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 & TECHNOLOGY
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SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

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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:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
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			

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 :	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	*40%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
	Understand										
Level 2	Apply	*40%*	-	*40%*	-	*40%*	-	*40%*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
	Create										
	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:	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
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																		
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	*40%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
	Understand										
Level 2	Apply	*40%*	-	*40%*	-	*40%*	-	*40%*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
	Create										
	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

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(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			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 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	*40%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
	Understand										
Level 2	Apply	*40%*	-	*40%*	-	*40%*	-	*40%*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
	Create										
	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:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
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			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 the structure and function of cell, communication and gene expression and homeostasis	1	80	70	H	H	H	H	-	M	L	H	H	H	-	H	H	H	H
CLO-2 :	Describe the classification of nervous system, function and diseases associated with it	2	80	70	H	H	H	H	-	H	M	H	H	H	-	H	H	H	H
CLO-3 :	Discuss the structure and function of heart, lung, abnormal functioning	2	80	70	M	H	M	H	M	M		M	H	H	-	H	H	H	H
CLO-4 :	Describe anatomy and function of digestive system and urinary system and its disturbances	2	80	70	H	H	H	H	-	L	H	L	H	H	-	H	H	H	H
CLO-5 :	Describe the types of endocrine system, its role in maintaining homeostasis and reproductive biology	2	80	70	H	H	H	H	-	M	H	H	H	L	-	H	H	H	H
CLO-6 :	Explain how human body function and reproduce with maintaining homeostasis	2	80	70	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)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
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Level 1	Remember	*40%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
	Understand										
Level 2	Apply	*40%*	-	*40%*	-	*40%*	-	*40%*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

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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:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
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			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 :	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	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
	SLO-2					
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	*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*
	SLO-2					
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	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	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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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			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 :	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	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.
	SLO-2					
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	*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.*
	SLO-2					
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	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	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. 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			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 :	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	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
	SLO-2					
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	*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*
	SLO-2					
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	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	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			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 :	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	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
	SLO-2					
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	*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*
	SLO-2					
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	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	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*

ACADEMIC CURRICULA

Engineering Science 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	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:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
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			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 :	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	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
	SLO-2					
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, 47th 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

	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. 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:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
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			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 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*

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. 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:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
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			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 :	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 correlations*	*Liquid phase equimolal counter diffusion*	*Classification of dryers, solids handling in dryers*	*Mechanism of extractive distillation*
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	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	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			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 :	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	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	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. V. Ganesh, SRMIST*
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:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
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			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 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	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
	SLO-2					
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	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	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**			**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 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	*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)*
	SLO-2					
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	*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*
	SLO-2					
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	*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*
	SLO-2					

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	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	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)	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 :	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	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	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:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
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			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 :	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	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
	SLO-2					
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	*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*
	SLO-2					
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	*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*
	SLO-2					

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	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	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. 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 (%)
CLO-1 :	Identify and describe the energy exchange processes in engineering systems.	2	75	70
CLO-2 :	Understand the second law of thermodynamics and its application to a wide range of systems	2	75	70
CLO-3 :	Extrapolate the psychrometric properties and performance of refrigeration and air conditioning systems	2	75	70
CLO-4 :	Extrapolate the different modes of heat transfer like conduction, convection and radiation.	2	75	70
CLO-5 :	Analyze the heat transfer in refrigeration and air-conditioning systems, internal combustion engine and heat exchangers.	3	75	70
CLO-6 :	Understand the basic laws of thermodynamics and its applications in different engineering systems	3	75	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	M	M	L	L	L	L	L	L	L	H	M	M	M
CLO-2 :	H	H	M	M	L	L	L	L	L	L	L	H	M	M	M
CLO-3 :	H	H	M	M	L	L	L	L	L	L	L	H	M	M	M
CLO-4 :	H	H	M	H	M	M	L	L	L	L	L	H	M	M	M
CLO-5 :	H	H	M	H	M	M	M	L	L	L	L	H	M	M	M
CLO-6 :	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	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	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			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 :	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	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	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:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
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	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLO-1 :	Analyze fundamentals of nanotechnology, different classes of nanomaterials and their sizes and dimensions	2	80	75
CLO-2 :	Describe various physical properties of nanomaterials	2	80	70
CLO-3 :	Apply chemical and physical methods to synthesize and fabricate nanomaterials	2	75	70
CLO-4 :	Distinguish various characterization techniques involved in nanotechnology	2	80	75
CLO-5 :	Identify the potentialities of nanotechnology	2	80	70
CLO-6 :	Perform preliminary level research in nanoscience/nanotechnology	2	80	75

		Program Learning Outcomes (PLO)														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		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 fundamentals of nanotechnology, different classes of nanomaterials and their sizes and dimensions	H	M	H	H	M	H	H	H	M	H	M	H	H	H	H
CLO-2 :	Describe various physical properties of nanomaterials	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	H	H	H	H	H	H	H	H	H	H	H	H	H	M	H
CLO-4 :	Distinguish various characterization techniques involved in nanotechnology	H	M	H	H	H	M	H	H	H	H	H	H	M	H	H
CLO-5 :	Identify the potentialities of nanotechnology	M	M	M	H	M	H	H	H	M	H	M	H	H	H	H
CLO-6 :	Perform preliminary level research in nanoscience/nanotechnology	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	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	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 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)	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 :	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	-	*40%*	-	*30%*	-	*30%*	-	*30%*	-	-
	Understand										
Level 2	Apply	-	*40%*	-	*40%*	-	*40%*	-	*40%*	-	-
	Analyze										
Level 3	Evaluate	-	*20%*	-	*30%*	-	*30%*	-	*30%*	-	-
	Create										
	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			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 :	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	-	*40%*	-	*30%*	-	*30%*	-	*30%*	-	-
	Understand										
Level 2	Apply	-	*40%*	-	*40%*	-	*40%*	-	*40%*	-	-
	Analyze										
Level 3	Evaluate	-	*20%*	-	*30%*	-	*30%*	-	*30%*	-	-
	Create										
	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	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			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 :	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	-	*40%*	-	*30%*	-	*30%*	-	*30%*	-	-
	Understand										
Level 2	Apply	-	*40%*	-	*40%*	-	*40%*	-	*40%*	-	-
	Analyze										
Level 3	Evaluate	-	*20%*	-	*30%*	-	*30%*	-	*30%*	-	-
	Create										
	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. Mr. Ashok Kumar V, NITTE School of Management Entrepreneurship Development, ashokkumarvv2007@gmail.com*	*1. Dr. Shantanu Patil, SRMIST*	*3. Dr. W. Richard Thilagaraj, SRMIST*
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:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
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:	Level of Thinking (Bloom)	Expected Proficiency (%)	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	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		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 nature and purpose of marketing; understand the fundamentals of each of the most important marketing tasks	L	H	-	M	-	-	-	-	M	L	-	H	-	-	-
CLO-2 :	Use the Business Models in their startups	L	H	-	M	-	-	-	-	M	L	-	H	-	-	-
CLO-3 :	Identify and appreciate the strong linkages between finance and globalization	L	H	-	M	-	-	-	-	M	L	-	H	-	-	-
CLO-4 :	Implement tax process	L	H	-	M	-	-	-	-	M	L	-	H	-	-	-
CLO-5 :	Acquire Design Thinking concepts to implement in the startup	L	H	-	M	-	-	-	-	M	H	-	H	-	-	-
CLO-6 :	Implement the essential business basics	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	-	*40%*	-	*30%*	-	*30%*	-	*30%*	-	-
	Understand										
Level 2	Apply	-	*40%*	-	*40%*	-	*40%*	-	*40%*	-	-
	Analyze										
Level 3	Evaluate	-	*20%*	-	*30%*	-	*30%*	-	*30%*	-	-
	Create										
	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:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
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			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 :	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	
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	*40%*	-	*30%*	-	*30%*	-	*30%*	-	-	-
	Understand										
Level 2	Apply	*40%*	-	*40%*	-	*40%*	-	*40%*	-	-	-
	Analyze										
Level 3	Evaluate	*20%*	-	*30%*	-	*30%*	-	*30%*	-	-	-
	Create										
	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 & 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	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:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
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			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 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	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	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**			**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 :	*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			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 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	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	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:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
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			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 :	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	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	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:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
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			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 :	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	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	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			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 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	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	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			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 :	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	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	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
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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			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 :	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	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	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*
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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			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 :	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	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	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:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
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			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 :	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	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	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*
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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	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	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

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 :	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

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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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:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
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			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 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	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	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*
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			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 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	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	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			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 :	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	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	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			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 :	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	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	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:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
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			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 :	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	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	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. Sathyanarayanan J, Mindray Medical India Pvt Ltd, sathyanarayananjayagopal@mindray.com	*1. Dr. S. Poonguzhali, Anna University, poongs@annauniv.edu*	*1. Dr. D. Ashokkumar, SRMIST*
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:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
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			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 :	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	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	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			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 :	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	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	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. Mrs. Lakshmi Prabha, SRMIST*
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:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
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			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Program Learning Outcomes (PLO)														
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
					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	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	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:
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:	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 :	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	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	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. 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

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	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 (Level of Thinking (Bloom))	Learning 2 (Expected Proficiency (%))	Learning 3 (Expected Attainment (%))
CLO-1 :	To demonstrate the various types of basic sensors.	3	80	75
CLO-2 :	Understand the inductive and capacitive sensors which are used for measuring various parameters.	3	80	75
CLO-3 :	Understand the thermal and radiation sensors	3	80	75
CLO-4 :	Have an adequate knowledgeon the various magnetic sensors	3	80	75
CLO-5 :	To demonstrate the various types of basic sensors measuring non electrical quantity	3	80	75
CLO-6 :	Select the right transducer for the given application	3	80	75

	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	H	-	-	-	H	H	-	-
CLO-2	H	-	-	H	-	H	-	-	-	-	-	H	-	H	-
CLO-3	-	-	-	-	-	H	-	-	H	H	-	-	H	-	-
CLO-4	-	H	H	-	-	-	-	-	-	-	-	-	-	H	-
CLO-5	-	-	H	-	H	-	-	-	-	-	-	H	-	-	H
CLO-6	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	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	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	LOGIC AND DISTRIBUTED CONTROL SYSTEM	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

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		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

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