ACADEMIC CURRICULA

Engineering Science Courses

Regulations - 2018

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

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

Kattankulathur, Kancheepuram, Tamil Nadu, India

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

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-1 :	*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:*	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 SLO-2	*Lab 1: Determine critical solution temperature (CST) of phenol-water system*	*Lab 4: Estimate aspirin drug in tablets using pH meter*	*Lab 7: Repeat class*	*Lab 10: Determine the rate constant of acid catalyzed hydrolysis of an ester*	*Lab 13: Determine fatty acid methyl ester using gas chromatography*
S-6	SLO-1	*Vapor pressure-Composition and Boiling point-Composition curves of Type III solutions*	*Problems on Gibbs' free energy*	*One component system - CO_2 system*	*Introduction to Photochemistry*	*Principle, Instrumentation, Working, Applications, and Limitations of analytical techniques*

	SLO-2	*Fractional distillation of binary liquid systems; The Lever rule*	*Problems on Gibbs' free energy*	*One component system - Sulphur system*	*Laws of photochemistry*	*UV –Vis spectroscopy*
S-7	SLO-1	*Distillation of immiscible liquids*	*Significance of equilibrium constant*	*Three component systems -Triangular phase diagram*	*Quantum yield*	*Infra-red spectroscopy*
	SLO-2	*Steam ditillation*	*Equilibrium constants: K_p, K_c, and, K_x*	*Three component system: acetic acid-chloroform-water system*	*Photochemical reactions*	*Atomic absorption spectroscopy*
S-8	SLO-1	*Partially miscible liquids*	*Relationship between K_p, K_c, and, K_x*	*Three component system: two salts and water system*	*Photochemical rate law*	*Chromatographic techniques: General principle*
	SLO-2	*Critical solution temperature; Phenol-water system*	*Temperature dependence of Equilibrium constant - Van't Hoff Equation*	*The Nernst distribution law and distribution co-efficient*	*Determination of quantum yields*	*Column chromatography*
S 9-10	SLO-1 SLO-2	*Lab 2: Determine molecular weight by Rast method*	*Lab 5: Estimate sulphate by nephelometry*	*Lab 8: Determine partition co-efficient of benzoic acid between benzene and water*	*Lab 11: Determine the amount of manganese in the given sample of ore*	*Lab 14: Repeat class*
S-11	SLO-1	*Solutions of gases in liquids : Factors influencing solubility of a gas, Henry's law*	*Pressure dependence of equilibrium constants*	*Conditions for the validity of the distribution law*	*Problems on Beer Lambert's law*	*Paper chromatography*
	SLO-2	*Colligative Properties*	*Problems on equilibrium constants*	*Association of the solute in one of the solvents*	*Problems on quantum yield*	*Thin layer chromatography*
S-12	SLO-1	*Relative lowering of vapour pressure, Osmosis and osmotic pressure*	*Problems on equilibrium constants*	*Dissociation of the solute in one of the solvents*	*Kinetics of hydrogen-chlorine reaction: Mechanism*	*Gas chromatography*
	SLO-2	*Elevation in boiling point, Depression in freezing point*	*Le Chatelier's Principle*	*Applications of Nernst distribution law*	*Kinetics of hydrogen-chlorine reaction: Derivation*	*High Performance Liquid Chromatography*
S-13	SLO-1	*Determination of molecular weight from colligative properties*	*Effect of change in concentration, temperature, and pressure*	*Problems on Nernst distribution law*	*Kinetics of hydrogen-bromine reaction: Mechanism*	*Open-ended problems on choice and usage of analytical instruments*
	SLO-2	*Effect of association/dissociation on colligative properties*	*Le Chatelier's principle and physical equilibria*	*Problems on Nernst distribution law*	*Kinetics of hydrogen-bromine reaction: Derivation*	*Open-ended problems on choice and usage of analytical instruments*
S 14-15	SLO-1 SLO-2	*Lab 3: Determine strength of the given acid mixture by conductometric titration*	*Lab 6: Phase diagram of three component system*	*Lab 9: Estimate amount of iron present in a sample using UV-Vis spectrophotometer*	*Lab 12: Determine the amount of reducing sugar by DNS method*	*Lab 15: Practical Model Examination*

Learning Resources	*1.B. R. Puri, L. R. Sharma, Madan S. Pathania, Principles of Physical Chemistry, 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			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 :	*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:*																		
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:
CLR-1 :	Describe the various modes of heat transfer and evaluate the rate of steady state heat transfer
CLR-2 :	Explain and analyze the basic concepts of natural and forced convection as applied to various flows and geometry
CLR-3 :	Illustrateprinciples of mass transfer, Diffusion phenomena of mass transfer operations, mass transfer coefficients and calculate mass transfer rates
CLR-4 :	Elucidate the principles of drying, different types of driers and calculate drying time for different drying periods
CLR-5 :	Clarify the concept of distillation and various types of distillation and extraction
CLR-6 :	Introduce the basic principles of heat and mass transfer processes, and its applications

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1 Level of Thinking (Bloom)	2 Expected Proficiency (%)	3 Expected Attainment (%)	PLO 1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	13 PSO - 1	14 PSO - 2	15 PSO – 3
CLO-1 :	Calculate the 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 Understand	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
Level 2	Apply Analyze	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
Level 3	Evaluate Create	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

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

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

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

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

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			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*	*Introduction to ejectors*

					T and V.	
S-5	SLO-1	*Problem solving on closed systems*	*Vander Waals equation*	*Entropy changes of an ideal gas in a closed system*	*Two-phase systems: temperature dependence of the vapor pressure of liquids*	*Power cycles*
	SLO-2	*Problem solving on closed systems*	*Redlich/Kwong equation*	*Entropy changes of an ideal gas in a closed system*	*Two-phase systems: temperature dependence of the vapor pressure of liquids*	*Rankine cycle.*
S-6	SLO-1	*Constant volume processes and Constant pressure processes.*	*Problems solving on equation of state*	*Problems solving on Carnot's equation*	*Problems solving on fundamental properties*	*Otto engine*
	SLO-2	*Enthalpy, heat capacity*	*Problems solving on equation of state*	*Problems solving on entropy*	*Problems solving on fundamental properties*	*Diesel engine*
S-7	SLO-1	*Problems solving on enthalpy*	*Virial equations of state,*	*Problems solving on entropy*	*Thermodynamic diagrams.*	*Principles of refrigeration*
	SLO-2	*Problems solving on heat capacity*	*Application of the virial equations*	*Mathematical statement of the second law*	*Joule Thomson expansion*	*Heat Pump*
S-8	SLO-1	*Energy balance for steady-state flow processes*	*Problems solving using Virial equation*	*Entropy balance for open systems*	*Joule Thomson expansion - applications.*	*Carnot refrigerator*
	SLO-2	*Energy balance for steady-state flow processes*	*Problems solving using Virial equation*	*Statement of the third law of thermodynamics.*	*Liquefaction processes*	*Vapor-compression cycle*
S-9	SLO-1	*Problems solving for open system*	*Theorem of corresponding states, acentric factor*	*Problems solving using third law of Thermodynamics*	*Linde liquefaction process*	*Absorption refrigeration*
	SLO-2	*Problems solving for open system*	*Problems solving using acentric factor*	*Problems solving using third law of Thermodynamics*	*Claude liquefaction process*	*Absorption refrigeration*

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

Learning Assessment

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

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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:
CLR-1 :	Identify the applications of analog electronics
CLR-2 :	Identify the applications of digital logic families
CLR-3 :	Design the combinational and sequential logic circuits
CLR-4 :	Implement the combinational and sequential logic circuits
CLR-5 :	Analyze the design of counters and registers
CLR-6 :	Utilize the concepts in real time scenarios

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

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

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

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

Learning Assessment

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

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

Course Designers

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

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

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

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

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			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 SLO-2	*Lab 1: IP Addressing*	*Lab 4: Router Configuration (Creating Passwords, Configuring Interfaces)*	*Lab 7: RIP v1*	*Lab 10: EIGRP Authentication and Timers*	*Lab 13: Examining Network Address Translation (NAT)*
S-5	SLO-1	*Layers in the OSI model, Functions of Physical layer, data link layer*	*Special Addresses*	*Multiplexing: FDM*	*Types of Errors*	*Distance Vector Routing, Problem Solving*
	SLO-2	*Functions of Network layer, Transport layer*	*Special Addresses*	*Multiplexing: FDM*	*Types of Errors*	*Link state Routing*
S-6	SLO-1	*Functions of Session, Presentation layer and Application layer*	*Classless Addressing*	*TDM*	*Forward Error correction*	*Problem solving*
	SLO-2	*TCP/IP protocol suite , Link layer protocols*	*Problem Solving*	*WDM*	*CSMA, CSMA/CD*	*Path vector Routing*

S 7-8	SLO-1 SLO-2	*Lab 2: Subnetting (VLSM)*	*Lab 5: Basic Switch Configuration: Vlan*	*Lab 8: RIP v2*	*Lab 11: Single-Area OSPF Link Costs and Interface*	*Lab 14: BGP Configuration*
S-9	SLO-1	*Network layer protocols*	*Private Address, NAT, Supernetting*	*Guided Media: Twisted Pair, Coaxial Cable Fiber optic cable*	*Hamming Distance*	*RIP v1,RIP v2*
	SLO-2	*Transport layer protocols*	*Hub, Repeaters, Switch*	*Unguided media: Radio waves*	*Correction Vs Detection*	*OSPF*
S-10	SLO-1	*Serial and Parallel Transmissions*	*Bridge*	*Microwaves*	*HDLC*	*EIGRP*
	SLO-2	*Addressing*	*Structure of Router*	*Infrared*	*PPP*	*BGP*
S 11-12	SLO-1 SLO-2	*Lab 3: LAN Configuration using straight through and cross over cables*	*Lab 6: Static and Default Routing*	*Lab 9: EIGRP Configuration, Bandwidth, and Adjacencies*	*Lab 12: Multi-Area OSPF with Stub Areas and Authentication*	*Lab 15: Configuring Static and Default Routes*

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

Learning Assessment

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

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

Course Designers

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

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

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

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

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)
CLO-1 :	*Determine Transfer function of a system by mathematical modeling, block diagram reduction and signal flow graphs*	1,2	80	80
CLO-2 :	*Identify the standard test inputs, time domain specifications and calculate steady state error*	1,2	85	80
CLO-3 :	*Plot a root locus curve and analyze the system stability using Routh array*	2,3	90	85
CLO-4 :	*Analyze the frequency domain specifications from bode and polar plots*	2,3	90	85
CLO-5 :	*Design a closed loop control system for specific application*	1,2,3	80	80
CLO-6 :	*Identification of controller parameters and tuning*	1,2,3	85	85

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: Professional Achievement	14 PSO – 2: Project Management Techniques	15 PSO – 3: Analyze & Research
CLO-1	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-2	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-3	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-4	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-5	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-6	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-

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

S-5	SLO-1	*Conversions of Mechanical system to Electrical system*	*Step response of over damped second order system*	*Computation of Routh array*	*Bode plot of typical systems*	*Design Specification, controller configurations-PID controller*
	SLO-2	*f-V and f-I electrical analogies*	*Step response of undamped second order system*	*Routh array of stable systems*		
S-6	SLO-1	*Block diagram reduction rules and methodology*	*Time domain specifications and their significance*	*Routh array of Unstable systems*	*Polar plot and significance*	*Design of speed control system for DC motor*
	SLO-2		*Numerical solution*	*Routh array of Unstable systems*	*Nyquist stability criterion*	
S-7	SLO-1	*Evaluation of transfer function using block diagram reduction*	*Transient and steady state error analysis*	*Root locus technique*	*Sketching of polar plot on polar graphs*	*Design of control system for Twin Rotor Multi input Multi output System(TRMS) with one degree of freedom*
	SLO-2		*Static and dynamic Error coefficients*	*Rules for sketching root locus*		
S-8	SLO-1	*Signal flow graphs and evaluation of transfer function*	*Static error constants and evaluation of steady state error*	*Root locus plot of typical systems*	*Polar plot of typical systems*	*Case study 1*
	SLO-2					
S-9	SLO-1	*Block diagram to signal flow conversion*	*Dynamic error constants and evaluation of steady state error*	*Root locus plot of typical systems*	*Polar plot of typical systems*	*Case study 2*
	SLO-2					

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

Learning Assessment

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

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Mr. Anuj Kumar, Bombard*ier Transportation, Ahmedabad, *kumaranuj.anii@gmail.com*	1. *Dr. Meenakshi, Professo*r 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			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 :	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:																		
CLO-1 :	Solve statically determinate equilibrium problems in the field of Engineering	2	80	75	H	H	M	M	M	L	L	L	L	L	L	L	L	L	L
CLO-2 :	Solve problems related to dry friction and analyze machines that are functioning based on the theory of friction	2	85	75	H	H	M	M	M	L	L	L	L	L	L	L	L	L	L
CLO-3 :	Determine centroid and moment of inertia for composite objects	2	85	75	H	H	M	M	M	L	L	L	L	L	L	L	L	L	L
CLO-4 :	Analyze kinematics of particles with rectilinear, curvilinear motions, solve dynamic equilibrium problems in particles	2	80	75	H	H	M	M	M	L	L	L	L	L	L	L	L	L	L
CLO-5 :	Analyze kinematics of rigid bodies with translation, rotation, general plane motion, solve dynamic equilibrium in rigid bodies	2	80	75	H	H	M	M	M	L	L	L	L	L	L	L	L	L	L
CLO-6 :	Solve static and dynamic equilibrium of particle and rigid body problems	2	75	70	H	H	M	M	M	L	L	L	L	L	L	L	L	L	L

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

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

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

Learning Assessment

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

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

Course Designers

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

Duration (hour)		12	12	12	12	12
S-1	SLO-1	*Introduction to thermodynamics*	*Second law of thermodynamics*	*Introduction to psychrometric properties*	*Introduction to heat transfer*	*Introduction to IC engine and engine components*
	SLO-2	*Statistical and classical approach.*	*Kelvin Planck statement, Clausius statement*	*Dry air, moist air, dry bulb temperature.*	*Modes of heat transfer: Conduction, convection and radiation*	*Working principle of two and four stroke of SI and CI engine*
S-2	SLO-1	*Thermodynamic system, properties, processes and cycles.*	*Reversible and irreversible processes*	*Wet bulb temperature, dew point temperature, specific humidity*	*Fourier law of conduction*	*Modes of Heat transfer in IC engine*
	SLO-2	*Thermodynamic equilibrium: Mechanical, chemical and thermal equilibrium.*	*Second law aspects of heat engine*	*Calculations of vapor mixtures*	*General heat conduction equation in Cartesian co-ordinates.*	*Heat transfer and Engine energy balance*
S-3	SLO-1	*Quasi-static process, Work and heat transfer*	*Performance of heat engine*	*Introduction to Psychrometric chart*	*Heat stored in the element, heat Conduction with internal heat generation*	*Problems on heat transfer in IC engine*
	SLO-2	*Problems on Work and heat transfer*	*Second law aspects of refrigerator*	*Psychrometric processes.*	*Plane wall and cylinder with uniform heat generation*	*Principle of Heat flux measurement in IC engine*
S-4	SLO-1	*zeroth law of thermodynamics*	*CoP of refrigerator*	*Sensible heating process*	*Heat Conduction through plane wall*	*Introduction to turbine, Classifications of turbines*
	SLO-2	*First law of thermodynamics.*	*Second law aspects of heat pump*	*Sensible cooling process*	*Heat Conduction through composite wall*	*Merits, demerits and its applications of gas turbine*

S-5	SLO-1	*First law of thermodynamics applied to closed systems*	*CoP of heat pump*	*Humidification and dehumidification*	*Heat Conduction through hollow Cylinder*	*Evaluation of Thermodynamics model in pneumatic cylinder*
	SLO-2	*Isobaric process*	*Problems on combination of heat engine, heat pump and refrigerator*	*Cooling and dehumidification*	*Heat Conduction through composite cylinder*	*Analysis of heat transfer between the air and the cylinder wall*
S-6	SLO-1	*Isochoric process*	*Clausius inequality*	*Adiabatic mixing*	*Heat Conduction through hollow Sphere*	*Conduction heat transfer in Electronics equipment heat sink*
	SLO-2	*Isothermal process*	*concept of entropy*	*Solving problems by using psychrometric chart*	*Heat Conduction through composite Sphere*	*Convection heat transfer in electronics equipment heat sink*
S-7	SLO-1	*Isentropic process*	*Entropy changes in different thermodynamics processes*	*Solving problems on sensible heating process*	*Introduction about convection*	*Introduction to heat exchanger and its types*
	SLO-2	*Polytropic process*	*Entropy changes in isobaric process*	*Solving problems on sensible cooling process*	*Characteristics parameters in free convection*	*Heat transfer analysis in heat exchangers*
S-8	SLO-1	*First law of thermodynamics applied to open systems*	*Entropy changes in Isochoric process*	*Solving problems on adiabatic mixing Elements of refrigeration systems.*	*Empirical correlations for free convection with horizontal plate*	*Analysis of heat transfer in refrigeration*
	SLO-2	*Steady flow energy equation for boiler, turbine and heat exchanger*	*Entropy changes in Isothermal process*	*Coefficient of performance*	*Empirical correlations for free convection with horizontal Cylinder*	*Analysis of heat transfer in Air conditioning system*
S-9	SLO-1	*Steady flow energy equation for turbine.*	*Problems on Entropy changes in different thermodynamics processes*	*Air-conditioning systems*	*Forced convection with laminar flow over a flat plate*	*Heat transfer problems on refrigeration system*
	SLO-2	*Limitations of first law of thermodynamics*	*Problems on Entropy changes in combined processes*	*Open and closed system.*	*Forced convection with Turbulent flow over a flat plate*	*Heat transfer problems on Air conditioning system*
S-10	SLO-1	*Introduction to thermodynamics*	*Second law of thermodynamics*	*Introduction to psychrometric properties*	*Introduction to heat transfer*	*Introduction to IC engine and engine components.*
	SLO-2	*Statistical and classical approach.*	*Kelvin Planck statement, Clausius statement*	*Dry air, moist air, dry bulb temperature.*	*Modes of heat transfer: Conduction, convection and radiation.*	*Working principle of two and four stroke of SI and CI engine*
S-11	SLO-1	*Thermodynamic system, properties, processes and cycles.*	*Reversible and irreversible processes*	*Wet bulb temperature, dew point temperature, specific humidity.*	*Fourier law of conduction*	*Modes of Heat transfer in IC engine*
	SLO-2	*Thermodynamic equilibrium: Mechanical, chemical and thermal equilibrium.*	*Second law aspects of heat engine*	*Calculations of vapor mixtures*	*General heat conduction equation in Cartesian co-ordinates.*	*Heat transfer and Engine energy balance*
S-12	SLO-1	*Quasi-static process, Work and heat transfer*	*Performance of heat engine*	*Introduction to Psychrometric chart*	*Heat stored in the element, heat Conduction with internal heat generation*	*Problems on heat transfer in IC engine*
	SLO-2	*Problems on Work and heat transfer*	*Second law aspects of refrigerator*	*Psychrometric processes*	*Plane wall and cylinder with uniform heat generation*	*Principle of Heat flux measurement in IC engine*

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

Learning Assessment

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

Level 3	Analyze Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

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

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

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-1 :	*Understand the 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:*	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 Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

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

Course Designers

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

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

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

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

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

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

	SLO-2	*Fullerenes and buckyballs*	*Electronic States: Dependence of size and dimensionality*	*Flame pyrolysis*	*Nanoindentation*	*Nanomaterials for data storage*
S-6	SLO-1	*Carbon nanotubes*	*The electron density of states D(E)*	*Physical Vapor Deposition: Thermal evaporation*	*Raman scattering*	*Chemical sensors*
	SLO-2	*Graphene*	*Luttinger liquid behavior of electrons in 1D metals*	*DC/RF magnetron sputtering*	*Surface enhanced -Raman scattering*	*Biosensors*
S-7	SLO-1	*Metal based nano materials*	*Magnetic properties of nanomaterials: Particle size and magnetic behavior*	*Molecular beam epitaxy (MBE)*	*UV-Vis - absorption spectra of nanoparticles of different sizes*	*Nanomedicine*
	SLO-2	*Nanogold and nanosilver*	*Superparamagnetism: Langevin function, surface effects, magnetoresistance*	*Chemical vapor deposition(CVD)*	*Semiconductor nanoparticles*	*Nanobiotechnology*
S-8	SLO-1	*Metal-oxide based nano materials*	*Optical properties: instances of light absorption in nanomaterials*	*Metal organic chemical vapor deposition (MOCVD)*	*Metal nanoparticle: Surface plasmons*	*Nanotoxicology*
	SLO-2	*Nanocomposites and nanopolymers*	*Red- and blue shift*	*Layer-by-layer growth of highly controlled high-quality ultrathin films deposition*	*Surface plasmon resonance*	*Challenges in nanotoxicology*
S-9	SLO-1	*Nanoglasses and nanoceramics*	*Phenomenon of light absorption, light emission- quantum yield*	*Nanofabrication: Concept of lithography*	*Magnetic measurements*	*Nanotechnology in cosmetics*
	SLO-2	*Biological nanomaterials*	*Photoluminescence and electroluminescence of nanomaterials*	*Photo and electron beam lithography techniques*	*Vibrating sample magnetometer (VSM)*	*Nanotechnology in aviation industry*

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

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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*