Working*	*sensors for smell*	*Glucose Biosensor*	*Block diagram*

S-7	SLO-1	*Statistical analysis of data*	*Capacitive transducers*	*sensors for sound*	*bio affinity based biosensor*	*Applications*
	SLO-2	*Statistical analysis of data*	*Construction and Working*	*sensors for sound*	*bio affinity based biosensor*	*Advantages and Disadvantages*
S-8	SLO-1	*Standards: international standards, primary standards*	*Inductive transducers*	*sensors for vision*	*microorganism based biosensors*	*eNose: Construction*
	SLO-2	*secondary standards and working standards*	*Construction and Working*	*sensors for vision*	*microorganism based biosensors*	*Working*
S-9	SLO-1	*Calibration methodologies*	*Photomultiplier tube*	*Sensors for osmolality and taste*	*Advantages and limitations of Biosensor*	*Applications of eNose*
	SLO-2	*Calibration methodologies*	*Construction and Working*	*Sensors for osmolality and taste*	*Advantages and limitations of Biosensor*	*Applications of eNose*

Learning Resources	1. *Sawhney A.K, A Course in electrical and electronic measurements and instrumentation, 19th ed., Dhanpat Rai & Co (P) Ltd, 2014* 2. *Patranabis D, "ensors and transducers", 2nd ed., Prentice Hall of India, 2004*	3. *A. D. Helfrick, W. D. Cooper, Modern electronic instrumentation and measurement techniques, 4th ed., Prentice Hall of India, 1998.*

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		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
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Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

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Course Code	18ECE264T	Course Name	DIAGNOSTIC AND THERAPEUTIC EQUIPMENT	Course Category	E	*Professional Elective*	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Electronics and Communication Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Gain thorough knowledge about the working principle of coronary care equipments*
CLR-2 :	*Understand the functioning and uses of different surgical equipments*
CLR-3 :	*Utilize different components of respiratory care equipment and Bone mineral density measuring techniques*
CLR-4 :	*Comprehend about the different components and working principle of sensory diagnosis and therapeutic equipments*
CLR-5 :	*Understand the functioning of different types of physiotherapy and electrotherapy equipments*
CLR-6 :	*Understand the functioning of electrotherapy equipments*

		Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Explain the working principle of coronary care equipments*	3	80	75	H	-	-	-	-	-	-	-	-	-	-	-	L	-	-
CLO-2 :	*Describe the functioning and uses of different surgical equipments*	3	80	70	L	-	-	-	-	-	-	-	-	-	-	-	L	-	-
CLO-3 :	*Give an overview about the different components and working principle of respiratory care equipments and Bone mineral density measuring techniques*	3	75	70	M	-	-	-	-	-	-	-	-	-	-	-	L	-	-
CLO-4 :	*Give an overview about the different components and working principle of sensory diagnosis and therapeutic equipments*	3	80	75	M	-	-	-	-	-	-	-	-	-	-	-	L	-	-
CLO-5 :	*Illustrate the functioning of different types of physiotherapy and electrotherapy equipments*	3	80	70	M	-	-	-	-	-	-	-	-	-	-	-	L	-	-
CLO-6 :	*Illustrate the functioning of different types of electrotherapy equipments*	3	80	70	H	-	-	-	-	-	-	-	-	-	-	-	L	-	-

		Coronary care equipments	**Surgical equipments**	**Respiratory care equipments and Bone mineral density measuring equipments**	**Sensory diagnosis equipments**	**Physiotherapy and electrotherapy equipments**
Duration (hour)		**9**	**9**	**9**	**9**	**9**
S-1	SLO-1	*Need for cardiac pacemaker*	*Principles of surgical diathermy unit*	*Mechanics of respiration, Artificial ventilation*	*Mechanism of hearing, sound conduction system*	*Short wave diathermy, Simplified circuit diagram, Methods of applying electrodes*
	SLO-2	*Types of pacemaker and different modes of operation*	*Surgical diathermy machine Block diagram and description*	*Respiratory care equipment: humidifier*	*Measurements of sound, Transducers used to measure sound*	*Inductive and condenser method, Inductive heating by coil in drum*
S-2	SLO-1	*External pacemaker – Block diagram*	*Endoscopy basic components*	*Nebulizer, aspirators*	*Block diagram and description of basic audiometer*	*Micro wave diathermy, Production of microwaves*
	SLO-2	*Three types of External pacemaker based on the type of output waveform*	*Types of endoscopy – Fiber optic and rigid types*	*Ventilators –Functional diagram, Types of ventilator*	*pure tone audiometer*	*Simplified circuit diagram of micro wave diathermy*
S-3	SLO-1	*Implantable pacemakers, requirements, Classification codes for pacemakers*	*Applications of endoscopy- Laparoscope, gastro scope*	*Classification of ventilator*	*Speech audiometer*	*Ultrasonic therapy unit- Block diagram description*
	SLO-2	*Types of implantable pacemakers, Various pacing modalities in demand pacemaker*	*Applications of endoscopy- bronchoscope, arthroscopy*	*Ventilator- Microprocessor controlled ventilator*	*Calibration of audiometers*	*Dosage control in ultrasonic therapy unit*
S-4	SLO-1	*Ventricular synchronous demand pacemaker*	*Cobalt T-60 machine – Basic components*	*Electronics block diagram of ventilator*	*Block diagram and description of Bekesy audiometer system*	*Electro diagnosis and electrotherapy basics – Intensity time curve of muscles,*
	SLO-2	*Rate responsive pacemaker*	*Gamma Knife*	*Capnography – Block diagram description*	*Block diagram and description of Evoked response audiometry system*	*Different types of waveforms used in electrotherapy*
S-5	SLO-1	*Need for Defibrillator, AC Defibrillator*	*Cryogenic surgical techniques*	*Anesthesia machine – schematic diagram of an anesthesia machine*	*Hearing aids, Conventional analog type hearing aid*	*Electro diagnostic/ Stimulating unit – Schematic block diagram*
	SLO-2	*DC Defibrillator – schematic diagram*	*Applications of cryogenic surgery*	*Block diagram & description of an anesthesia monitor*	*Digital hearing aid*	*Interferential current therapy – Principle of generation of interference currents*
S-6	SLO-1	*Defibrillator electrodes, DC Defibrillator with synchronizer*	*Operating microscope – basic principle*	*Baby incubator – Principle of operation*	*cochlear implants*	*Transcutaneous electrical nerve stimulation*

	SLO-2	*Automatic or advisory external defibrillator (AED)*	*Operating microscope – components*	*Baby incubator – Block diagram description*	*Different types of cochlear implants*	*Spinal cord stimulator*
S-7	SLO-1	*Implantable Defibrillator architecture and types*	*Lithotripsy- Schematic of an acoustic shock wave pulse*	*BMD measurements: Single X-ray absorptiometry (SXA) – basic principle*	*Tonometry – Impression type, Applanation tonometry*	*Diaphragm pacing by radio frequency for treatment of Chronic ventilator insufficiency*
	SLO-2	*Pacer cardioverter defibrillator*	*The first Lithotripter machine*	*Single X-ray absorptiometry (SXA) – Instrumentation*	*Non-contact type tonometry*	*Deep brain stimulation*
S-8	SLO-1	*Defibrillator analyzer – block diagram*	*Modern lithotripter system – Block diagram description*	*Dual X-ray absorptiometry (DXA) - basic principle*	*Measurement of basal skin response and galvanic skin response - Principle*	*Bladder stimulator – schematic diagram of bladder stimulator*
	SLO-2	*Defibrillator protection circuit in ECG*	*Shock wave generator, Shock wave sources,*	*Dual X-ray absorptiometry (DXA) - Instrumentation*	*Measurement of basal skin response and galvanic skin response - Block diagram*	*Circuit diagram of bladder stimulator*
S-9	SLO-1	*Heart lung machine*	*Focussing system, Coupling, Imaging systems in Lithotripsy machine*	*Quantitative ultrasound bone densitometer - basic principle*	*Biofeedback instrumentation – Basic principle*	*Phototherapy unit – Principle of operation and application*
	SLO-2	*Types of oxygenators used in Heart lung machine*	*laser lithotripsy*	*Quantitative ultrasound bone densitometer - Instrumentation*	*EMG feedback for rehabilitation study*	*Types of phototherapy unit*

Learning Resources	1. *R.S.Khandpur, Handbook of Bio-Medical instrumentation, 3rd ed., Tata McGraw Hill, 2014* 2. *Albert M.Cook and Webster. J.G, Therapeutic Medical Devices", 1st ed., Prentice Hall, 1982* 3. *Sydney Lou Bonnick, Lori Ann Lewis, Bone Densitometry and Technologists, 3rd ed., Springer, 2013* 4. *Cotton.P. B, and Williams. C. B., Endoscopic Equipment, in Practical Gastrointestinal Endoscopy: The Fundamentals, 6th ed., Wiley-Blackwell, 2008* 5. *Marc. Safran, Bobby. Chhabra. A., Mark. Miller.D, Primer of Arthroscopy, 2nd ed., Elsevier Health Sciences, 2010*	6. *Ventura, Risegari, The Art of Cryogenics Low-Temperature Experimental Techniques, 1st ed., Elsevier Science, 2007* 7. *Leslie Cromwell, Fred J.Weibell, Erich A.Pfeiffer, Bio-Medical Instrumentation and Measurements, 2nd ed., Pearson Education, 2007* 8. *John G.Webster, Specifications of Medical Instrumentation Application and Design, 4th ed., Wiley, 2015*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Sathyanarayanan J, Mindray Medical India Pvt Ltd, sathyanarayananjayagopal@mindray.com	*1. Dr. S. Poonguzhali, Anna University, poongs@annauniv.edu*	*1. Dr. S. P. Angeline Kirubha, SRMIST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	*2. P. Vinupritha, SRMIST*

Course Code	18ECE265J	Course Name	BIOMEDICAL SIGNAL PROCESSING	Course Category	E	*Professional Elective*	L	T	P	C
							2	0	2	3

Pre-requisite Courses	*18ECC204J*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Electronics and Communication Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Utilize the characteristics of various bio signals*
CLR-2 :	*Utilize knowledge in time domain and frequency domain filtering techniques to remove noise from bio signals*
CLR-3 :	*Apply various signal processing techniques in analysis of ECG signals*
CLR-4 :	*Utilize knowledge in Wavelets and speech signal analysis*
CLR-5 :	*Analyze the characteristics of non-stationary signals*
CLR-6 :	*Analyze the classification of normal and abnormal ECG signal.*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	**Learning** 1 Level of Thinking (Bloom)	2 Expected Proficiency (%)	3 Expected Attainment (%)	**Program Learning Outcomes (PLO)** 1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	13 PSO - 1	14 PSO - 2	15 PSO - 3
CLO-1 :	*Analyze the physiological origin and characteristics of various biomedical signals*	3	80	75	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	*Apply time-domain and frequency domain filtering techniques to remove noise from biomedical signals*	3	80	70	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-3 :	*Analyze various signal processing methods to process the ECG and HRV signals.*	3	75	70	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-4 :	*Apply wavelet transform techniques to analyze the biomedical signal*	3	80	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-5 :	*Analyze the characteristics of non-stationary signals and perform the classification of normal and abnormal signal*	3	80	70	M	-	M	-	M	-	-	-	L	L	M	-	M	-	L
CLO-6 :	*Perform the classification of normal and abnormal signal*	3	80	70	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Duration (hour)		**12**	**12**	**12**	**12**	**12**
S-1	SLO-1	*Bioelectric signals-ENG, ERG*	*Time domain filters-Synchronized averaging*	*ECG waveform analysis*	*Introduction to wavelets*	*Analysis of non-stationary signals*
	SLO-2	*EOG , EEG signal characteristics*	*Moving averaging filters*	*Envelope Extraction and Analysis*	*Continuous and Discrete wavelet*	*Time variant system*
S-2	SLO-1	*ECG signal physiological origin*	*Frequency domain filters Removal of high frequency noise-Butterworth low pass filter*	*P wave detection*	*Discrete wavelet transform*	*Fixed segmentation*
	SLO-2	*characteristics*	*Design procedure*	*Estimation of R-R Interval*	*pyramid algorithm*	*Short time Fourier transform*
S 3-4	SLO-1 SLO-2	*Lab1: Representation of basic biosignals*	*Lab4: Design of Butterworth Low pass filter to remove high frequency noise*	*Lab7: Analysis of ECG signal*	*Lab 10: Wavelet transform for 1-D Signal Processing*	*Lab 13: Mini project*
S-5	SLO-1	*PCG signal*	*Removal of low frequency noise-Butterworth high pass filters*	*QRS complex detection-Template subtraction method*	*Comparison of Fourier transform and wavelet transform*	*Adaptive segmentation*
	SLO-2	*Characteristics*	*Removal of periodic artefacts-Notch & Comb Filter*	*Template correlation method*	*Comparison of Fourier transform and wavelet transform*	*Algorithm*
S-6	SLO-1	*VAG*	*Introduction to Adaptive filter*	*Derivative based method-High speed QRS detection algorithm,*	*Speech analysis – Cepstrum*	*Autocorrelation function method*
	SLO-2	*VMG*	*Adaptive noise canceller*	*High speed QRS detection algorithm*	*Homomorphic filtering of speech signals*	*generalized likelihood ratio*
S 7-8	SLO-1 SLO-2	*Lab2: Correlation of Biosignals*	*Lab5: Design of Butterworth high pass filter to remove low frequency noise*	*Lab8: Detection of QRS complex from ECG*	*Lab11: Analysis of speech signal*	*Lab 14: Mini project*
S-9	SLO-1	*Bioacoustic signal-Auscultation*	*Optimal Filtering: Wiener Filter*	*Simple high speed QRS width detection algorithm-Differentiation, smoothing*	*Time frequency representation*	*Classification of signal: Normal and ectopic ECG beats*
	SLO-2	*Voice, Korotkoff sound*	*Wiener Filter(Contd.)*	*Moving average integrator, thresholding*	*Spectrogram*	*Algorithm*

S-10	SLO-1	*Biomechanical Signal*	*Wiener Filter(Contd.)*	*Heart rate variability (HRV)-Introduction*	*Time scale representation*	*Case studies- in ECG and PCG*
	SLO-2	*Biochemical Signal*	*Wiener Filter*	*Time & Frequency domain methods*	*Scalogram*	*PCG and carotid pulse*
S 11-12	SLO-1 SLO-2	*Lab3: Analysis of EEG signal*	*Lab6: Design of Adaptive filters*	*Lab9: Analysis of Heart rate variability*	*Lab 12: Mini project*	*Lab 15: Model Practical Exam*

Learning Resources	1. *Rangaraj.M.Rangayyan, Biomedical signal processing, 2nd ed., Wiley-IEEE press, 2015* 2. *Reddy D.C, Biomedical signal processing: Principles and techniques, 2nd ed., Tata McGraw-Hill, 2005*	3. *Willis J. Tompkins, Biomedical Digital Signal Processing, PHI, 2004*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Sathyanarayanan J, Mindray Medical India Pvt Ltd, sathyanarayananjayagopal@mindray.com	*1. Dr. S. Poonguzhali, Anna University, poongs@annauniv.edu*	*1. Dr. U. Snekhalatha, SRMIST*
2. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*2. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*2. Dr. T. Rajalakshmi, SRMIST*

Course Code	18ECE266T	Course Name	BIOMEMS	Course Category	E	*Professional Elective*	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Electronics and Communication Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Get an idea about the MEMS and Microsystem basics*
CLR-2 :	*Understand the microsystem fabrication processes and materials used for MEMS*
CLR-3 :	*Understand the micromachining processes*
CLR-4 :	*Acquire the knowledge required for the development of microfluidic systems*
CLR-5 :	*Identify the applications of bioMEMS in healthcare industry*
CLR-6 :	*Understand the applications of MEMS and BioMEMS*

		Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	*Analyze the working principle of MEMS & Microsystems in healthcare domain*	*3*	*80*	*75*	*M*	-	*L*	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	*Explain the microsystem fabrication processes and materials used for MEMS*	*3*	*80*	*70*	-	-	*L*	-	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	*Differentiate the various Micromanufacturing techniques in miniature applications*	*3*	*75*	*70*	-	-	*M*	-	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	*Analyze the working principle of Microfluidic Systems in healthcare*	*3*	*80*	*75*	-	-	*M*	-	-	-	-	-	-	-	-	-	*M*	-	-
CLO-5 :	*Illustrate the concepts of BioMEMS with suitable examples*	*3*	*80*	*70*	-	-	*M*	-	-	-	-	-	-	-	-	-	*M*	-	-
CLO-6 :	*Analyze the applications of MEMS in Biomedical domain*	*3*	*80*	*70*	*M*	-	*L*	-	-	-	-	-	-	-	-	-	-	-	-

		Microsensor and Microactuator	**Materials for MEMS & fabrication Techniques**	**Basics of Micromachining**	**Microfluidics**	**BioMEMS**
Duration (hour)		**9**	**9**	**9**	**9**	**9**
S-1	SLO-1	*MEMS and Microsystems- Introduction*	*Substrates and Wafers*	*Bulk micromanufacturing*	*Microfluidics Introduction*	*BioMEMS Introduction*
	SLO-2	*Advantages of MEMS & Microsystems*	*Silicon as a Substrate Material*	*Isotropic etching*	*Fluid Properties*	*Application of BioMEMS*
S-2	SLO-1	*Typical MEMS and Microsystem Products*	*Materials for MEMS: Silicon compounds*	*Anisotropic etching*	*Applications of Microfluidic Systems in biomedical*	*Lab on a chip*
	SLO-2	*Application of Microsystems in Healthcare Industry*	*Silicon Piezoresistor*	*Etch Stop Techniques*	*Fluid actuation methods*	*DNA Sensors*
S-3	SLO-1	*Microsensors- Acoustic wave sensor*	*Gallium arsenide*	*Etch Stop Techniques*	*Dielectrophoresis (DEP)*	*Hybridization Types*
	SLO-2	*Microsensors- Optical Sensors*	*Quartz*	*Dry Etching*	*Electrowetting*	*Microsystem approaches to PCR*
S-4	SLO-1	*Microsensors- Biomedical Sensors & Biosensors*	*Piezoelectric crystals*	*Dry Etching Techniques*	*Electrothermal*	*Microsystem approaches to PCR*
	SLO-2	*Chemical Sensors*	*Polymers*	*Dry Etching Techniques*	*Thermocapillary*	*Mobile Point of Care Monitors*
S-5	SLO-1	*Pressure Sensors*	*Packaging Materials*	*Surface Micromachining*	*Electroosmosis*	*Implantable MEMS for glaucoma therapy*
	SLO-2	*Thermal Sensors*	*Photolithography*	*Surface Micromachining Process Sequence*	*Optoelectrowetting (Light-actuated microfluidic device)*	*Implantable MEMS for glaucoma therapy*
S-6	SLO-1	*Microactuator*	*Ion Implantation*	*LIGA Introduction*	*Microfluidic channel*	*MEMS based Implantable Drug Delivery System*

	SLO-2	*Different types of actuation*	*Diffusion*	*Application*	*Microdispenser*	*MEMS based Implantable Drug Delivery System*
S-7	SLO-1	*Application of Microactuations: Microgrippers*	*Oxidation*	*LIGA Process*	*Microneedle*	*Integrated microsystems for artificial retinal implants*
	SLO-2	*Application of Microactuations: Microvalve and Micropump*	*Chemical vapor deposition (CVD)*	*LIGA Process*	*Microfilter*	*Integrated microsystems for artificial retinal implants*
S-8	SLO-1	*Inch-Worm Technology*	*CVD Types*	*Merits and Demerits of Bulk Micromachining*	*Microseparator*	*MEMS-based neuronal intervention devices*
	SLO-2	*Micro-accelerators*	*Physical vapor deposition (PVD)*	*Merits and Demerits of Surface Micromachining*	*Microreactor*	*MEMS-based neuronal intervention devices*
S-9	SLO-1	*Examples of biomedical microsensors and microactuators*	*Epitaxy*	*Merits and Demerits of LIGA Process*	*Micromixer*	*Current Point of Care Technology*
	SLO-2	*Examples of biomedical microsensors and microactuators*	*Etching*	*Summary of Micromachining*	*Capillary Electrophoresis*	*Current Point of Care Technology*

Learning Resources

1. *Tai-Ran Hsu, MEMS & Microsystems- Design, Manufacture and Nanoscale Engineering, 2nd ed., John Wiley & Sons, 2008*
2. *Nitaigour Premchand Mahalik, MEMS, Tata McGraw Hill, 2008*
3. *Steven S.cSaliterman, Fundamentals of BioMEMS & Medical Microdevices,1st ed., International Society for Optical Engineering, 2006*
4. *Ellis Meng, Biomedical Microsystems, 1st ed., CRC Press, 2011*
5. *Simona Badilescu, Muthukumaran Packirisamy, BioMEMS Science and Engineering Perspectives, 1st ed., CRC Press, 2011*
6. *Albert Folch, Introduction to BioMEMS, 1st ed., CRC Press, 2013*
7. *Gerald A Urban, BioMEMS, 1st ed., Springer, 2006*
8. *Chang Liu, Foundations of MEMS, 2nd ed., Prentice Hall, 2012*
9. *Abraham P. Lee and James L. Lee, BioMEMS and Biomedical Nanotechnology, Vol. 1, 1st ed., Springer, 2006*
10. *Wanjun Wang & Steven A.Soper, BioMEMS- Technologies and applications, 1st ed., CRC Press, 2007*
11. *Walter Karlen and Krzysztof Iniewski, Mobile Point-of-Care Monitors and Diagnostic Device Design, 1st ed., CRC Press, 2015*
12. *Nam-Trung Nguyen & Steven T Wereley, Fundamentals and Applications of Microfluidics, 2nd ed., Artech House, 2006*
13. *Dongqing Li, Encyclopedia of Microfluidics and Nanofluidics, 1st ed., Springer, 2008*
14. *Chao-Min Cheng, Chen-MengKuan & Chien-Fu Chen, In-Vitro Diagnostic Devices: Introduction to Current Point of Care Diagnostic Devices, 1st ed., Springer, 2016*
15. *Mel L. Mendelson, Learning Bio-Micro-Nanotechnology, 1st ed., CRC Press, 2013*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	*2. Dr. D. Ashok Kumar, SRMIST*

Course Code	18ECE267J	Course Name	BIOMECHANICS	Course Category	E	Professional Elective	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Utilize concepts of kinematics and kinetics of human motion and functioning of bone.
CLR-2 :	Utilize the mechanics of joints, skeletal muscle, elbow and hand
CLR-3 :	Analyze mechanics applied in various movement and loads on shoulder, hip and knee.
CLR-4 :	Analyze movements and loads applied on spine, foot and its effect on human gait.
CLR-5 :	Utilize the fluid medium in human movement and application of sports biomechanics.
CLR-6 :	Understand the concepts of reactive services applied in human movements

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO - 3
CLO-1 :	Apply principles and concepts of biomechanics in the field of kinematics and kinetics of human motion	3	80	75	M	M	-	-	-	-	-	-	-	-	-	L	L	-	-
CLO-2 :	Identify the basic functionalities of joints, skeletal muscle, elbow and hand.	3	80	70	-	M	-	L	M	-	-	-	-	-	-	L	L	L	-
CLO-3 :	Analyze the functionality and various forces applied on shoulder, hip and knee.	3	75	70	M	M	L	M	M	-	-	-	-	-	-	-	-	L	M
CLO-4 :	Apply various loads on spine and foot to analyze the information on various human gait.	3	80	75	-	-	M	M	M	-	-	-	-	-	-	-	-	L	M
CLO-5 :	Communicate and implement the knowledge in various applications related to human movement	3	80	70	M	M	-	-	-	-	-	-	-	-	-	L	L	-	-
CLO-6 :	Apply rehabilitation services in all biomechanical activities	3	80	70	-	M	-	L	M	-	-	-	-	-	-	L	L	L	-

		Kinetic, kinematics of human motion & Biomechanics of human bone	Biomechanics of skeletal muscle, Elbow and hand	Biomechanics of Shoulder, hip and knee	Biomechanics of spine Analysis of gait	Sports Biomechanics
Duration (hour)		12	12	12	12	12
S-1	SLO-1	Forms of motion, Spatial reference systems, analysis of human movement	Joint architecture	Structure of the shoulder	Structure of the spine, Spinal curves	Biomechanics in physical education- Qualitative analysis of kicking
	SLO-2	Standard reference terminology, Joint movement terminology	Articular cartilage and connective tissue	Movements of the shoulder	Movements of the spine	Qualitative analysis of batting
S-2	SLO-1	Basic concepts related to kinetics	Joint stability, Joint flexibility	Muscles of the shoulder	Loads on the spine	Human movement in fluid medium- Nature of fluids
	SLO-2	Mechanical loads on the human body, Effects of loading	Techniques for increasing joint Flexibility, Joint injuries	Loads on the shoulder and common injuries of the shoulder	Common injuries of the back and neck	Laminar and turbulent flow and flow properties
S 3-4	SLO-1 SLO-2	Lab 1: Analysis of mechanical stress and strain	Lab 4: Study of joints	Lab 7: 3D modeling of radius and ulna	Lab 10: Segmentation and modeling of lumbar spine	Lab 13: Mini project
S-5	SLO-1	Linear and angular kinematic quantities	Structural organization of skeletal muscle- Muscle fibers	Structure of the hip	Gait analysis	Buoyancy
	SLO-2	Relationships between linear and angular motion	Motor units and fiber types	Movements at the hip	Various methods in Gait analysis	Drag and lift force
S-6	SLO-1	Kinematics of projectile motion, Factors influencing Projectile trajectory	Factors affecting muscular force generation	Muscles and loads on the hip	Types of phases	Biomechanics in Strength and conditioning Qualitative analysis of squat technique
	SLO-2	Analyzing projectile motion	Muscular strength, power and endurance	Common injuries of the hip Joint	Measurement approaches and systems for gait	Qualitative analysis of Drop jumps
S 7-8	SLO-1 SLO-2	Lab 2: Projectile motion analysis using MATLAB	Lab 5: Study of Body composition parameters	Lab 8: Segmentation and modeling of femur bone	Lab 11: Analysis of gait	Lab 14: Mini project
S-9	SLO-1	Composition and structure of bone tissue	Structure of the elbow	Structure of the knee	Structure of the foot	Qualitative analysis of Throwing technique

	SLO-2	*Bone growth and development*	*Loads on the elbow and common injuries of the elbow*	*Movements at the knee*	*Movements of the foot*	*Qualitative analysis of Dribbling technique*
S-10	SLO-1	*Bone response to stress*	*Structure of the joints of the hand*	*Muscles and loads on the knee*	*Loads on the foot*	*Biomechanics in sports medicine and rehabilitation*
	SLO-2	*Osteoporosis*	*Movements of the hand*	*Common injuries of the knee and lower leg*	*Common injuries of foot*	*Dealing with sports injuries*
S 11-12	SLO-1 SLO-2	*Lab 3: Measurement of bone mineral density*	*Lab 6: Segmentation of radius and ulna*	*Lab 9: Segmentation and modeling of fibula and tibia*	*Lab 12: Repeat class*	*Lab 15: Model Exam*

Learning Resources	1. *Susan J Hall, Basic Biomechanics, 4th ed., Tata McGraw hill, 2004* 2. *Duane Knudson, Fundamentals of Biomechanics, 2nd ed., Springer, 2007*	3. *Roger Bartlett, Introduction to Sports Biomechanics: Analysing Human Movement Patterns, 2nd ed., Taylor and Francis, 2007*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Sathyanarayanan J, Mindray Medical India Pvt Ltd, sathyanarayananjayagopal@mindray.com	*1. Dr. S. Poonguzhali, Anna University, poongs@annauniv.edu*	*1. Dr. D Ashok Kumar, SRMIST*
2. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*2. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*2. Ms. A. Bhargavi Haripriya, SRMIST*

Course Code	18ECE180J	Course Name	TRANSDUCER ENGINEERING	Course Category	E	Professional Elective	L	T	P	C
							2	0	2	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Electronics and Communication Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Utilize methods of measurement, & know about various types of errors in instruments*
CLR-2 :	*Analyze the behavior of transducers under static and dynamic conditions and to model the transducers*
CLR-3 :	*Analyze different types of resistive, inductive and capacitive transducers*
CLR-4 :	*Identify applications of resistive, inductive and capacitive transducer*
CLR-5 :	*Utilize methods of measurement, & know about various types of errors in instruments*
CLR-6 :	*Locate the different type of sensors used in real life applications and paraphrase their importance*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO - 3
CLO-1 :	*Apply mathematical knowledge, science, engineering fundamentals to solve problems pertaining to various measurements*	3	80	75	H	H	-	-	-	-	-	-	-	-	-	-	H	-	H
CLO-2 :	*Determine the static and dynamic characteristics of transducer*	3	80	70	H	H	-	M	-	-	-	-	-	-	-	-	H	-	H
CLO-3 :	*Analyze the resistive, inductive and capacitive transducers which are used for measuring various parameters*	3	75	70	H	-	M	M	-	-	-	-	-	-	-	-	H	-	H
CLO-4 :	*Select the right transducer for the given application*	3	80	75	H	H	-	M	-	-	-	-	-	-	-	-	H	-	H
CLO-5 :	*Identify the various miscellaneous transducers*	3	80	70	H	-	H	-	-	-	-	-	H	M	-	-	H	-	H
CLO-6 :	*Select the right transducer for the given application*	3	80	70	H	H	-	-	-	-	-	-	-	-	-	-	H	-	H

Duration (hour)		12	12	12	12	12
S-1	SLO-1	*General configuration and description of measuring Instruments*	*Characteristics of instruments : Static characteristics: Accuracy, precision, resolution, sensitivity*	*Inductive sensor: common types- brief discussion with respect to material, construction and input output variable*	*Miscellaneous Transducers: Piezoelectric transducer*	*Smart Transducers: Smart Sensors, Components of Smart Sensors*
	SLO-2	*Basic methods of measurement*	*Characteristics of instruments : linearity, span and range, threshold, Hysterisis, Dead Time*	*Reluctance change type*	*Hall Effect transducer*	*General architecture of Smart Sensors*
S-2	SLO-1	*Functional Elements of Measurement Systems*	*Dynamic characteristics*	*Magnetostrictive type*	*Magneto elastic sensor*	*Evolution of Smart Sensors*
	SLO-2	*Definition, principles of sensing and transduction*	*Resistive Transducers: RTD Materials, Temperature measurement change in physical properties, 3 wire and 4 wire RTD*	*Mutual inductance change type*	*Digital transducers*	*Advantages of Smart Sensors*
S 3-4	SLO-1 SLO-2	*Lab1: Identifying the components of measuring instruments.*	*Lab 4: Characteristics of RTD*	*Lab 7: Characteristics of Thermistor*	*Lab10: Characteristics of Hall effect transducer*	*Lab13: Temperature measurement using LABVIEW and DAQ Hardware*
S-5	SLO-1	*Units, Standards*	*Potentiometer Type- Forms, material*	*Transformer Type*	*Radiation sensors: Materials*	*Application area of Smart Sensors*
	SLO-2	*Unit conversions*	*Potentiometer Types- resolution, accuracy, sensitivity.*	*LVDT: Construction, material, output input relationship, I/O curve, discussion.*	*Radiation sensors: construction, response*	*MEMS sensor*
S-6	SLO-1	*Error: Classification of errors, Limiting error and probable error*	*Strain gauge: Theory, type, materials, design consideration, sensitivity*	*RVDT: Construction, material*	*Photo emissive cell types*	*NEMS sensor*
	SLO-2	*Error analysis– Statistical methods*	*Derivation of gauge factor, variation with temperature, adhesive, rosettes*	*Synchros, Microsyn*	*Photovoltaic cells*	*Proximity sensors*
S 7-8	SLO-1 SLO-2	*Lab2: Determining the transfer function of a first order transducer*	*Lab 5: Characteristics of strain gauge*	*Lab 8: Characteristics of LVDT*	*Lab11: Characteristics of Synchros*	*Lab14: Displacement measurement using LABVIEW and DAQ Hardware*
S-9	SLO-1	*Problems in Statistical methods- mean, median mode,variance*	*Thermistor: Material, shape, ranges and accuracy specification*	*Capacitive Transducers: Variable distance- parallel plate type*	*Photodiodes*	*Fiber optic sensors*

	SLO-2	*Problems in Statistical methods- standard deviation, probable error of one reading*	*Thermocouple:Thermo emf sensor: types, Laws of thermo couple. Reference junction compensation*	*Capacitive Transducers: variable area-parallel plate, cylindrical type, variable dielectric constant type*	*Light Dependent Resistor*	*Biosensors*
S-10	SLO-1	*Classification of transducers*	*Load cell-Principle, construction*	*Capacitive Transducers: calculation of sensitivity. Stretched diaphragm type*	*Geiger counters*	*Film sensors*
	SLO-2	*Selection of transducers*	*Hot-wire anemometer*	*Capacitor Microphone, response characteristics*	*Scintillation detectors*	*Environmental Monitoring sensors (Water Quality & Air pollution)*
S 11-12	SLO-1 SLO-2	*Lab3: Statistical Error analysis- Mean, SD, variance for an open loop response of thermocouple*	*Lab 6: Characteristics of Thermistor*	*Lab 9: Characteristics of capacitive transducer*	*Lab12: Characteristics of LDR*	*A mini project on MEMS / Nano/ smart/ fiber/ sensor using any software tools*

Learning Resources	1. *Doeblin, E.O., Measurement Systems: Applications and Design, 6th ed., Tata McGraw-Hill, 2011* 2. *Bentley, J. P., Principles of Measurement Systems, 4th ed., Addison Wesley Longman, 2004* 3. *Patranabis, D., Sensors and Transducers, 2nd ed., Prentice Hall, 2010*	4. *Murthy, D.V.S., Transducers and Instrumentation, Prentice Hall, 2010* 5. *Neubert H.K.P., Instrument Transducers – An Introduction to their Performance and Design, Oxford University Press, Cambridge, 2003*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. D. Karthikeyan, Controlsoft Engineering India Pvt Ltd, karthikeyan.d@controlsoftengg.in	*1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com*	*1. Mrs.N.Deepa, SRMIST*
2. V. Venkateswaran, Instrumentation Consultant, vvenkat99@gmail.com	*2. Dr. D. Nedumaran, Madras University, dnmaran@gmail.com*	*2. Mrs.Indirani, SRMIST*

Course Code	18ECE181T	Course Name	MEASUREMENTS AND INSTRUMENTATION	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Electronics and Communication Engineering*	**Data Book / Codes/Standards**	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Utilize the various techniques that are used to measure Current and Voltage*
CLR-2 :	*Utilize the various techniques that are used to measure power and energy*
CLR-3 :	*Design circuits to measure resistance, capacitance and inductance*
CLR-4 :	*Analyze different techniques to measure noise and signal processing*
CLR-5 :	*Analyze the working of various display devices and recorders*
CLR-6 :	*To study the working of various recorders*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO - 3
CLO-1 :	*Analyze the techniques used to measure current and voltage*	3	80	75	H	-	-	-	-	H	-	-	-	-	-	H	H	-	H
CLO-2 :	*Analyze the techniques to measure power and energy*	3	80	70	H	-	-	-	-	H	-	-	-	-	-	H	-	-	H
CLO-3 :	*Design circuits for measuring resistance, inductance and capacitance*	3	75	70	H	H	M	H	M	H	-	-	-	-	-	H	H	-	H
CLO-4 :	*Apply the knowledge and practices for signal conditioning to the real-world problem*	3	80	75	H	H	M	H	M	-	-	-	H	-	-	H	-	-	H
CLO-5 :	*Apply knowledge of measurement and instrumentation in display and recording devices*	3	80	70	H	-	M	-	H	-	-	-	-	-	-	H	-	-	H
CLO-6 :	*Apply knowledge of measurement and instrumentation in recording devices*	3	80	70	H	-	-	-	-	H	-	-	-	-	-	H	H	-	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Introduction to measurements and Instrumentation. Classification of Instruments.*	*Introduction of power energy measurements*	*Introduction to measurement of resistance, capacitance, inductance and frequency*	*Introduction to measurement of Non-Electric Quantities*	*Introduction to display devices and recorders*
	SLO-2	*Galvanometer Introduction and its type.*	*Measurement of power in A.C. circuits*	*Classification of resistance types*	*Non-electric parameters*	*Digital display methods*
S-2	SLO-1	*D'Arsonval Galvanometer – construction, working and torque derivation.*	*Derivation of total power in A.C circuits*	*Methods of Low resistance measurement – Ammeter Voltmeter, Kelvins Double bridge method, Potentiometer.*	*Measurement of Pressure*	*Digital Storage Oscilloscope,*
	SLO-2	*PMMC – construction, working and torque derivation*	*Measurement of power in D.C. circuits*	*Methods of Medium resistance measurement*	*low and high pressure*	*Digital Voltmeter*
S-3	SLO-1	*Vibration galvanometer – construction, working and derivation*	*Derivation of total power in D.C. circuits*	*Substitution method & Voltmeter - ammeter method*	*Measurement of Vibration*	*Ramp type, integrating, potentiometric*
	SLO-2	*Introduction to Moving iron instruments*	*Introduction to Electrodynamic wattmeter*	*Wheatstone bridge method*	*Nature & its quantities*	*Recorders*
S-4	SLO-1	*Attraction type – construction and working*	*Electrodynamic wattmeter - Construction, Working and derivation*	*Methods of High resistance measurement*	*Measurement of Temperature*	*Continuous and discrete recorders*
	SLO-2	*Repulsion type– Construction and working*	*Errors in Electrodynamic wattmeter*	*Megger*	*Thermistor, thermocouple*	*Strip chart recorder*
S-5	SLO-1	*Electro dynamometer – working principle*	*Numerical Problem*	*Methods of Earth resistance measurements*	*Measurement of Radiation*	*X-Y recorder*
	SLO-2	*Dynamometer type Instrument-Construction and working*	*Power measurement in polyphase systems- basics*	*Introduction and general equations of A.C. Bridges*	*Pyrometers*	*UV Recorder*
S-6	SLO-1	*Induction type Instruments*	*Three Wattmeter method*	*Methods of Inductance measurements*	*Measurement of Flow*	*Direct recording*

	SLO-2	*Construction and Working*	*Two & One Wattmeter method*	*problems*	*Ultrasonic flow transducer, electromagnetic flow meter*	*Audio recorder*
S-7	SLO-1	*Introduction to ammeter and voltmeter*	*Numerical Problems*	*Methods of Capacitance measurements*	*Measurement of Humidity*	*Advantages and Disadvantages*
	SLO-2	*Extension of ammeter ranges*	*Introduction to Single phase induction type energy meter*	*problems*	*Using Hygrometers*	*Video Recorder*
S-8	SLO-1	*Extension of voltmeter ranges*	*Single phase induction type energy meter - Construction, working principle*	*Methods of Mutual inductance*	*Measurement of Sound*	*Advantages and Disadvantages*
	SLO-2	*Calibration of ammeters*	*Testing of energy meters*	*Methods of Mutual inductance*	*Using microphones*	*Case Study on Plasma, LCD and Led Displays*
S-9	SLO-1	*Calibration of voltmeter*	*Phantom loading*	*Methods of Frequency measurements*	*Measurement of Level*	*Case Study on digital voice recorder*
	SLO-2	*summary*	*Meter testing circuits*	*problems*	*Ultrasonic method, capacitive methods*	*Summary*

Learning Resources	1. *Sawhney, A.K., A Course in Electrical & Electronic Measurements & Instrumentation, Dhanpat Rai and Co., 2010* 2. *Golding. E. W, and Widdis F.C, Electrical Measurements and Measuring Instruments, 5th ed., A.H. Wheeler & Company, 2003* 3. *Carr, J.J., Elements of Electronic Instrumentation and Measurement, Pearson Education India, 2011*	4. *Copper. W.D., Helfrick.. A.D, Modern Electronic Instrumentation and Measurement Technique , 5th ed., Prentice Hall of India, 2002* 5. *Bell, A.D., Electronic Instrumentation and Measurements, 2nd ed., Prentice Hall of India, 2003* 1. *Northrop, R.B., Introduction to Instrumentation and Measurements, Taylor & Francis, New Delhi, 2008*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. D. Karthikeyan, Controlsoft Engineering India Pvt Ltd, karthikeyan.d@controlsoftengg.in	*1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com*	*1. Mr.C. Likith Kumar, SRMIST*
2. V. Venkateswaran, Instrumentation Consultant, vvenkat99@gmail.com	*2. Dr. D. Nedumaran, Madras University, dnmaran@gmail.com*	*2. Dr. A. Vimala Juliet, SRMIST*

Course Code	18ECE182T	Course Name	AUTOMOTIVE INSTRUMENTATION SYSTEMS	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Analyze the basics of automotive systems and requirements*
CLR-2 :	*Utilize the principles behind various sensors and its application across a vehicle*
CLR-3 :	*Utilize the various electrical systems pertaining to engine*
CLR-4 :	*Analyze different safety and security systems*
CLR-5 :	*Know about the basics of automotive systems and requirements*
CLR-6 :	*Know about the sensors and various systems of automotive domain.*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO - 3
CLO-1 :	*Analyze the automotive domain and electronic systems in it*	3	85	80	H	H	-	-	L	-	-	-	-	-	-	H	H	-	H
CLO-2 :	*Identify the effect of electromagnetic interference*	3	85	80	H	H	-	L	-	-	-	-	-	-	-	-	M	-	H
CLO-3 :	*Identify the sensor and actuator technologies involved in a car*	3	90	80	H	H	M	L	M	-	-	-	-	-	-	H	H	H	-
CLO-4 :	*Analyze the various electrical systems and electronics involved in it for upgraded operation*	3	90	80	H	H	M	L	M	-	-	-	-	-	-	H	M	-	H
CLO-5 :	*Analyze new systems on safety, security and body of a car*	3	85	80	H	H	M	L	M	-	-	-	-	-	-	H	M	H	M
CLO-6 :	*Understand the automotive problems and provide solutions through new system design.*	3	85	80	H	H	-	-	L	-	-	-	-	-	-	H	H	-	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Introduction to Automotive Electronics*	*Intake Air Temperature (IAT) Sensor*	*Starting Systems – Requirements*	*Tire pressure monitoring systems*	*Power Windows*
	SLO-2	*Outline to Automotive Sensors*	*Engine Coolant Oil Temperature Sensor*	*Starter Motor – selection and working principle*	*Capacitive based Pressure Sensor*	*Smart Window Lift Control Module*
S-2	SLO-1	*Requirements in Automotive Sensor*	*Exhaust Gas Recirculation Temperature Sensor*	*Diagnosing Faults – Symptoms*	*Anti-lock braking system*	*Central Locking System*
	SLO-2	*Open and Closed Loop Control Strategies*	*Exhaust Gas Temperature Sensor*	*Testing Procedures*	*Anti-lock braking system*	*Power Seat*
S-3	SLO-1	*Shop safety – General safety*	*Manifold Absolute Pressure (MAP) Sensor*	*Charging systems – Requirements*	*Traction Control System*	*Automatic Wiper systems*
	SLO-2	*Electrical Safety*	*High Pressure Fuel Sensor, Engine Oil Pressure Sensor*	*Components and operation*	*Adaptive Cruise Control*	*Electronic Vehicle Immobilizer*
S-4	SLO-1	*Office Safety*	*Crankshaft Angular Position Sensor*	*Diagnosing Faults – Symptoms*	*Types of Adaptive Cruise Control*	*Oil Pressure Warning System*
	SLO-2	*Lifting Procedures*	*Cam Position Sensor*	*Testing Procedures*	*Types of Adaptive Cruise Control*	*Engine Overheat Warning System*
S-5	SLO-1	*Electrical wiring, Terminals & Switching*	*Piston Position Sensor*	*Ignition systems – Requirements*	*Parking guide systems*	*Speed Warning System*
	SLO-2	*Multiplexed Networking*	*Throttle Plate Angular Position*	*Conventional Ignition System*	*Air Bag System*	*Door Lock Indicators*
S-6	SLO-1	*Circuit Diagrams and Symbols*	*Knock Sensor*	*Electronic Ignition System*	*Reversible Seat Belt Pre-tensioner*	*Gear Neutral Indicator*
	SLO-2	*Electromagnetic Interference*	*Oxygen Concentration Sensor*	*Programmed Ignition System*	*Electronic Power Steering systems*	*Anti-Theft Alarm System*

S-7	SLO-1	*Electromagnetic Compatibility*	*Mass Air Flow (MAF) Rate Sensor*	*Distributor less Ignition System*	*Vehicle Stabilization System*	*Brake Actuation Warning System*
	SLO-2	*Use of Diagnostic Equipment*	*Rain Sensor*	*Direct Spark Ignition System*	*Vehicle Stabilization System*	*Computer Controlled Air Conditioning Systems*
S-8	SLO-1	*Look Up Tables*	*Acceleration Sensor*	*Fuel Injection System – Requirements*	*Collision Avoidance System*	*On Board Diagnostics*
	SLO-2	*Applications*	*Yaw Rate Sensor*	*Components and operation*	*Collision Avoidance System*	*Roof Control Module*
S-9	SLO-1	*Case Study I*	*Chassis Level Sensor*	*Types of Fuel Injection System*	*Case Study II*	*Case study III*
	SLO-2	*Case Study I*	*Fuel Level Sensor*	*Types of Fuel Injection System*	*Case Study II*	*Case study III*

Learning Resources	1. *Tom Denton, Automotive Electricals / Electronics System and Components, 3rd ed., 2004* 2. *BOSCH, Automotive Electrics, Automotive Electronics: Systems & Components, BOSCH, 4th ed., 2005.*	3. *Jack Erjavec, A Systems Approach to Automotive Technology, Cengage Learning, 2009* 4. *Ronald K.Jurgen, Automotive Electronics Reliability, Vol 2, SAE International, 2010*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. D. Karthikeyan, Controlsoft Engineering India Pvt Ltd, karthikeyan.d@controlsoftengg.in	*1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com*	*1. Mr. Arockia Vijay Joseph, SRMIST*
2. V. Venkateswaran, Instrumentation Consultant, vvenkat99@gmail.com	*2. Dr. D. Nedumaran, Madras University, dnmaran@gmail.com*	*2. Dr. A. Vimala Juliet, SRMIST*

Course Code	18ECE183T	Course Name	SAFETY INSTRUMENTED SYSTEM	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Know the standard and regulation of SIS design.
CLR-2 :	Know the Corrective and Preventive maintenance of SIS.
CLR-3 :	Know the requirement of field device and the control components.
CLR-4 :	Know the failure diagnostic technique.
CLR-5 :	Acquire the knowledge on the software development model and Industrial application of SIS.
CLR-6 :	Know the function of safety life cycle and hazard analysis.

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO - 3
CLO-1 :	Develop, operate and maintain the safety systems.	3	80	75	H	-	H	-	-	H	H	H	-	-	-	H	H	-	-
CLO-2 :	Perform the corrective and preventive maintenance of SIS.	3	80	70	H	-	-	H	-	H	-	-	-	-	-	H	-	H	-
CLO-3 :	Understand the knowledge of field devices and reliability.	3	75	70	-	-	-	-	-	H	-	-	H	H	-	-	H	-	-
CLO-4 :	Evaluate the failure diagnostic technique.	3	80	75	-	H	H	-	-	-	-	-	-	-	-	-	-	H	-
CLO-5 :	Develop, operate and maintain the safety systems.	3	80	70	-	-	H	-	H	-	-	-	-	-	-	H	-	-	H
CLO-6 :	gain knowledge on safety life cycle and function of protective layers.	3	80	70	H	-	H	-	-	H	H	H	-	-	-	H	H	-	-

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Industry Guidelines	Introduction to Safety Instrumentation	Importance of field device	Introduction of failure diagnostic mode	Selection of Technology
	SLO-2	Industry Standards and Regulations.	Hazards & risk	Impact of Field Devices on System Performance.	Equipment Failure mode	Relay systems-PLC based system
S-2	SLO-1	Set of Standards.HSE – PES, AIChE – CCPS,	Process Hazards Analysis (PHA)	Percentage Split of System Failures	Fail –Safe, Fail-danger, Annunciation	Safety PLCs
	SLO-2	IEC 61508, ANSI/ISA, OSHA (29 CFR 1910.119 - Process Safety Management of Highly Hazardous Chemicals)	Safety cycle	Issues relating to field devices. Wiring of Field Devices.	Reliability block diagram. Series system ,Parallel systems, Fault trees, Fault tree symbols	Safety System Complexity
S-3	SLO-1	Technology Choices, Redundancy Choices, Field Devices, Test Intervals.	Shutdown/Interlock/Instrumented Systems (Safety Instrumented Systems – SIS).	Sensors	Comparison of Reliability block diagram and Fault tree	Communication with others system
	SLO-2	Design Lifecycle	Physical Protection	Switches, Transmitters	Fault tree AND gates ,fault tree OR gates	Software development models for safety related system
S-4	SLO-1	Hazard & Risk Analysis- HAZOP analysis	Mitigation Layers	Sensor Diagnostics	Approximation technique	Rapid prototyping, V model
	SLO-2	Allocation of Safety Functions to Protective Layers	Containment Systems	Smart Transmitters	Common mistakes	Water model, spiral model
S-5	SLO-1	Requirements	Scrubbers and Flares	Final Elements	Markov models	Implementation Procedure
	SLO-2	Develop Safety Specification	Fire and Gas (F&G) Systems	Valve Diagnostics	Markov solution technique	case study- Introduction
S-6	SLO-1	SIS Design & Engineering	Evacuation Procedures.	Smart Valve Positioners	Realistic safety instrumented system modeling	The Safety Lifecycle and Its Importance

	SLO-2	*Installation , Commissioning*	*Diversification*	*Redundancy*	*Event tree analysis*	*Case Description: Furnace/Fired Heater Safety Shutdown System*
S-7	SLO-1	*Validation*	*Corrective and Preventive maintenance*	*Voting Schemes and Redundancy*	*Failure mode and effect analysis*	*Safety Instrumented system in PLC*
	SLO-2	*Operations and Maintenance*	*Types of corrective and preventive maintenance*	*Design Requirements for Field Devices*	*Mathematical and statistical basis for risk analysis of technical systems*	*Safety Instrumented system in oil and gas facilities*
S-8	SLO-1	*Modifications. Decommissioning.*	*Mathematical models for performing corrective measures*	*Operator Interface requirement, Communication Interface requirement*	*Factory Acceptance Test*	*Nuclear plant safety discussion*
	SLO-2	*Process Hazard Analysis (PHA)*	*SIS Requirement for system behavior on detection of a fault*	*Final Element Design Requirements,*	*Spurious trip rate*	*Safety Instrumented system in DCS*
S-9	SLO-1	*Failure mode, Effects, and criticality analysis(FMECA), Probability of failure on demand(PFD)*	*Hardware fault Tolerance*	*Differences between using certified vs. proven-in-use devices*	*Risk Assessment*	*Installation, Commissioning and Pre-startup Tests*
	SLO-2	*Examples of usage of standards on specific applications.*	*SIS Integration: Architectural Issues*	*Circuit measures to increase the reliability*	*safety integrity levels (SIL)*	*Operation and Maintenance Procedures*

Learning Resources	1. Paul Gruhn, *Harry Cheddie, Safety Instrumented Systems: Design, Analysis and Justification, 2nd ed., International Society of Automation, 2005* 2. *William M.Goble, Harry Cheddie, Safety Instrumented Systems Verifications: Practical Probabilistic Calculations, ISA-2005*	3. *Roger L. Brauer, Safety and Health for Engineers, John Wiley Sons, 2006* 4. *B.S. Dhillon, Maintainability, Maintenance and Reliability for Engineers, CRC Press, 2006* 5. *Swapan Basu, "Plant Hazard analysis and Safety Instrumentation systems" Academic Press, 2016*

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1. D. Karthikeyan, Controlsoft Engineering India Pvt Ltd, karthikeyan.d@controlsoftengg.in	*1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com*	*1. Mrs. K. Vibha, SRMIST*
2. V. Venkateswaran, Instrumentation Consultant, vvenkat99@gmail.com	*2. Dr. D. Nedumaran, Madras University, dnmaran@gmail.com*	*2. Dr. G Joselin Retna Kumar, SRMIST*

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