ACADEMIC CURRICULA

Professional Core Courses

Regulations - 2018

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

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Kattankulathur, Kancheepuram, Tamil Nadu, India

ACADEMIC CURRICULA

Professional Core Courses

AEROSPACE ENGINEERING

Regulations - 2018

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

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

Kattankulathur, Kancheepuram, Tamil Nadu, India

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

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

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

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 the forces under equilibrium	2	85	75	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Identify the centroids and determine moment of inertia	2	85	75	H	H	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	Determine the forces acting on particle both kinetics and kinematics	2	85	75	H	-	H	H	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	Determine the forces acting on rigid body both kinetics and kinematics	2	85	75	H	H	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-5 :	Application of determining space orbit	2	85	75	H	-	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-6 :	Apply the concepts of fundamental mechanics and space mechanics in real time applications	2	85	75	H	H	H	H	-	-	-	-	-	-	-	-	-	-	-

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

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

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. K. B. Ravichandrakumar, SRMIST*
2. Dr. Vinay Kumar Gupta, National Physical Laboratory, guptavinay@nplindia.org	*2. Dr. S. Elangovan, BIHER,Chennai, email : subelango@yahoo.co.in*	*2. Mr. Iynthezhuthon, SRMIST*

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

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

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

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1 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 :	Accrue the knowledge of fluid properties and principle and function of pressure measuring instruments	2	85	75	H	M	M	L	-	-	-	-	L	-	-	M	L	-	-
CLO-2 :	Analyze the fluid flow problems and system and control volume concept	2	85	75	H	H	M	M	-	-	-	-	L	-	-	M	L	-	-
CLO-3 :	Apply the mathematical techniques of potential flow problems	2	85	75	H	H	M	M	-	-	-	-	-	-	-	M	-	-	-
CLO-4 :	Apply the dimensional analysis and fluid flow through pipes	2	85	75	H	H	M	M	-	-	-	-	L	-	-	M	L	-	-
CLO-5 :	Accrue the knowledge about boundary layer concept	2	85	75	H	M	M	L	-	-	-	-	-	-	-	M	-	-	-
CLO-6 :	Accrue comprehensive knowledge in fluid mechanics applications	2	85	75	H	H	M	M	-	-	-	-	L	-	-	M	L	-	-

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

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

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. S. Raja, National Aerospace Laboratories, Bangalore, raja@nal.res.in	*1. Dr. S. Elangovan, BIHER,Chennai, email : subelango@yahoo.co.in*	*1. Mr. S. Rajkumar, SRMIST*
2. Dr. Vinay Kumar Gupta, National Physical Laboratory, guptavinay@nplindia.org	*2. Dr. K. M. Parammasivam, Madras Institute of Technology, Chennai, mparams@mitindia.edu*	*2. Mr. M. Abdur Rasheed, SRMIST*

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

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

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

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 laws of Thermodynamics and its applications to Aerospace Engineering	2	80	70	H	M	L	L	-	-	-	-	-	-	-	H	-	-	-
CLO-2 :	Comprehend the concept and applications of energy, entropy and exergy	2	80	70	H	M	M	M	-	-	L	-	-	L	-	H	M	M	M
CLO-3 :	Understand various gas and vapor power cycles with applications	2	80	70	H	M	L	M	-	-	-	-	L	-	-	H	-	-	-
CLO-4 :	Understand the gas mixture behavior and chemical reactions	2	80	70	H	M	M	M	-	-	M	M	M	M	L	H	M	M	M
CLO-5 :	Utilize the fundamental concepts for the physical understanding of engineering and technology	2	80	70	H	M	M	M	M	L	L	-	L	M	L	H	M	M	M
CLO-6 :	Apply the Thermodynamic Principles to Aerospace Engineering Applications	2	80	70	H	M	M	M	M	L	L	M	L	M	L	H	M	M	M

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

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

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. Vinay Kumar Gupta, National Physical Laboratory, guptavinay@nplindia.org	*1. Prof. D.P. Mishra, IIT Kanpur, mishra@ iitk.ac.in.*	*1. Dr. R. Vasudevan, SRMIST*
2. Dr. S. Raja, National Aerospace Laboratories, Bangalore, raja@nal.res.in	*2. Prof. Prasanta Kumar Das, IIT Kharagpur, pkd@mech.iitkgp.ernet.in.*	*2. Dr. T. Selvakumaran, SRMIST*

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

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

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

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

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

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

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. Vinay Kumar Gupta, National Physical Laboratory, guptavinay@nplindia.org	*1. Dr..Srinivasa Rao Bakshi, IITM, Chennai, sbakshi@iitm.ac.in*	*1. Mr. N Bharat, SRMIST*
2. Dr. S. Raja, National Aerospace Laboratories, Bangalore, raja@nal.res.in	*2. Dr. Ramesh Babu, N , nrbabu@iitm.ac.in*	*2. Mr. K B Ravichandra kumar, SRMIST*

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

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

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

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 control system in an airplane	2	80	70	H	-	L	L	L	-	-	-	-	-	-	L	L	M	M
CLO-2 :	Acquire knowledge on hydraulic and pneumatic system of modern jet airliner.	2	80	70	H	-	M	L	M	-	-	-	-	-	-	-	M	M	M
CLO-3 :	Learn the working of various systems of piston and gas turbine engine	2	80	70	H	-	L	L	M	-	-	-	-	-	-	L	M	M	M
CLO-4 :	Appreciate the need and functions of Cabin Environmental Systems and auxiliary systems of aircraft.	2	80	70	H	-	L	L	L	-	M	M	-	-	-	L	M	M	M
CLO-5 :	Gain knowledge on principle and operation of various aircraft instruments.	2	80	70	H	L	L	L	M	-	-	-	-	M	-	L	H	H	M
CLO-6 :	Acquire comprehensive knowledge of aircraft systems, engine systems and its instrumentation.	2	80	70	H	L	L	L	M	-	M	M	-	M	-	L	M	M	M

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

S-7	SLO-1	*Digital Fly by Wire System (DFBW)*	*Study of Typical Pneumatic System for Modern Airliner*	*Magneto Ignition System & its Operation*	*Introduction to Fire Detection Systems*	*Principle & Operation of Electronic Instruments – EADI & EHSI*
	SLO-2	*Operation of DFBW & its Advantages*	*Operation and its Advantages*	*Components of Ignition System of Gas Turbine Engine*	*Requirements for Fire Detection System*	*Principle & Operation of Electronic Systems Monitor Displays*
S-8	SLO-1	*Need for Automatic Flight Control Systems*	*Introduction to Landing Gear System*	*Need for Starting System*	*Types*	*Principle & Operation of EICAS*
	SLO-2	*Operation of Autopilot System*	*Classification of Landing Gear System*	*Types of starters*	*Principle and Operation*	*Need for Instrument Landing System (ILS)*
S-9	SLO-1	*Auto Throttle System (ATS)*	*Components of Landing Gear System*	*Pneumatic Starting System for Modern airliner*	*Need for Anti-Icing & De-Icing System*	*Components of ILS and their functions*
	SLO-2	*Advantages of ATS*	*Applications*	*Advantages of Pneumatic Starting System*	*Types and Applications.*	*Advantages*

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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, ap_haran@rediffmail.com*	*1. Dr. S. Sivakumar, SRMIST*
2. Dr. Raja S, CSIR-NAL, Bangalore, raja@nal.res.in	*2. Dr. K. M. Parammasivam, Madras Institute of Technology, Chennai, mparams@mitindia.edu*	*2. Mr. G. Mahendra Perumal, SRMIST*

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

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

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

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1 Level of Thinking (Bloom)	Learning 2 Expected Proficiency (%)	Learning 3 Expected Attainment (%)
CLO-1 :	Differentiate a ductile material and a brittle material after performing a tension test	2	80	70
CLO-2 :	Analyze the shear force and bending diagrams in cantilever and simply supported beams	2	80	75
CLO-3 :	Make calculations for the design of a beam based on the bending stress and desired deflection	2	75	70
CLO-4 :	Design the shaft for a particular torque transmission and springs for energy absorption	2	80	75
CLO-5 :	Find the planes of principal stresses in a stressed model and hoop stress, longitudinal stress in thin walled pressure vessel	2	85	75
CLO-6 :	Calculate the various stresses generated in a particular element subjected to different loading	2	80	70

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

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

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

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. Raja S, CSIR-NAL, Bangalore, raja@nal.res.in	*1. Dr. K. M. Parammasivam, Madras Institute of Technology, Chennai, mparams@mitindia.edu*	*1. Mr. S. Chandra Sekhar, SRMIST*
2. Wg.Cdr K.Manoharan (Retd), Blue Dart Aviation Ltd., manoharank@bluedart.com	*2. Dr. A. P. Haran, Park College of Engineering & Technology, ap_haran@rediffmail.com*	*2. Mr. K B Ravichandra kumar, SRMIST*

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

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

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

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 lift generation and lift generating devices	1	80	75	M	M	M	H	M	-	-	-	-	-	-	M	-	H	-
CLO-2 :	Analyze the forces and moments acting on aero foils and wings under ideal flow conditions.	2	80	75	H	H	H	H	H	-	-	-	-	-	-	H	-	H	-
CLO-3 :	Analyze the aerofoil characteristics.	3	70	60	H	H	H	H	H	-	-	-	-	-	-	H	-	H	-
CLO-4 :	Analyze the wing characteristics.	3	70	60	H	H	H	H	H	-	-	-	-	-	-	H	-	H	-
CLO-5 :	Analyze the propeller characteristics.	3	70	60	H	H	H	H	H	-	-	-	-	-	-	H	-	H	-
CLO-6 :	Analyze the aerodynamic interaction effects between different components of aircraft	2	70	65	H	H	H	H	H	-	-	-	-	-	-	H	-	H	-

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

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

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. Raja S, CSIR-NAL, Bangalore, raja@nal.res.in	*1. Dr. K. M. Parammasivam, Madras Institute of Technology, Chennai, mparams@mitindia.edu*	*1. Mr. R. Mohamed Arif, SRMIST*
2. Wg.Cdr K.Manoharan (Retd), Blue Dart Aviation Ltd., manoharank@bluedart.com	*2. Dr. P. K Dash, Nitte Meenakshi Institute of Technology, Bangalore, drpdash@gmail.com*	*2. Mr. K B Ravichandra kumar, SRMIST*

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

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

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

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 performance and component efficiencies of gas turbine propulsion systems	2	80	70	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Analyze inlets, combustion chambers, nozzles used in Air breathing engines	2	85	75	H	H	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	Analyze the compressors in gas turbine propulsion systems	2	75	70	H	-	-	H	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	Analyze the turbines in gas turbine propulsion systems	2	85	80	H	H	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-5 :	Analyze the performance of Pulse Jet, RAMJET and SCRAMJET engines	2	85	75	H	-	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-6 :	Analyze the performance and component efficiencies of gas turbine propulsion systems	2	80	70	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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

S-7	SLO-1	*Typical engine performance*	*Nozzle*	*Centrifugal compressor*	*Turbine blade cooling methods*	*Problems faced in supersonic combustion*
	SLO-2	*Typical engine performance*	*Classification of nozzles*	*Working Principle of a centrifugal compressor*	*Turbine and compressor matching*	*Problems faced in supersonic combustion*
S-8	SLO-1	*Methods of thrust augmentation*	*Numerical Problems on Nozzles.*	*Work and compression ratio*	*Numerical Problems on Axial flow turbine*	*Numerical Problems on SCRAMJET*
	SLO-2	*Methods of thrust augmentation*	*Numerical Problems on Nozzles.*	*Work and compression ratio*	*Numerical Problems on Axial flow turbine*	*Numerical Problems on SCRAMJET*
S-9	SLO-1	*Introduction to Air breathing engines*	*Inlets*	*Compressor*	*Turbine*	*Pulse Jet Engine-Operating Principle*
	SLO-2	*Ideal and actual Brayton cycle*	*Classification of Inlets*	*Classification of compressors*	*Classification of turbines*	*RAMJET Engine*

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. Raja S, CSIR-NAL, Bangalore, raja@nal.res.in	*1. Dr. P. K Dash, Nitte Meenakshi Institute of Technology, Bangalore, drpdash@gmail.com*	*1. Mr. G. Saravanan, SRMIST*
2. Wg.Cdr K.Manoharan (Retd), Blue Dart Aviation Ltd., manoharank@bluedart.com	*2. Dr. K. M. Parammasivam, Madras Institute of Technology, Chennai, mparams@mitindia.edu*	*2. Mr. G. Mahendra Perumal, SRMIST*

ACADEMIC CURRICULA

Professional Core Courses

AUTOMOBILE ENGINEERING

Regulations - 2018

SRM INSTITUTE OF SCIENCE & 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	18AUC201J	Course Name	MANUFACTURING TECHNOLOGY FOR AUTOMOTIVE ENGINEERS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

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

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

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 different welding and casting process.	2	85	75	H	M	H	L	H	M	M	H	H	M	L	H	H	H	H
CLO-2 :	Compare various shaping and forming process	2	80	75	H	M	H	H	H	M	M	H	H	M	L	M	H	H	H
CLO-3 :	Solve problems on cutting forces, tool life and analytical methods of estimating cutting temperature	2	90	85	H	H	H	H	L	M	M	H	M	M	M	H	H	H	M
CLO-4 :	Produce Prismatic Components and Gears	2	85	80	H	M	H	H	H	H	H	H	H	H	M	H	H	H	H
CLO-5 :	Compare various surface finishing operations	2	80	75	H	M	M	M	H	H	H	H	H	H	M	H	H	H	H
CLO-6 :	Apply different welding, casting processes, shaping, forming, machining and surface finishing processes	2	85	75	H	M	H	L	H	M	M	H	H	M	L	H	H	H	H

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

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

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

Learning Assessment

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

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

Course Designers

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

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

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

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

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 :	Draw orthographic projection for simple 3D part diagrams	1	90	85	H	M	M	M	M	L	L	L	M	M	L	M	H	M	M
CLO-2 :	Represent the standard Automotive parts in conventional symbols and representations	1	90	85	M	H	L	M	M	L	L	L	M	L	L	H	H	M	H
CLO-3 :	List drawing standards	2	90	85	H	M	M	M	M	L	L	L	M	M	L	M	M	M	H
CLO-4 :	Apply the principle of geometric dimensioning & tolerancing in assembly drawing	3	85	80	M	M	L	H	M	L	L	L	M	M	L	H	M	M	H
CLO-5 :	Describe and draw the part drawings of Automotive component	3	85	80	M	M	L	H	M	L	M	L	M	M	L	M	H	L	M
CLO-6 :	Assemble and draw the part drawings into a finished Automotive component	3	85	80	M	M	H	M	H	L	M	L	M	M	L	M	H	L	H

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

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

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	*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. N. Varatharaj, Comstar Automotive Technologies Pvt, Ltd, nvaratha@comstarauto.com	*1. Dr. P. Ramkumar, IIT Madras, ramkumar@iitm.ac.in*	*1. Dr. Rajendran R, SRMIST*
2. Mr. D. Srinivasan, Ford India LTD., dsriniv9@ford.com	*2. Dr. M. Murugan, VIT Vellore, hod.me@vit.ac.in*	*2. Mr. Jerome Stanley M, SRMIST*

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

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

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

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1 Level of Thinking (Bloom)	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	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	To learn the basic assumptions, significance and efficiency of various air standard cycles	2	80	75	H	H	M	M	L	L	M	L	M	L	L	L	H	H	M
CLO-2 :	Acquire understanding and numerically applying the methods to determine engine performance parameters	3	80	75	H	H	M	M	M	L	M	L	M	L	L	M	H	H	M
CLO-3 :	Understand and apply basic heat transfer concepts in real world applications	3	80	75	H	H	M	M	M	L	M	L	M	L	L	M	H	H	H
CLO-4 :	Apply the knowledge in calculating the performance of air compressors and refrigerators	3	80	75	H	H	M	M	M	L	H	H	M	L	L	M	H	H	H
CLO-5 :	Calculate performance of air conditioning system using Psychrometric chart and applications in automotive climate control	3	80	75	H	H	M	M	M	L	M	M	M	L	L	M	H	H	H
CLO-6 :	Identify knowledge on engines, heat transfer systems and air conditioning systems	3	80	75	H	H	M	M	L	L	M	L	M	L	L	L	H	H	M

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

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

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. Gunabalan, Manager, R&D Turbo Energy, Chennai,	*1. Dr. Chandramohan, NIT Warangal,*	*1. Mr. C. Prabhu, SRMIST*
2. Mr. Shantha Kumar, Lead Engineer, Royal Enfield,	*2. Dr. Ganesh, Anna University, Chennai*	*2. Dr. S. Thiyagarajan, SRMIST*

ACADEMIC CURRICULA

Professional Core Courses

BIOTECHNOLOGY

Regulations - 2018

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

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

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

Kattankulathur, Kancheepuram, Tamil Nadu, India

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

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

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

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 in details the structures and reactions of biomolecules (proteins, lipids, nucleic acids, and carbohydrates)	1	80	70	L	-	-	H	H	-	-	-	H	H	-	H	H	H	H
CLO-2 :	Describethe synthesis of biomolecules and their role in metabolic pathways along with their regulation	1	80	70	-	L	-	H	H	-	-	-	H	H	-	H	H	H	H
CLO-3 :	Demonstrate an understanding of the metabolic pathways - the energy-yielding andenergy-requiring reactions in life	2	80	70	-	H	-	H	H	-	-	-	H	H	-	H	H	H	H
CLO-4 :	Describe how these biochemical processes are not isolated but tightly integrated, with specific control sites and key junctions	2	80	70	-	L	-	H	H	-	-	-	H	H	-	H	H	H	H
CLO-5 :	Demonstratethe role of biomolecules in metabolic diseases and disorders	2	80	70	-	H	-	H	H	-	-	-	H	H	-	H	H	H	H
CLO-6 :	Explain the importance of laboratory safety and standard operating procedures of lab equipment	1	80	70	-	H	-	H	H	-	-	-	H	H	-	H	H	H	H

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

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

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. Dr. Karthik Periyasamy, Aurobindo Pharma Limited, Hyderabad karthikmpk@gmail.com	*2.Prof. R. B. Narayanan, SVCE, Chennai, rbn@svce.ac.in*	*2. Dr. V. Vinoth Kumar SRMIST*

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

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

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

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 on the basic concepts of cell biology	2	80	70	M	M	-	H	-	-	-	H	-	-	-	-	H	H	H
CLO-2 :	Plan on designing and conducting experiments involving cell structures and functions	2	85	75	M	M	H	H	-	-	-	H	H	-	-	-	H	H	H
CLO-3 :	Recognize the basis of cell structure and its function in development and cell death	2	75	80	M	M	H	H	H	-	-	H	H	-	-	-	H	H	H
CLO-4 :	Describe the steps involved in cell-cell signaling in mammalian cell systems	2	85	80	M	M	H	H	H	H	H	H	H	-	-	-	H	H	H
CLO-5 :	Devise examples and advances in the different areas of diagnostic and therapeutic applications of cells	3	85	80	M	M	H	H	H	M	H	H	H	-	-	-	H	H	H
CLO-6 :	Design the experiments using routine and specialized cells to study cell proliferation, mitosis spread and karyotyping	3	80	75	M	M	H	H	H	M	H	H	H	-	-	-	H	H	H

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

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

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. 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. S. Sujatha, SRMIST*

Course Code	18BTC103J	Course Name	MICROBIOLOGY	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

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

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

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 :	Illustrate the roles and characteristics of microorganisms	2	80	70	-	H	-	-	-	-		-	H	-	-	-	H	H	H
CLO-2 :	Identify growth of microorganisms, its impact in environment, applications of advanced microscopical techniques	2	85	75	-	H	H	-	-	-	H	-		-	-	-	H	H	H
CLO-3 :	Explain the role of microbes in public health and antimicrobial agents	2	75	80	H	-	H	M	H	-	H	-	H	-	H	-	H	H	H
CLO-4 :	Discuss various interactions of microbes with various microbes, animals and plants	2	85	80	H	-	H		H	-	M	-	H	-	H	-	H	H	H
CLO-5 :	Explain the applications of microbes and their products in various field	3	85	80	H	H	H	H	H	-	M	-	H	-	H	-	H	H	H
CLO-6 :	Illustrate the fundamental and applied Microbiology	2	80	75	H	H	H	H	H	-	M	-	H	-	H	-	H	H	H

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

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

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. S. Sam Gunasekar, Orchid Chemicals and Pharmaceuticals Ltd., sam@orchidpharma.com	*1. Dr. A. Gnanamani, CSIR-Central Leather Research Institute, agmani_2000@yahoomail.com*	*1. Dr. K. Ramani, SRMIST*
2.Dr. D. Gunaseelan, BIOCON Ltd., guna.sachin@gmail.com	*2. Dr. Anbumani Sadasivam, CSIR-Indian Institute of Toxicology Research,anbumani@iitr.res.in*	*2. Dr. R. Muthukumar, SRMIST*

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

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

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

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

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

S-7	SLO-1	*Cytoplasmic inheritance*	*Mapping by three factor cross*	*Chromosome preparation from amniotic fluid and chorionic villi*	*Preparation of linkage maps in bacteria*	*Changes in allele frequency by selection*
	SLO-2	*Pedigree analysis - Solving Problems*	*Solving Problems*	*Banding technique*	*Solving Problems*	*Selection dynamics*
S-8	SLO-1	*Mechanisms of sex determination*	*Combining of map segments*	*Karyotype preparation and analysis*	*Merozygote analysis*	*Random genetic drift*
	SLO-2	*Sex linked inheritance*	*Preparation of linkage map*	*Prenatal diagnosis*	*Fine structure mapping*	*Dynamics of random genetic drift*
S-9	SLO-1	*Epigenetics - reprogramming*	*Somatic cell hybridization*	*Fluorescent in situ hybridization*	*Solving Problems*	*Genetic equilibrium*
	SLO-2	*X-inactivation*	*HAT selection procedure*	*Comparative Genomic hybridization*	*Solving Problems*	*Solving Problems*

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. Barathi, SRMIST*
2. Dr. Karthik Periyasamy, Aurobindo Pharma Limited, Hyderabad, karthikmpk@gmail.com	*2. Prof. R. B. Narayanan, SVCE, Chennai, rbn@svce.ac.in*	*2. Dr. K. T. Ramyadevi, SRMIST*

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

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

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

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 on the basic concepts and principles of nucleic acids from the perspective of engineers	2	80	70	-	H	-	-	-	-	-	-	H	-	-	-	H	H	H
CLO-2 :	Illustrate the mechanism involved in the duplication of hereditary material.	2	85	75	-	H	H	-	-	-	H	-		-	-	-	H	H	H
CLO-3 :	Illustrate the mechanism and role of the nucleic acids in gene expression.	2	75	80	H	-	H	M	H	-	H	-	H	-	H	-	H	H	H
CLO-4 :	Discuss the structure and machinery of nucleic acids responsible for cell functioning.	2	85	80	H	-	H		H	-	M	-	H	-	H	-	H	H	H
CLO-5 :	Explain the regulation of gene expression under anabolic and catabolic conditions.	3	85	80	H	H	H	H	H	-	M	-	H	-	H	-	H	H	H
CLO-6 :	Explain the role of biological macromolecules which are essential to life.	2	80	75	H	H	H	H	H	-	M	-	H	-	H	-	H	H	H

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

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

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. S. Sam Gunasekar, Orchid Chemicals and Pharmaceuticals Ltd., sam@orchidpharma.com	*1. Dr. A. Gnanamani, CSIR-Central Leather Research Institute, agmani_2000@yahoomail.com*	*1. Dr. K. Ramani, SRMIST*
2. Dr. D. Gunaseelan, BIOCON Ltd., guna.sachin@gmail.com	*2. Dr. Anbumani Sadasivam, CSIR-Indian Institute of Toxicology Research,anbumani@iitr.res.in*	*2. Dr. R. Muthukumar, SRMIST*

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

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

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

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLO-1 :	Describe the immune system and their structure and classification	1	80	70
CLO-2 :	Discuss about genetic control of antibody production, cellular immunology	2	80	70
CLO-3 :	Explain various methods to assess immune function, their application and interpretation of the results	2	80	70
CLO-4 :	Describe the role of the immune molecules in infectious diseases, autoimmunity, and cancer will be discussed	2	80	70
CLO-5 :	Discuss about hypersensitive immune reaction, vaccination and cancer immunology	2	80	70
CLO-6 :	Describe how immune cells, organ and processes function to protect human body against infective agents and cancer cells.	2	80	70

		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 :	Describe the immune system and their structure and classification	M	-	H	H	L	L	L	H	-	H	M	H	M	H	H
CLO-2 :	Discuss about genetic control of antibody production, cellular immunology	M	M	-	H	H	M	H	H	-	H	M	H	M	H	H
CLO-3 :	Explain various methods to assess immune function, their application and interpretation of the results	M	M	L	H	H	-	-	H	M	H	M	H	H	H	H
CLO-4 :	Describe the role of the immune molecules in infectious diseases, autoimmunity, and cancer will be discussed	-	-	-	H	H	M	H	H	M	H	M	L	H	H	H
CLO-5 :	Discuss about hypersensitive immune reaction, vaccination and cancer immunology	M	M	-	H	H	-	H	H	M	H	H	M	H	H	H
CLO-6 :	Describe how immune cells, organ and processes function to protect human body against infective agents and cancer cells.	M	L	M	H	H	M	M	H	M	H	H	M	H	H	H

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

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

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	*1. Dr. Joe Varghese, CMC Vellore, joevarghese@cmcvellore.ac.in*	*1. Dr. S. Thyagarajan, SRMIST*
2. Dr. Karthik Periyasamy, Aurobindo Pharma Limited, Hyderabad, karthikmpk@gmail.com	*2. Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	*2. Dr. S. Nageswaran, SRMIST*

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

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

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

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1 Level of Thinking (Bloom)	Learning 2 Expected Proficiency (%)	Learning 3 Expected Attainment (%)
CLO-1 :	Explain the various aspects of fermenter and types of fermentation process	2	80	70
CLO-2 :	Practice the components of media and its prerequisites to produce bioproducts	3	80	70
CLO-3 :	Interpret the stoichiometry and energetics of product formation mediated by cell growth	3	80	70
CLO-4 :	Analyze and interpret key elements of the fermentation data to operate the bioreactor accordingly	2	80	70
CLO-5 :	Apply various models to understand the kinetics and mechanism of microbial growth	3	80	70
CLO-6 :	Employ fermentation skills to synthesize value added bioproducts	3	80	70

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

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

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

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. Dr. Karthik Periyasamy, Aurobindo Pharma Limited, Hyderabad, karthikmpk@gmail.com	*2. Prof. R. B. Narayanan, SVCE, Chennai, rbn@svce.ac.in*	*2. Dr. V. Vinoth Kumar, SRMIST*

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

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

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

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1 Level of Thinking (Bloom)	Learning 2 Expected Proficiency (%)	Learning 3 Expected Attainment (%)
CLO-1 :	Discuss on the basics of plant genomes organizations and expressions	2	80	70
CLO-2 :	Demonstrate the various methods of genetic manipulations in plants	2	85	75
CLO-3 :	Illustrate the mechanism and role of plant tissue culture for mass multiplications	2	75	80
CLO-4 :	Discuss the molecular aspects of plant adaptability to various stresses	2	85	80
CLO-5 :	Explain the significance of plant breeding and genetic manipulations of plants for economic importance	3	85	80
CLO-6 :	Explain the basic concepts and to use the plant biotechnology techniques for crop improvements	2	80	75

Course Learning Outcomes (CLO):	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 :	-	H	-	H	-	-	-	-	H	-	-	-	H	H	H
CLO-2 :	H	H	H	H	H	-	H	H	H	-	H	-	H	H	H
CLO-3 :	H	H	H	H	H	-	H	-	H	-	H	-	H	H	H
CLO-4 :	H	M	H	M	-	-	M	-	H	-	H	-	H	H	H
CLO-5 :	H	H	H	H	H	-	M	H	H	-	H	-	H	H	H
CLO-6 :	H	H	H	H	H	-	H	H	H	-	H	-	H	H	H

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

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

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. Senthil, EID Parry, Chennai, *parrynutraceuticals@parry.murugappa.com*	*1. Prof. Usha Vijayraghavan. IISc, Bangalore, uvr@mcbl.iisc.ernet.in*	*1. Dr. Sarada, SRMIST*
1. Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	*2. Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in*	*2. Dr. Pachaiappan, SRMIST*

ACADEMIC CURRICULA

Professional Core Courses

CHEMICAL ENGINEERING

Regulations - 2018

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

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

Kattankulathur, Kancheepuram, Tamil Nadu, India

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

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

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

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

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

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

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

Learning Assessment

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

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

Course Designers

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

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

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

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

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 fundamental knowledge in fluids properties, classification, flow in boundary layers, and pressure measurements	1	80	70	H	H	L	-	-	-	-	-	-	-	-	-	H	H	-
CLO-2 :	Interpret Bernoulli equation, Friction factor and pressure measurements	2	85	75	H	H	M	M	M	-	-	-	-	-	-	-	H	H	-
CLO-3 :	Interpret the Ergun equation, Navier–Stokes, settling velocity and fluidization	2	80	75	H	M	M	-	M	-	-	-	-	-	-	-	H	H	-
CLO-4 :	Differentiate types of seals, valves and pumps	2	85	75	M	L	M	M	M	-	-	-	-	-	-	-	L	H	-
CLO-5 :	Differentiate flow meters and flow rate calculations	2	85	75	H	H	H	-	M	-	-	-	-	-	-	-	L	H	-
CLO-6 :	Understand the flow behavior of fluids and their handling.																		

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

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

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. Mr. A. Subramaniam, PESCO Beam Environmental Solutions Pvt. Ltd.,	*1. Dr. Lima Rose Miranda, Anna University, limamiranda2007@gmail.com*	*1. Dr. K. Anbalagan SRMIST*
2. Mr. S. T. Kalaimani, CPCL, Chennai	*2. Dr. T. R. Sundararaman, Rajalakshmi Engineering College, sundararaman.tr@rajalakshmi.edu.in*	*2. Dr. S. Vishali, SRMIST*

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

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

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

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 :	Characterize the particles size analysis	2	85	70	-	H	-	H	L	-	-	-	-	-	-	M	H	-	-
CLO-2 :	Describe the size reduction machineries	1	90	80	H	H	-	M	-	-	-	-	-	-	-	-	H	-	-
CLO-3 :	Demonstrate the fluid-solid separation techniques	3	85	75	H	H	M	H	-	-	M	-	-	-	-	-	H	-	-
CLO-4 :	Formulate the filtration concepts and design the equipment	2	85	75	H	H	H	H	-	-	M	-	-	-	-	-	H	-	-
CLO-5 :	Apply the concepts of agitation and mixing in processes	3	80	70	H	H	M	H	-	-	-	-	-	-	-	-	H	-	-
CLO-6 :	Understand particle separation based on size and their handling	3	80	70	H	H	M	H	-	-	-	-	-	-	-	-	H	-	-

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

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

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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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1. Dr. Mr. A. Subramaniam, PESCO Beam Environmental Solutions Pvt. Ltd.,	*1. Dr. Lima Rose Miranda, Anna University, limamiranda2007@gmail.com*	*1. Dr. K. Deepa, SRMIST*	
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Course Code	18CHC207T	Course Name	HEAT TRANSFER	Course Category	C	Professional Core	L	T	P	C
							4	0	0	4

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

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

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 :	Evaluate rate of heat transfer, analyze steady state and unsteady state conduction and evaluate heat transfer coefficient	2	80	75	H	M	L	-	-	-	-	-	-	-	-	-	M	-	-
CLO-2 :	Evaluate heat transfer coefficient of natural, forced convection as applied to various flows and geometry	2	80	75	H	M	L	-	-	-	-	-	-	-	-	-	M	M	-
CLO-3 :	Design the heat exchangers	2	80	75	H	H	H	L	-	-	-	-	-	-	-	-	M	M	L
CLO-4 :	Analyze the principles of radiation heat transfer	2	80	75	H	M	L	-	-	-	-	-	-	-	-	-	M	-	-
CLO-5 :	Design the evaporators	2	80	75	H	H	M	L	-	-	-	-	-	-	-	-	M	M	L
CLO-6 :	Understand the concepts of heat transfer and the equipments	2	80	75	H	M	L	-	-	-	-	-	-	-	-	-	M	-	-

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

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

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

Learning Assessment

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

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

Course Designers

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

Course Code	18CHC208T	Course Name	PRINCIPLES OF MASS TRANSFER	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

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

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

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 :	Gain basic knowledge of mass transfer principles, and solve diffusion problems for fluids	2	80	75	H	H	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-2 :	Determine mass transfer coefficients and identify rate controlling mechanism	2	80	75	H	H	M	L	-	-	-	-	-	-	-	-	M	M	-
CLO-3 :	Design the absorption column and analyze the performance of packed and plate columns	3	80	75	H	H	M	M	-	-	-	-	-	-	-	-	M	M	-
CLO-4 :	Solve humidification and dehumidification problems and design cooling towers	3	80	75	H	H	M	L	-	-	-	-	-	-	-	-	M	M	-
CLO-5 :	Gain knowledge on the basic principles of drying, selection of driers and calculate drying time	2	80	75	H	H	M	M	-	-	-	-	-	-	-	-	M	M	-
CLO-6 :	Understand the fundamentals of mass transfer and the equipments																		

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

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

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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, limamiranda2007@gmail.com*	*1. Mrs. E. Poonguzhali, SRMIST*
2. Mr. S. T. Kalaimani, CPCL, Chennai	*2. Dr. T. R. Sundararaman, Rajalakshmi Engineering College, sundararaman.tr@rajalakshmi.edu.in*	*2. Ms. E. Kavitha, SRMIST*

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

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

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

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 :	Handle the size reduction machineries	1	80	75	M	L							H						
CLO-2 :	Learn the fundamentals and understand the design of filters	2	80	75	H	M	M	M					L						
CLO-3 :	Differentiate the fluid–Solid separation techniques and can implement the knowledge in design the equipments	3	90	80	H	M	M	M					L			H			
CLO-4 :	Interpret the knowledge in design of piping system	2	80	75	M	M	L	M					L			H			
CLO-5 :	Operate and execute the knowledge to design of pumps	2	80	75	L	L	L						L			H			
CLO-6 :	Analyze the various size reduction techniques and fluid flow.	1	80	75	M	L							H						

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

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

Learning Assessment

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

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

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Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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2. Mr. S. T. Kalaimani, CPCL, Chennai	2. Dr. T. R. Sundararaman, Rajalakshmi Engineering College, sundararaman.tr@rajalakshmi.edu.in	2. Mrs. D. Nanditha, SRMIST

ACADEMIC CURRICULA

Professional Core Courses

CIVIL ENGINEERING

Regulations - 2018

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

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

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

Kattankulathur, Kancheepuram, Tamil Nadu, India

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

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

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

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 geological agencies and their actions	2	85	80	H	-	-	-	-	-	M	-	L	-	-	H	H	-	-
CLO-2 :	Identify the physical property of rock forming minerals	2	85	75	H	-	-	-	-	-	M	-	L	-	-	H	H	-	-
CLO-3 :	Classify, Structure, Identify texture and the distribution of various types rocks	2	80	75	H	-	-	-	-	-	H	-	L	-	-	H	H	-	-
CLO-4 :	Interpret the various geological structure	2	85	80	H	-	-	-	-	-	H	-	L	-	-	H	H	-	-
CLO-5 :	Analyze the investigation techniques	3	85	75	H	-	H	M	-	-	H	-	M	-	-	H	H	-	-
CLO-6 :	Analyze the primary measures for civil Engineering projects	3	80	75	H	H	H	H	-	-	H	-	M	-	-	H	H	-	-

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

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

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. Sarunjith K J, National Centre for Sustainable Coastal Management, sarunjith@ncscm.res.in	*Dr. R. Nagendra, Anna University, geonag@gmail.com*	*Dr. R Annadurai, SRMIST*	*Dr. Sachikanta Nanda, SRMIST*
2. Dr. Nagasundaram M, Geological Survey of India, nagasundaram.m@gsi.gov.in	*Dr. S. G. D. Shreedhar, University of Madras, sgd.sri@unom.ac.in*	*Dr. Aparna S Bhaskar, SRMIST*	

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

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

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

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 properties of fluid	2	85	80	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-2 :	Analyze hydrostatic pressure force	3	85	75	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-3 :	Apply hydrostatic laws in various pressure measuring devices	3	85	75	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-4 :	Identify the importance of fluid kinematics	2	85	80	H	H	-	M	-	-	-	-	-	-	-	-	H	-	-
CLO-5 :	Identify the applications of fluid dynamics	2	80	75	H	H	-	M	-	-	-	-	-	-	-	-	H	-	-
CLO-6 :	Analyze laminar and turbulent flow in pipes	3	85	75	H	H	-	M	-	-	-	-	-	-	-	-	H	-	-

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

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

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. Abdul Hakeem, National Remote Sensing Center, Hyderabad, abdulhakeem_k@nrsc.gov.in	*1. Dr. R. Saravanan, Anna University, rsaran@annauniv.edu*	*1. Dr. R. Sathyanathan, SRMIST*
2. Dr. Sat Kumar Tomer, Satyukt Analytics Pvt Ltd., Bengaluru, sat@satyukt.com	*2. Dr. S. Saravanan, NIT Trichy, saravanans@nitt.edu*	*2. Dr. Deeptha Thattai, SRMIST*

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

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

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

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 concept of Pascal's law	3	90	85	H	M		-	-	-	-	-	H	-	-	-	H	-	H
CLO-2 :	Identify the applications of buoyancy	3	85	80	H	M	-	-	-	-	-	-	H	-	-	-	H	-	H
CLO-3 :	Identify the applications of Bernoulli's principle	3	90	85	H	M	-	-	-	-	-	-	H	-	-	-	H	-	H
CLO-4 :	Identify the working principle, components and functions of orificemeter, venturimeter and pitot tube	3	85	80	H	M	-	-	-	-	-	-	H	-	-	-	H	-	H
CLO-5 :	Estimate the losses in pipes	3	85	80	H	M	-	-	-	-	-	-	H	-	-	-	H	-	H
CLO-6 :	Identify the working principle, and functions of orifice and mouthpiece	3	85	80	H	M	-	-	-	-	-	-	H	-	-	-	H	-	H

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

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	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. Abdul Hakeem, National Remote Sensing Center, Hyderabad, abdulhakeem_k@nrsc.gov.in	1. Dr. R. Saravanan, Anna University, rsaran@annauniv.edu	1. Dr. R. Sathyanathan, SRMIST
2. Dr. Sat Kumar Tomer, Satyukt Analytics Pvt Ltd., Bengaluru, sat@satyukt.com	2. Dr. S. Saravanan, NIT Trichy, saravanans@nitt.edu	2. Mr. Shaik Niyazuddin Guntakal, SRMIST

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

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

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

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 state of stress, evaluate principal stresses and principal strains including stresses in compound sections	3	80	75	H	H	-	-	-	-	-	-	-	-	-	-	H	-	H
CLO-2 :	Determine bending moment and shear force distribution along the beam	3	85	75	H	H	-	-	-	-	-	-	-	-	-	-	H	-	H
CLO-3 :	Determine bending and shear stress distribution across the cross section of rectangular, 'I', 'T' sections.	3	75	75	H	H	-	H	-	-	-	-	-	-	-	-	H	-	H
CLO-4 :	Compute slope, deflection of beams (Macaulay's, conjugate beam method) analyze determinate, indeterminate trusses	3	90	80	H	H	-	-	-	-	-	-	-	-	-	-	H	-	H
CLO-5 :	Analyze columns using Euler's, Rankine's theories of columns, theories of failure in real time applications	3	85	75	H	H	-	-	-	-	-	-	-	-	-	-	H	-	H
CLO-6 :	Apply Macaulay's method, Clapeyron's theorem to solve indeterminate beam problems	3	80	75	H	H	-	-	-	-	-	-	-	-	-	-	H	-	H

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

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

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. Er. G.Hariharanath, GA Consultants, Chennai, gac1996@hotmail.com	*1. Dr. G. Appa Rao, Professsor, IIT Madras, garao@iitm.ac.in*	*1. Dr. K. Gunasekaran, SRMIST*
2. Er. AGV. Desigan, Design Group Engineering Consultancy Pvt Ltd. Chennai, desigan.agv@gmail.com	*2. Dr. C. Uma Rani, Professor, Anna University, umarani@annauniv.edu*	*2. Dr. P. R. Kannan Rajkumar, SRMIST*

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

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

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

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 modulus of elasticity of steel, double shear test and hardness test	3	90	85	H	M		-	M	-	-	-	H	-	-	-	H	-	H
CLO-2 :	Identify torsional, impact strength of steel, identify compressive strength of bricks and concrete	3	85	80	H	M	-	-	M	-	-	-	H	-	-	-	H	-	H
CLO-3 :	Apply the knowledge of non-destructive testing technique of rebound hammer and UPV tests	3	90	85	H	H	-	-	M	-	-	-	H	-	-	-	H	-	H
CLO-4 :	Compute stiffness and deflection of helical springs	3	85	80	H	M	-	-	M	-	-	-	H	-	-	-	H	-	H
CLO-5 :	Determine modulus of elasticity of concrete, split tensile strength and flexural strength of concrete	3	85	80	H	M	-	-	M	-	-	-	H	-	-	-	H	-	H
CLO-6 :	Find bond strength between steel bar and concrete (pull-out test)	3	85	80	H	M	-	-	M	-	-	-	H	-	-	-	H	-	H

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

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	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. Er. G. Hariharanath, GA Consultants, Chennai, gac1996@hotmail.com	1. Dr. G. Appa Rao, Professsor, IIT Madras, garao@iitm.ac.in	1. Dr. K. Gunasekaran, SRMIST
2. Er. AGV. Desigan, Design Group Engineering Consultancy Pvt Ltd. Chennai, desigan.agv@gmail.com	2. Dr. C. Uma Rani, Professor, Anna University, umarani@annauniv.edu	2. Dr. P. R. Kannan Rajkumar, SRMIST

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

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

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

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 making of linear, direction measurements and creation of Plan/Map	2	90	80	H	H	-	-	L	-	-	-	-	M	-	-	H	-	-
CLO-2 :	Determine or set the altitude of the point/or set of points w.r.t the given datum	3	85	75	H	H	-	-	M	-	-	-	-	M	-	-	H	-	-
CLO-3 :	Measure the horizontal and vertical angle and derive the measurements at times of obstacle and inaccessible points	3	80	75	H	H	-	-	M	-	-	-	-	M	-	-	H	-	-
CLO-4 :	Apply knowledge of optics to make the angular measurements in rolling/hilly terrain	3	85	80	H	H	-	-	M	-	-	-	-	M	-	-	H	-	-
CLO-5 :	Set horizontal, vertical control and setting out works	2	85	80	H	H	-	-	H	-	M	-	-	M	-	M	H	-	-
CLO-6 :	Calculate areas, volumes and setting out curves	3	80	75	H	H	-	-	H	-	M	-	-	M	-	M	H	-	-

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

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

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

Learning Assessment

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

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

Course Designers

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

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

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

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

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 :	traverse and prepare the site layout	3	90	85	H	H	L	-	L	-	-	-	H	H	-	-	H	-	H
CLO-2 :	traverse, resulting in precise location of points using prismatic compass	3	85	80	H	H	L	-	L	-	-	-	H	H	-	-	H	-	H
CLO-3 :	Prepare site layouts	3	80	75	H	H	M	-	M	-	-	-	H	H	-	-	H	-	H
CLO-4 :	Profile land levels and contouring	3	85	80	H	H	M	-	M	-	-	-	H	H	-	-	H	-	H
CLO-5 :	Determine horizontal distance of the inaccessible target	3	85	80	H	H	H	-	M	-	-	-	H	H	-	L	H	-	H
CLO-6 :	Estimate the height of inaccessible target	3	80	75	H	H	H	-	M	-	-	-	H	H	-	L	H	-	H

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

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

Learning Assessment

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

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Er. Hariharanath, GA Consultants, Chennai, gac1996@hotmail.com	1. Dr. K. Srinivasa Raju, Anna University, raju_irs@yahoo.com	1. Dr. Sachikanta Nanda, SRMIST
2. Er. AGV. Desigan, Design Group Engineering Consultancy Pvt Ltd. Chennai, desigan.agv@gmail.com	2. Dr. E.S.M. Suresh, NITTTR, Chennai, esmsuresh@gmail.com	2. Dr. J. Satish Kumar, SRMIST

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

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Understand the behavior of indeterminate structures using slope deflection method			
CLR-2 :	Apply moment distribution method in the analysis of indeterminate structures			
CLR-3 :	Get exposed to stiffness matrix method			
CLR-4 :	Analyze indeterminate structures using flexibility matrix method			
CLR-5 :	Understand the behavior of determinate and indeterminate structures under moving loads			
CLR-6 :	Get an insight into the behavior of arches and suspension bridges			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 slope deflection method to analyze indeterminate beams and plane rigid jointed frames	3	90	75	H	H	-	M	-	-	-	-	-	-	-	-	H	-	-
CLO-2 :	Use moment distribution method to analyze indeterminate beams and plane rigid jointed frames	3	95	75	H	H	-	M	-	-	-	-	-	-	-	-	H	-	-
CLO-3 :	Make use of computer based matrix stiffness method and direct stiffness method to analyze indeterminate beams and plane rigid jointed frames	3	90	75	H	H	-	M	M	-	-	-	-	-	-	-	H	M	-
CLO-4 :	Apply energy concepts and matrix flexibility method to analyze indeterminate beams and plane rigid jointed frames	3	80	75	H	H	-	M	-	-	-	-	-	-	-	-	H	-	-
CLO-5 :	Draw influence line diagrams for determinate and indeterminate structures and apply the same for determinate and indeterminate structures for finding stress resultants due to moving loads	3	95	75	H	H	-	M	-	-	-	-	-	-	-	-	H	-	-
CLO-6 :	Analyze three hinged parabolic, circular archesand two hinged parabolic arches and study concepts behind the analysis of fixed arches Analyze suspension cables and get an insight into to suspension bridges with two and three hinged girders	3	85	75	H	H	-	M	-	-	-	-	-	-	-	-	H	-	-

		Influence Lines Diagrams (ILD) and Moving Loads	Arches and Suspension Bridges	Flexibility Matrix Method	Slope Deflection and Moment Distribution Methods	Direct and Element Stiffness Matrix Methods
Duration (hour)		9	9	9	9	9
S-1	SLO-1	Introduction to influence line diagram (ILD) and Muller Breslau's principle	Introduction to arches: three hinged, two hinged, fixed. Eddy's theorem	Revisiting Castigliano's energy theorems	Fixed end moments, effect of rotations and settlement on support moments	Relation between SDM, matrix stiffness method, derive direct stiffness method
	SLO-2	ILD for BM and SF for cantilever	theoretical arch, analyze three hinged parabolic arches with supports at same level	Form basic determinate structure of an indeterminate structure by releasing the redundant reactions or inserting hinges	Principle of superposition and joint equilibrium, derivation of slope deflection method (SDM)	Advantages of Stiffness method over flexibility method, Analysis of propped cantilever using direct stiffness method
S-2	SLO-1	ILD for BM and SF for simply supported, overhanging beam. Introduction to IRC trailer load	Analyze three hinged parabolic arches with supports at different levels	Derive flexibility coefficients using unit load method.	Apply SDM for drawing bending moment diagram (BMD) and shear force diagram (SFD) for propped cantilevers with and without overhang	Analyze continuous beams using direct stiffness method
	SLO-2	Find max. BM, SF using ILD for cantilever, simply supported, overhanging beam subject to moving point loads and udl	Analyze three hinged circular arches with supports at the same level	Determine deflection of basic determinate beams using flexibility coefficients	Apply SDM for the analysis of beams up to a degree of static indeterminacy of 2 including the effect of support settlements	Apply direct stiffness method for single storey portal frame
S-3	SLO-1 SLO-2	Tutorial class	Tutorial class	Tutorial class	Tutorial class	Tutorial class
S-4	SLO-1	Concept of absolute maximum BM in simply supported beams	Derive horizontal reaction for two hinged parabolic arches including support movement, temperature change and rib shortening	Derive direct flexibility matrix equation. Solving propped cantilever using flexibility method	Solve rigid jointed plane frame with degree of static indeterminacy 2 using SDM	Introduction to element stiffness method-coordinate systems – element and global
	SLO-2	Find absolute maximum BM and SF in a simply supported beam subjected to series	Analyze two hinged parabolic arches with a single point load	Formulate flexibility matrix for a two-span continuous beam with one of the end	Moment Distribution Method (MDM), definition of stiffness, carry over factors	Derive element stiffness matrix for truss, beam, frame elements in local coordinates

		of moving loads		*supports fixed*	*with demonstrative analysis of propped cantilever*	
S-5	SLO-1	*Find absolute maximum BM /SF in a simply supported beam subjected to udl – shorter and longer than the span*	*Analyze two hinged parabolic arches with udl occupying the entire span*	*Analyze two span continuous beam with one of the end supports fixed using direct flexibility method*	*Analyze 2 span- continuous beams using MDM*	*Rotation matrix for truss element and transformation of element stiffness matrix in local coordinates to global coordinates*
	SLO-2	*ILD of propped cantilevers*	*Analyze two hinged parabolic arches with part udl occupying anywhere in the span*	*Form flexibility matrix for single storey portal frame with static indeterminacy of 2 with supports at same level and analyzing*	*Analyze 3 span- continuous beams using MDM includingeffect of support settlements*	*Rotation matrix for frame element and transformation of element stiffness matrix in local coordinates to global coordinates*
S-6	SLO-1	*Tutorial class*	*Tutorial class*	*Tutorial class*	*Tutorial class*	*Tutorial class*
	SLO-2					
S-7	SLO-1	*ILD for two span continuous beam for end support reaction*	*Introduction to suspension cables*	*Form flexibility matrix for single storey portal frame with static indeterminacy of 2 with supports at different levels and analyzing*	*Analyze non-sway frames using MDM*	*Compute load vector in global coordinates for truss problems. Assemble global stiffness matrix for truss problem*
	SLO-2	*ILD for two span continuous beam for mid support reaction*	*Analyze suspension cables with udl – maximum and minimum cable tension and support reactions – resultant (Supports at same level)*	*Find support reactions for a single storey portal frame with static indeterminacy of 3 with supports at same level and subjected to a lateral point load at beam level*	*Introduction to sway in portal frames*	*Compute joint load vector in beam/frame problems with uniformly distributed and point loads*
S-8	SLO-1	*ILD for two span continuous beam for mid support moment*	*Analyze suspension cables with udl – maximum and minimum cable tension and support reactions – resultant (Supports at different levels)*	*Form flexibility matrix for a single storey portal frame with a static indeterminacy of 3 with supports at same level and subjected to udl over the beam*	*Fixed end moments due to sway in single storey frames and analysis of single storey portal frames with sway using MDM*	*Assemble global stiffness matrix for two span continuous beams. Partition global stiffness matrix and find unknown displacements and reactions*
	SLO-2	*ILD for two span continuous beam for span BM and span shear*	*Find forces at anchor towers – saddle support with rollers and hinged supports. Introduction to two hinged and three hinged stiffening girders*	*Find support reactions for a single storey portal frame with static indeterminacy of 3 with supports at same and different levels and subjected to either udl over the beam or lateral load at beam level*	*KANI'S METHOD* *Introduction to Kani's method for multistory frames and definition of rotation factors and sway corrections*	*Assemble global stiffness matrix for single storey portal frame, partitioning, solve for unknown displacements and find element forces from known displacements upto a static indeterminacy of 3*
S-9	SLO-1	*Tutorial class*	*Tutorial class*	*Tutorial class*	*Tutorial class*	*Tutorial class*
	SLO-2					

Learning Resources	*1. Menon D, Structural Analysis, Alpha Science International Limited, 2009* *2. Pandit G.S., Gupta S.P., Structural Analysis- A Matrix Approach, 2nd ed., Tata McGraw-Hill, 2010* *3. Punmia B.C., Ashok Kumar Jain, Arun Kumar Jain, Theory of Structures, 12th ed., Laxmi Publications, 2004* *4. Vaidyanathan R, Perumal. P, Comprehensive Structural Analysis-Volume I & II, Laxmi Publications, 2004*	*5. Bhavikatti S. S, Structural Analysis, Vol-1 &2, E-2, Vikas Publishing House Pvt Limited, 2009* *6. Hibbeler R.C., Structural Analysis, 8th ed., Prentice Hall, 2012* *7. NPTEL Course: Structural Analysis – I. https://onlinecourses.nptel.ac.in/noc17_ce25/preview* *8. NPTEL Course: Structural Analysis – II https://nptel.ac.in/downloads/105105109/*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. Er. G.Hariharanath, GA Consultants, Chennai, gac1996@hotmail.com	*1. Dr. G. Appa Rao, Professsor, IIT Madras, garao@iitm.ac.in*	*1. Dr. K. Sathyanarayanan, SRMIST*
2. Er. AGV. Desigan, Design Group Engineering Consultancy Pvt Ltd. Chennai, desigan.agv@gmail.com	*2. Dr. C. Uma Rani, Professor, Anna University, umarani@annauniv.edu*	*2. Prof. G. Augustine Maniraj Pandian, SRMIST*

Course Code	18CEC205L	Course Name	COMPUTER AIDED STRUCTURAL ANALYSIS LABORATORY	Course Category	C	Professional Core	L	T	P	C
							0	0	2	1

Pre-requisite Courses	Nil	Co-requisite Courses	18CEC205T	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Utilize the Calculate the Area of Steel of beams using MS Excel program
CLR-2 :	Utilize the method of solving Matrix Equation using Stiffness Matrix
CLR-3 :	Analyze behavior of 2D and 3D Moment Resistant Steel Frames using STAAD Pro or ETABS
CLR-4 :	Analyze behavior of Plane Steel Frames using STAAD Pro or ETABS
CLR-5 :	Utilize the flexural and shear behavior of RCC beam
CLR-6 :	Acquire knowledge on the torsional behavior of RCC beam

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1 Level of Thinking (Bloom)	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 :	Calculate the Area of Steel of beams using MS Excel program	3	90	85	H	M	H	-	H	-	-	-	H	-	-	-	H	H	H
CLO-2 :	Solve matrix equation using stiffness matrix	3	85	80	H	M	-	-	H	-	-	-	H	-	-	-	H	H	H
CLO-3 :	Report on the behavior of 2D and 3D Moment Resistant Steel Frames	3	90	85	H	M	-	-	H	-	-	-	H	-	-	-	H	H	H
CLO-4 :	Analyze the behavior of Plane Steel Frames	3	85	80	H	M	-	-	H	-	-	-	H	-	-	-	H	H	H
CLO-5 :	Analyze the Flexural and shear resistance of RCC beams	3	85	80	H	M	-	-	H	-	-	-	H	-	-	-	H	-	H
CLO-6 :	Design the beam for torsion	3	85	80	H	M	M	-	H	-	-	-	H	-	-	-	H	-	H

Duration (hour)		6	6	6	6	6
S 1-2	SLO-1	Programming in MS Excel for calculating Ast	Solving Matrix Problems in MS Excel	Exercise the solution in STAAD Pro or ETABS	Analysis in STAAD Pro or ETABS for moving IRC loads and verification	Study the behavior of RCC beam test under flexure
	SLO-2					
S 3-4	SLO-1	Solving Problems in MS Excel	2D and 3D Moment Resistant Steel Frames Using STAAD Pro or ETABS for real building model	Exercise the solution in STAAD Pro or ETABS	Plane Pin Jointed Steel Frames using STAAD Pro or ETABS	Study the behavior of RCC beam test under shear
	SLO-2					
S 5-6	SLO-1	Solving Matrix Equation using Stiffness Matrix	Exercise the solution in STAAD Pro or ETABS	Exercise the solution in STAAD Pro or ETABS and verification using text book problems	Exercise the solution in STAAD Pro or ETABS and verification using text book problems	Study the behavior of RCC beam test under torsion
	SLO-2					

Learning Resources	1. IS 456 :2000, Plain and Reinforced Concrete: Code of Practice, Bureau of Indian Standards, New Delhi.	2. Laboratory Manual - SRMIST

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	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. Er. G.Hariharanath, GA Consultants, Chennai, gac1996@hotmail.com	1. Dr. G. Appa Rao, Professsor, IIT Madras, garao@iitm.ac.in	1. Dr. K. Sathyanarayanan, SRMIST
2. Er. AGV. Desigan, Design Group Engineering Consultancy Pvt Ltd. Chennai, desigan.agv@gmail.com	2. Dr. C. Uma Rani, Professor, Anna University, umarani@annauniv.edu	2. Prof. G. Augustine Maniraj Pandian, SRMIST

Course Code	18CEC206T	Course Name	HYDRAULIC ENGINEERING AND DESIGN	Course Category	C	Professional Core	L	T	P	C
							2	1	0	3

Pre-requisite Courses	18CEC202T	Co-requisite Courses	18CEC206L	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Utilize dimensional and model analysis			
CLR-2 :	Address concepts related to open channel flow			
CLR-3 :	Utilize basic hydraulic concepts in measuring discharge and velocity in open channel			
CLR-4 :	Create insights into the components and functions of roto-dynamic pump			
CLR-5 :	Address concepts related to the components and functions of positive displacement pump			
CLR-6 :	Utilize the components, functions and uses of Pelton wheel, Kaplan and Francis turbines			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	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 solve various fluid problems involving dimensional and model analysis	3	80	70	H	H	-	M	-	-	-	-	-	-	-	-	H	-	-
CLO-2 :	Analyze problems related to open channel flow	3	85	75	H	H	H	L	-	-	-	-	-	-	-	-	H	-	-
CLO-3 :	Identify various devices to measure and estimate discharge and velocity in open channel	3	85	75	H	M	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-4 :	Analyze the components and functions of rotodynamic pump	3	85	75	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-5 :	Identify the components and functions of positive displacement pump	3	85	75	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-6 :	Identify the components, functions and uses of various hydraulic turbines	3	80	70	H	H	H	L	-	-	-	-	-	-	-	-	H	-	-

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Dimensional and Model analysis	Open channel flow	Backwater computation by direct step method	Gauging flumes, non-modular/venturiflume	Air vessel and its functions
	SLO-2	Use of dimensional analysis, fundamental quantities and derived quantities	Comparison between open channel and pipe flows; Types of channels and types of flow in channels	Rapidly varied flow, hydraulic jump and its types	Standing wave / Modular flume	Working principle of hydraulic ram, jet pump and gear pump
S-2	SLO-1	M-L-T system for various quantities	Chezy's formula and Manning's formula	Expression for loss of energy due to jump, length of hydraulic jump, height of jump	Measurement of velocity, current meter	Turbines
	SLO-2	Dimensional homogeneity	Solving problems using tutorial sheet 4	Energy dissipaters and stilling basins	Floats, Hot-wire Anemometer	Components of hydroelectric power plant, classification of hydraulic turbines
S-3	SLO-1	Solving problems using tutorial sheet 1	Solving problems using tutorial sheet 4	Solving problems using tutorial sheet 7	Solving problems using tutorial sheet 10	Solving problems using tutorial sheet 13
	SLO-2	Solving problems using tutorial sheet 1	Design of most economical section of a channel	Solving problems using tutorial sheet 7	Solving problems using tutorial sheet 10	Solving problems using tutorial sheet 13
S-4	SLO-1	Rayleigh's method	Rectangular channel and trapezoidal channel	Measurement of discharge and velocity in open channel	Pumps	Pelton wheel, velocity triangles and work done
	SLO-2	Buckingham's π method	Non uniform flow through open channels	Flow over notches; Rectangular, triangular	Centrifugal pump, components and working	Design aspects of Pelton wheel
S-5	SLO-1	Selection of repeating variables; Application of dimensional analysis	Specific energy and specific energy curve	Trapezoidal and stepped notch	Velocity triangle, work done, losses and efficiencies	Francis turbine, velocity triangles and work done
	SLO-2	Model analysis	Critical depth, critical velocity	Types of Weirs	Specific speed, multistage centrifugal pump – pumps in parallel and series	Design aspects of Francis turbine
S-6	SLO-1	Solving problems using tutorial sheet 2	Solving problems using tutorial sheet 5	Solving problems using tutorial sheet 8	Solving problems using tutorial sheet 11	Solving problems using tutorial sheet 14
	SLO-2	Solving problems using tutorial sheet 2	Solving problems using tutorial sheet 5	Solving problems using tutorial sheet 8	Solving problems using tutorial sheet 11	Solving problems using tutorial sheet 14

S-7	SLO-1	*Similitude – Geometric similarity*	*Minimum specific energy, critical flow; Subcritical flow and supercritical flow*	*Effect on discharge over a notch or weir due to error in the measurement of head*	*Characteristic curves, NPSH*	*Kaplan turbine, design aspects of Kaplan turbine*
	SLO-2	*Kinematic and dynamic similarity*	*Gradually varied flow*	*Velocity of approach and end contraction*	*Reciprocating pump, components and working*	*Draft tube, types*
S-8	SLO-1	*Dimensionless numbers and their significance*	*Characteristics of surface profiles*	*Cippoletti weir, broad crested weir*	*Coefficient of discharge, slip, indicator diagram*	*Specific speed and its significance*
	SLO-2	*Model (or similarity) laws; Model studies in fluid flow problems*	*Length of back water curve and afflux*	*Narrow crested weir, Ogee weir and drowned/submerged weir*	*Effect of acceleration and friction, Maximum speed of reciprocating pump*	*Characteristic curves of hydraulic turbines*
S-9	SLO-1	*Solving problems using tutorial sheet 3*	*Solving problems using tutorial sheet 6*	*Solving problems using tutorial sheet 9*	*Solving problems using tutorial sheet 12*	*Solving problems using tutorial sheet 15*
	SLO-2	*Solving problems using tutorial sheet 3*	*Solving problems using tutorial sheet 6*	*Solving problems using tutorial sheet 9*	*Solving problems using tutorial sheet 12*	*Solving problems using tutorial sheet 15*

Learning Resources	*1. Modi, P.N., Seth S.M., Hydraulics and Fluid Machines, Standard book house, 2005* *2. Subramanya, K., Theory and application of fluid mechanics, Tata McGraw Hill, 2002* *3. R.K., Fluid Mechanics and Hydraulic Machines, S.Chand, 2014*	*4. Chandramouli P.N., Applied Hydraulic Engineering, Yesdee, 2017* *5. NPTEL Course-Hydraulics. https://nptel.ac.in/courses/105106114/#* *6. NPTEL Course-Fluid Machinery. https://nptel.ac.in/courses/112104117/*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. Abdul Hakeem, National Remote Sensing Center, Hyderabad, abdulhakeem_k@nrsc.gov.in	*1. Dr. R. Saravanan, Anna University, rsaran@annauniv.edu*	*1. Dr. R. Sathyanathan, SRMIST*
2. Dr. Sat Kumar Tomer, Satyukt Analytics Pvt Ltd., Bengaluru, sat@satyukt.com	*2. Dr. S. Saravanan, NIT, Tiruchy, ssaravanan@nitt.edu*	*2. Dr. DeepthaThattai, SRMIST*

Course Code	18CEC206L	Course Name	HYDRAULIC ENGINEERING LABORATORY	Course Category	C	Professional Core	L	T	P	C
							0	0	2	1

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		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 :	Utilize the Chezy's and Manning's equations																		
CLR-2 :	Analyze the concept of hydraulic jump																		
CLR-3 :	Utilize knowledge on notches and flumes																		
CLR-4 :	Utilize knowledge in operating the current meter																		
CLR-5 :	Utilize centrifugal pump, reciprocating pump, submersible pump and gear oil pump for suitable applications																		
CLR-6 :	Utilize Pelton wheel turbine and Francis turbine for suitable applications																		
Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*																		
CLO-1 :	Apply the concept of Chezy's and Manning's equations	3	90	85	H	M	-	-	-	-	-	-	H	-	-	-	H	-	H
CLO-2 :	Analyze hydraulic jump	3	90	85	H	M	-	-	-	-	-	-	H	-	-	-	H	-	H
CLO-3 :	Evaluate discharge using notches and flumes	3	90	85	H	M	-	-	-	-	-	-	H	-	-	-	H	-	H
CLO-4 :	Evaluate velocity using current meter	3	90	85	H	M	-	-	-	-	-	-	H	-	-	-	H	-	H
CLO-5 :	Analyze the working of centrifugal pump, reciprocating pump, submersible pump and gear oil pump	3	90	85	H	M	-	-	-	-	-	-	H	-	-	-	H	-	H
CLO-6 :	Analyze the working of Pelton wheel turbine and Francis turbine	3	90	85	H	M	-	-	-	-	-	-	H	-	-	-	H	-	H

Duration (hour)		6	6	6	6	6
S 1-2	SLO-1	Determine Chezy's constant for an open channel	Measure hydraulic jump	Determine coefficient of discharge for triangular notch	Test Performance of centrifugal pump	Test Performance of gear oil pump
	SLO-2					
S 3-4	SLO-1	Determine Manning's roughness coefficient for an open channel	Determine coefficient of discharge for rectangular notch	Measure velocity using current meter	Test Performance of reciprocating pump	Test Performance of Pelton wheel turbine
	SLO-2					
S 5-6	SLO-1	Determine specific energy curve	Measure flow using rectangular and triangular notches	Measure discharge using venturiflume	Test Performance of submersible pump	Test Performance of Francis turbine
	SLO-2					

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

Learning Assessment

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

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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2. Dr. Sat Kumar Tomer, Satyukt Analytics Pvt Ltd., Bengaluru, sat@satyukt.com	2. Dr. S. Saravanan, NIT, Tiruchy, ssaravanan@nitt.edu	2. Mr. Shaik NiyazuddinGuntakal, SRMIST

Course Code	18CEC207T	Course Name	DESIGN OF RC AND STEEL STRUCTURES	Course Category	C	Professional Core	L	T	P	C
							4	0	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes/Standards		IS 456 :2000, SP 16-Column Design Charts, IS 800: 2007, Steel Tables	

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Utilize the behavior of RC sections under flexure and shear and to get introduced to the relevant IS codes
CLR-2 :	Design RC using Limit state method
CLR-3 :	Utilize the concepts in performing design of RC beams, slabs, columns and foundations
CLR-4 :	Analyze behavior of Steel sections under tension, compression and flexure, identify relevant IS codes
CLR-5 :	Design streel sections using Limit state method
CLR-6 :	Utilize the concepts in performing design of steel tension, compression and flexural members and their connections

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1 (Level of Thinking (Bloom))	Learning 2 (Expected Proficiency (%))	Learning 3 (Expected Attainment (%))	PLO 1 (Engineering Knowledge)	PLO 2 (Problem Analysis)	PLO 3 (Design & Development)	PLO 4 (Analysis, Design, Research)	PLO 5 (Modern Tool Usage)	PLO 6 (Society & Culture)	PLO 7 (Environment & Sustainability)	PLO 8 (Ethics)	PLO 9 (Individual & Team Work)	PLO 10 (Communication)	PLO 11 (Project Mgt. & Finance)	PLO 12 (Life Long Learning)	PLO 13 (PSO -1)	PLO 14 (PSO - 2)	PLO 15 (PSO - 3)
CLO-1 :	Identify effect of external loads on RC members, factors influencing their behavior, identify relevant IS codes	3	85	80	H	-	-	M	-	-	-	-	-	-	-	H	H	M	-
CLO-2 :	Analyze behavior of RC sections under flexure and shear	2	80	75	H	H	-	M	-	-	-	-	-	-	-	H	H	M	-
CLO-3 :	Apply Limit state method of design to RC beams, slabs, columns and foundations	2	85	80	H	H	H	H	-	-	-	-	-	-	-	H	H	M	-
CLO-4 :	Identify effect of external loads on Steel members, factors influencing their behavior, identify relevant IS codes	3	85	80	H	-	-	M	-	-	-	-	-	-	-	H	H	M	-
CLO-5 :	Analyze the behavior of Steel sections under tension, compression and flexure	2	80	75	H	H	-	M	-	-	-	-	-	-	-	H	H	M	-
CLO-6 :	Apply Limit state method of design to steel tension, compression and flexural members and their connections	2	85	80	H	H	H	H	-	-	-	-	-	-	-	H	H	M	-

Duration (hour)		12	12	12	12	12
S-1	SLO-1	***INTRODUCTION TO RC DESIGN*** *Grade of concrete - concrete mix design-IS code provisions-Design of nominal and design mix*	***RC SLABS*** *Reinforcement detailing of one way slabs*	***RC BEAMS*** *Concept of load transfer from slab to beam-Introduction to singly and doubly reinforced and flanged beams -Design recommendations as per IS 456:2000*	***RC STAIR-CASES*** *Design of dog-legged stair-case-Procedure*	***RC FOUNDATIONS*** *Introduction-Types of foundation-Transfer of forces at junction of column-foundation*
	SLO-2	*Basic design concepts- Design Philosophy-Working stress and Limit state method of design*	*Design of continuous slabs-Procedure*	*Design of singly reinforced beams-Procedure*	*Design of stair-cases-Example 1*	*Design recommendations as per IS 456:2000*
S-2	SLO-1	*RC DESIGN: Partial safety factors -Limit state method-advantages*	*RC SLABS Design of continuous slabs-Example 1*	*RC BEAMS Design of singly reinforced beams-Example 1*	*RC STAIR-CASES Design of stair-cases-Example 2*	*RC FOUNDATIONS Design of isolated foundation-axially loaded-sloped*
	SLO-2	*General design recommendations as per IS 456:2000*	*Design of continuous slabs-Example 2*	*Design of singly reinforced beams-Example 2*	*Reinforcement detailing-Use of SP 34*	*Design of isolated foundation-axially loaded-stepped*
S-3	SLO-1	***INTRODUCTION TO STEEL DESIGN AND PLASTIC ANALYSIS****: Types of steel structures - Properties of structural steel, Indian Standard Specifications and sections- Design criteria as per IS 800:2007-Analysis methods*	***STEEL TENSION MEMBERS*** *Design provisions of tension members*	***STEEL COMPRESSION MEMBERS*** *Design of simple columns-Procedure*	***STEEL CONNECTIONS*** *Design of pin connections*	*STEEL BEAMS Design provisions of beams*
	SLO-2	*Calculation of Loads as per IS codes-Design Philosophy-Introduction to Limit State Method of design – Partial safety factors- General design requirements as per IS800:2007*	*Design of simple tension members - Effective net area-Types of failures*	*Design of simple columns-Example 1*	*Design of lap joints-Procedure*	*Design of simple beams-restrained-Procedure*
S-4	SLO-1	*PLASTIC ANALYSIS :Plastic analysis, Plastic hinge mechanism, Plastic moment of resistance, Plastic modulus*	*STEEL TENSION MEMBERS Design of plates with holes subjected to tension-Procedure*	*STEEL COMPRESSION MEMBERS Design of simple columns-Example 2*	*STEEL CONNECTIONS Design of lap joints-Example 1*	***STEEL BEAMS*** *Design of simple beams-restrained-Example*
	SLO-2	*Shape Factor for rectangular, circular and triangular sections*	*Design of plates with holes subjected to tension-Example*	*Types of built up columns*	*Design of lap joints-Example 2*	*Lateral torsional buckling behaviour of unrestrained beams*

S-5	SLO-1	***RC DESIGN*** *:Behaviour of RC sections under flexure, stress blocks – IS, AC and BS*	***RC SLABS*** *Reinforcement detailing of continuous slabs*	***RC BEAMS*** *Design of doubly reinforced beams-Procedure*	***RC COLUMNS*** *Short and long columns, Effective length slenderness ratio, un braced and braced columns -Design recommendations as per IS 456:2000*	***RC FOUNDATIONS*** *Design of isolated foundation-eccentrically loaded-Procedure*
	SLO-2	*Behaviour of RC sections under shear*	*Design of two way slabs-Procedure*	*Design of doubly reinforced beams-Example 1*	*Design of axially loaded short columns*	*Design of isolated foundation-eccentrically loaded-Example*
S-6	SLO-1	*RC DESIGN :Design recommendations as per IS 456:2000-flexure*	*RC SLABS Design of two way slabs-Simply supported on the edges with corners not held down*	*RC BEAMS Design of doubly reinforced beams-Example 2*	*RC COLUMNS Uniaxial and biaxial bending of columns*	*RC FOUNDATIONS Design of combined rectangular foundation-Procedure*
	SLO-2	*Design recommendations as per IS 456:2000-shear*	*Design of two way slab- Simply supported on the edges with corners held down*	*Ductile detailing of beams as per IS 13920*	*Use of interaction curves from SP16*	*Design of combined rectangular foundation-Example*
S-7	SLO-1	***PLASTIC ANALYSIS****: Shape Factor for I section*	***STEEL TENSION MEMBERS*** *Design of angles subjected to tension-Procedure*	***STEEL COMPRESSION MEMBERS*** *Design of lacing-Procedure*	***STEEL CONNECTIONS*** *Design of butt joints-Procedure*	***STEEL BEAMS*** *Check for lateral torsional buckling of unrestrained beams-Steps*
	SLO-2	*Shape Factor for T and C sections*	*Design of angles subjected to tension-Example*	*Design of lacing-Example*	*Design of butt joints-Example 1*	*Check for lateral torsional buckling of unrestrained beams-Example*
S-8	SLO-1	*PLASTIC ANALYSIS: Load factor, Static method of plastic analysis*	*STEEL TENSION MEMBERS Design of built-up tension members-various cross-sections*	*STEEL COMPRESSION MEMBERS Design of batten-Procedure*	*STEEL CONNECTIONS Design of butt joints-Example 2*	*STEEL BEAMS Design of beams subjected to biaxial bending-Procedure*
	SLO-2	*Mechanism method of plastic analysis*	*Design of built-up tension members-Procedure*	*Design of batten-Example*	*Design of Truss joint-Procedure*	*Design of beams subjected to biaxial bending-Example 1*
S-9	SLO-1	***RC SLABS*** *Introduction-Types of slab -Introduction on moment co-efficient and design recommendations as per IS 456:2000*	***RC SLABS*** *Design of two way slabs-with edges fixed*	***RC BEAMS*** *Design of flanged beams-Procedure*	***RC COLUMNS*** *Design of long columns*	***RC FOUNDATIONS*** *Introduction to Strip Footing*
	SLO-2	*Design of one way slabs-Procedure*	*Design of two way slabs-Example*	*Design of flanged beams-design for torsion*	*Ductile detailing of columns as per IS 13920*	*Introduction to Raft Footing*
S-10	SLO-1	*RC SLABS Design of one way slabs-Example 1*	*RC SLABS Reinforcement detailing of two way slabs*	*RC BEAMS Design of flanged beams-Example 1*	*RC COLUMNS Reinforcement detailing at beam-column joints using SP34*	*RC FOUNDATIONS Design of pile foundation, pile cap*
	SLO-2	*Design of one way slabs-Example 2*	*Use of design handbooks*	*Design of flanged beams-Example 2*	*Extension of design of columns to piles*	*Reinforcement detailing*
S-11	SLO-1	***PLASTIC ANALYSIS*** *:Analysis of indeterminate beams with uniform M_p*	***STEEL TENSION MEMBERS*** *Design of built-up tension members-Example*	***STEEL CONNECTIONS*** *Types of connections-Bolted and welded*	***STEEL CONNECTIONS*** *Design of Truss joint-Example 1*	***STEEL BEAMS*** *Design of beams subjected to biaxial bending-Example 2*
	SLO-2	*Analysis of indeterminate beams with varying M_p*	*Tension splices*	*Types of bolts and welds-Permissible stresses*	*Design of Truss joint-Example 2*	*Design of built-up beams-Procedure*
S-12	SLO-1	*PLASTIC ANALYSIS :Analysis of single bay single storey rectangular portal frames-with same column heights*	***STEEL COMPRESSION MEMBERS*** *Design provisions of compression members*	*STEEL CONNECTIONS Load transfer mechanism*	***STEEL BEAMS*** *Behaviour of steel members in flexure*	*STEEL BEAMS Design of built-up beams-Example 1*
	SLO-2	*Analysis of single bay single storey rectangular portal frames with varying column heights*	*Effective length-Slenderness ratio-Types of buckling-Classification of cross-sections*	*Types of failure of connections*	*Phenomenon of web buckling and web crippling*	*Design of built-up beams-Example 2*

Learning Resources

1. *Varghese.P.C, Limit State Design of Reinforced Concrete, 2nd ed.,PHI Learning Pvt. Ltd., 2004*
2. *Unnikrishna Pillai.S, Devdoss Menon, Reinforced Concrete Design, 5th ed., Tata McGraw, 2003*
3. *Subramanian.N, Design of Reinforced Concrete Structures, Oxford University Press, 2013*
4. *Punmia.B.C, Ashok Kumar Jain,A run Kumar Jain, Limit State Design of Reinforced Concrete,1st edition, Laxmi Publications Pvt. Ltd., 2007*
5. *Duggal S.K, Limit state design of steel structures, Tata McGraw Hill, 2010*
6. *Subramanian.N, Design of Steel structures-Limit state method, Oxford University Press, 2016*
7. *Shah.V.L,, Veena Gore, Limit State Design of. Steel Structures, 1st ed.,Structures Publications, 2009*
8. *Punmia.B.C, Ashok Kumar Jain, Arun Kumar Jain,Comprehensive Design of Steel structures, Laxmi Publications Pvt. Ltd., 2007*
9. *NPTELCourse: Design of Reinforced Concrete Structures: https://onlinecourses.nptel.ac.in/noc18_ce24/preview*
10. *NPTELCourse: Design of Steel Structures https://onlinecourses.nptel.ac.in/noc17_ce21/preview*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. Er. G.Hariharanath, GA Consultants, Chennai, gac1996@hotmail.com	*1. Dr. G. Appa Rao, Professsor, IIT Madras, garao@iitm.ac.in*	*1. Dr. K. Sathyanarayanan, SRMIST*
2. Er. AGV. Desigan, Design Group Engineering Consultancy Pvt Ltd. Chennai, desigan.agv@gmail.com	*2. Dr. C. Uma Rani, Professor, Anna University, umarani@annauniv.edu*	*2. Prof. G. Augustine Maniraj Pandian, SRMIST*

Course Code	18CEC208T	Course Name	ENVIRONMENTAL ENGINEERING AND DESIGN	Course Category	C	Professional Core	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	18CEC208L	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Utilize the sources of water supply and its quality
CLR-2 :	Design and Construct water treatment for domestic supplies
CLR-3 :	Utilize sanitary engineering concepts for implementation
CLR-4 :	Design sewage treatment plants for towns and cities
CLR-5 :	Utilize solid waste management mechanisms
CLR-6 :	Analyze the role of Government and NGO's in sustaining the environment

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 sources of water and its quality	2	85	80	H	H	M	L	-	L	H	-	-	-	-	L	H	-	-
CLO-2 :	Design water treatment units for domestic purposes	3	85	75	H	H	H	H	-	-	H	-	-	-	-	-	H	-	-
CLO-3 :	Identify the collection and conveyance of domestic sewage	2	80	75	H	H	M	M	-	L	H	-	-	-	-	L	H	-	-
CLO-4 :	Design of sewage treatment units for sanitary sewage	3	85	75	H	H	H	H	-	-	H	-	-	-	-	-	H	-	-
CLO-5 :	Apply the concept of reducing, reuse, recycling in solid waste management	2	85	80	H	H	M	M	L	L	M	-	-	-	-	L	H	-	-
CLO-6 :	Analyze the environmental legislations	2	80	75	H	H	M	-	-	L	M	M	-	-	-	-	H	-	-

		Water Supply	Water Treatment	Sanitary Engineering	Disposal of Sewage	Solid Waste Management & Air Pollution
Duration (hour)		9	9	9	9	9
S-1	SLO-1	Water quality requirement for different beneficial uses	Concept and objectives of water treatment	Domestic and storm water quantity of sewage and flow variations	Concept of sewage disposal	Concept and generation of solid waste
	SLO-2	Importance of water supply scheme and Need for protected water supply	Principles of Aeration and Sedimentation. Types of sedimentation & design	Conveyance of sewage and types of sewers. Design of sewers	Pollution due to improper disposal of sewage	Municipal Solid Waste(MSW), composition and other parameters
S-2	SLO-1	Various sources of water available for supply	Principles of Coagulation and Flocculation	Pumping of sewage and sewer appurtenances	Zones of pollution and Self-purification of rivers	Quantification and Collection of MSW
	SLO-2	Per capita consumption-Demand	Types of coagulants used in water treatment	Laying and jointing of sewer lines	Oxygen sag curve. National river cleaning plans Dissolved Oxygen and BOD	Treatment and disposal of MSW
S-3	SLO-1	Solving problems using Tutorial Sheet 1	Solving problems using Tutorial Sheet 4	Solving problems using Tutorial Sheet 7	Solving problems using Tutorial Sheet 10	Solving problems using Tutorial Sheet 13
	SLO-2	Solving problems using Tutorial Sheet 1	Solving problems using Tutorial Sheet 4	Solving problems using Tutorial Sheet 7	Solving problems using Tutorial Sheet 10	Solving problems using Tutorial Sheet 13
S-4	SLO-1	Quality issues in various sources of water	Concept and theory of Filtration	Different plumbing systems adopted in buildings	Disposal of treated sewage in irrigation land	Waste from commercial establishments and other urban areas
	SLO-2	Water Pollution, sources, causes and effects. Water quality characteristics	Working principles of slow sand filters and design	Sanitary fittings used in buildings. Quantification of storm water	Sewage sickness and remedial measures	Effect of solid waste on environment
S-5	SLO-1	WHO and BIS standards and Water Borne Diseases	Working principles of rapid sand filters and design	Concept of Primary, Secondary and Tertiary treatments	Concept of sludge management	Segregation and disposal methods of sloid waste
	SLO-2	Population forecast using different methods	Disinfection of water and Chlorination	Screening and Grit Chambers	Thickening, Conditioning and Dewatering of sludge	Reduction at source, recovery and recycle
S-6	SLO-1	Solving problems using Tutorial Sheet 2	Solving problems using Tutorial Sheet 5	Solving problems using Tutorial Sheet 8	Solving problems using Tutorial Sheet 11	Solving problems using Tutorial Sheet 14
	SLO-2	Solving problems using Tutorial Sheet 2	Solving problems using Tutorial Sheet 5	Solving problems using Tutorial Sheet 8	Solving problems using Tutorial Sheet 11	Solving problems using Tutorial Sheet 14

S-7	SLO-1	*Water requirements for industrial need and agriculture*	*Advanced treatment like adsorption, ion exchange*	*Concept of aerobic and anaerobic treatment systems*	*Various disposal methods of sludge*	*Concept of Air Pollution: Properties and monitoring of Air pollutants*
	SLO-2	*Components of water supply system*	*Advanced treatment like membrane processes and UV methods.*	*Primary settling tanks and secondary settling tanks*	*Energy recovered from sludge*	*Air quality standards and control measures for Air Pollution*
S-8	SLO-1	*Transmission of water and distribution system*	*Effective water management Rain water harvesting methods*	*Principles of septic tanks and design.*	*Revenue from end product of sludge management*	*Basic concept of Noise Pollution and measurements*
	SLO-2	*Service reservoirs used in water supply*	*Measures taken for protecting the existing water bodies*	*Activated Sludge Process and Trickling Filters*	*Design of Sludge digestion tanks*	*Various control methods of noise pollution Acceptable standards for Noise levels*
S-9	SLO-1	*Solving problems using Tutorial Sheet 3*	*Solving problems using Tutorial Sheet 6*	*Solving problems using Tutorial Sheet 9*	*Solving problems using Tutorial Sheet 12*	*Solving problems using Tutorial Sheet 15*
	SLO-2	*Solving problems using Tutorial Sheet 3*	*Solving problems using Tutorial Sheet 6*	*Solving problems using Tutorial Sheet 9*	*Solving problems using Tutorial Sheet 12*	*Solving problems using Tutorial Sheet 15*

Learning Resources	1. *Metcalf, Eddy, Wastewater Engineering, Treatment and Reuse, Tata McGraw Hill, 2005* 2. *S. K. Garg, Water Supply Engineering, Khanna Publishers, 2017* 3. *S. K. Garg, Sewage Disposal and Air Pollution Engineering, Khanna Publishers, 2017* 4. *CPHEEO Manual on Water Supply and Treatment, Ministry of Drinking water and Sanitation, New Delhi, 2015*	5. *GeorgeTchobanoglous, Hilary Theisen, Samuel Vigil, Integrated Solid Waste Management, McGraw Hill,1993* 6. *CPHEEO Manual on Sewerage and Sewage Treatment, Ministry of Urban Development, New Delhi, 2010* 7. *NPTEL Course-Water, Society & Sustainability. https://onlinecourses.nptel.ac.in/noc18_hs36/* 8. *NPTEL Course-Wastewater Treatment & Recycling https://onlinecourses.nptel.ac.in/noc18_ce26*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. Rajkumar Samuel, Hubert Enviro-Care Systems, Chennai, rajkumar@hecs.in	*1. Dr. S. Madhava Kumar, IIT Madras, mathav@iitm.ac.in*	*1. Mr. K. Prasanna, SRMSIT*
2. Mr. A. Abdul Rasheed, CMWSS Board, juruterarasheed@gmail.com	*2. Dr. G. Dhinagaran, Anna University, Chennai, dhinagaran@annauniv.edu*	*2. Mr. D. Justus Reymond, SRMIST*

Course Code	18CEC208L	Course Name	ENVIRONMENTAL ENGINEERING LABORATORY	Course Category	C	Professional Core	L	T	P	C
							0	0	2	1

Pre-requisite Courses	Nil	Co-requisite Courses	18CEC208T	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Evaluate characteristics of water
CLR-2 :	Evaluate the characteristics of waste water
CLR-3 :	Conduct tests on water and wastewater
CLR-4 :	Utilize turbidity meter, pH meter, electrical conductivity meter
CLR-5 :	Utilize spectrophotometer, high volume sampler, noise level meter
CLR-6 :	Conduct titration experiments

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1 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	PSO 1	PSO 2	PSO 3
CLO-1 :	Evaluate the characteristics of water	3	90	85	H	M	-	-	-	-	H	-	-	-	-	-	H	-	H
CLO-2 :	Analyze the characteristics of waste water	3	85	80	H	M	-	-	-	-	H	-	-	-	-	-	H	-	H
CLO-3 :	Test water and wastewater sample	3	90	85	H	M	-	-	-	-	-	-	-	-	-	-	H	-	H
CLO-4 :	Identify the working of turbidity meter, pHmeter, electrical conductivity meter	3	85	80	H	M	-	-	-	-	-	-	-	-	-	-	H	-	H
CLO-5 :	Identify the working of spectrophotometer, high volume sampler, noise level meter	3	85	80	H	M	-	-	-	-	H	-	-	-	-	-	H	-	H
CLO-6 :	Conduct titration based experiments	3	85	80	H	M	-	-	-	-	H	-	-	-	-	-	H	-	H

Duration (hour)		6	6	6	6	6
S 1-2	SLO-1	Determine turbidity, electrical conductivity, pH	Determine solids contents in water: Total, volatile, fixed, suspended, dissolved, settle able and inorganic solids	Determine alkalinity and Acidity	Determine total hardness, calcium and magnesium hardness	Determine chloride and sulphate
	SLO-2					
S 3-4	SLO-1	Determine optimum coagulant dose	Determine Chemical Oxygen Demand (COD)	Determine Dissolved Oxygen(DO) and Biological Oxygen Demand(BOD)	Determine break point chlorination	Determine copper
	SLO-2					
S 5-6	SLO-1	Determine bacteriological quality measurement: MPN	Monitor Ambient air quality (TSP,RSPM)	Monitor Ambient air quality (So_x)	Monitor Ambient air quality (NO_x)	Measure Ambient noise
	SLO-2					

Learning Resources	1. S. K. Garg, Water Supply Engineering, Khanna Publishers, 2017 2. S. K. Garg, Sewage Disposal and Air Pollution Engineering, Khanna Publishers, 2017	3. IS:10500-2012, Indian Standards for Drinking Water, Bureau of Indian Standards, New Delhi. 4. Environmental Engineering lab manual, SRMIST

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								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
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2. Mr. A. Abdul Rasheed, CMWSS Board, juruterarasheed@gmail.com	2. Dr .G. Dhinagaran, Anna University, Chennai, dhinagaran@annauniv.edu	2. Mr. S. Ramesh, SRMIST

ACADEMIC CURRICULA

Professional Core Courses

COMPUTER SCIENCE AND ENGINEERING

Regulations - 2018

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

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

Kattankulathur, Kancheepuram, Tamil Nadu, India

Course Code	18CSC201J	Course Name	DATA STRUCTURES AND ALGORITHMS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	18CSC204J
Course Offering Department	Computer Science and Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Utilize the different data types; Utilize searching and sorting algorithms for data search
CLR-2 :	Utilize linked list in developing applications
CLR-3 :	Utilize stack and queues in processing data for real-time applications
CLR-4 :	Utilize tree data storage structure for real-time applications
CLR-5 :	Utilize algorithms to find shortest data search in graphs for real-time application development
CLR-6 :	Utilize the different types of data structures and its operations for real-time programming applications

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	Identify linear and non-linear data structures. Create algorithms for searching and sorting	3	80	70	L	H	-	H	L	-	-	-	L	L	-	H	-	-	-
CLO-2 :	Create the different types of linked lists and evaluate its operations	3	85	75	M	H	L	M	L	-	-	-	M	L	-	H	-	-	-
CLO-3 :	Construct stack and queue data structures and evaluate its operations	3	75	70	M	H	M	H	L	-	-	-	M	L	-	H	-	-	-
CLO-4 :	Create tree data structures and evaluate its types and operations	3	85	80	M	H	M	H	L	-	-	-	M	L	-	H	-	-	-
CLO-5 :	Create graph data structure, evaluate its operations, implement algorithms to identify shortest path	3	85	75	H	H	M	H	L	-	-	-	M	L	-	H	-	-	-
CLO-6 :	Construct the different data structures and evaluate their types and operations	3	80	70	L	H	-	H	L	-	-	-	L	L	-	H	-	-	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Introduction-Basic Terminology	Array	Stack ADT	General Trees	Graph Terminology
	SLO-2	Data Structures	Operations on Arrays – Insertion and Deletion	Stack Array Implementation	Tree Terminologies	Graph Traversal
S-2	SLO-1	Data Structure Operations	Applications on Arrays	Stack Linked List Implementation	Tree Representation	Topological sorting
	SLO-2	ADT	Multidimensional Arrays- Sparse Matrix	Applications of Stack- Infix to Postfix Conversion	Tree Traversal	Minimum spanning tree – Prims Algorithm
S-3	SLO-1	Algorithms – Searching techniques	Linked List Implementation - Insertion	Applications of Stack- Postfix Evaluation	Binary Tree Representation	Minimum Spanning Tree - Kruskal's Algorithm
	SLO-2	Complexity – Time , Space Trade off	Linked List- Deletion and Search	Applications of Stack- Balancing symbols	Expression Trees	Network flow problem
S 4-5	SLO-1	Lab 1: Implementation of Searching - Linear and Binary Search Techniques	Lab 4 : Implementation of Array – Insertion, Deletion.	Lab 7 :Implementation of stack using array and Linked List	Lab 10: Implementation of Tree using array	Lab 13: Implementation of Graph using Array
	SLO-2					
S-6	SLO-1	Algorithms - Sorting	Applications of Linked List	Applications of Stack- Nested Function Calls	Binary Tree Traversal	Shortest Path Algorithm- Introduction
	SLO-2	Complexity – Time , Space Trade off	Polynomial Arithmetic	Recursion concept using stack	Threaded Binary Tree	Shortest Path Algorithm: Dijkstra's Algorithm
S-7	SLO-1	Mathematical notations	Cursor Based Implementation – Methodology	Applications of Recursion: Tower of Hanoi	Binary Search Tree :Construction, Searching	Hashing: Hash functions - Introduction
	SLO-2	Asymptotic notations-Big O, Omega	Cursor Based Implementation	Queue ADT	Binary Search Tree : Insertion and Deletion	Hashing: Hash functions
S-8	SLO-1	Asymptotic notations - Theta	Circular Linked List	Queue Implementation using array	AVL Trees: Rotations	Hashing : Collision avoidance

	SLO-2	*Mathematical functions*	*Circular Linked List - Implementation*	*Queue Implementation using Linked List*	*AVL Tree: Insertions*	*Hashing : Separate chaining*
S 9-10	SLO-1	*Lab 2: Implementation of sorting Techniques – Insertion sort and Bubble Sort Techniques*	*Lab 5: Implementation of Linked List - Cursor Based Implementation*	*Lab 8: Implementation of Queue using Array and linked list*	*Lab 11: Implementation of BST using linked list*	*Lab 14 :Implementation of Shortest path Algorithm*
	SLO-2					
S-11	SLO-1	*Data Structures and its Types*	*Applications of Circular List -Joseph Problem*	*Circular Queue*	*B-Trees Constructions*	*Open Addressing*
	SLO-2	*Linear and Non-Linear Data Structures*	*Doubly Linked List*	*Implementation of Circular Queue*	*B-Trees Search*	*Linear Probing*
S-12	SLO-1	*1D, 2D Array Initialization using Pointers*	*Doubly Linked List Insertion*	*Applications of Queue*	*B-Trees Deletions*	*Quadratic probing*
	SLO-2	*1D, 2D Array Accessing using Pointers*	*Doubly Linked List Insertion variations*	*Double ended queue*	*Splay Trees*	*Double Hashing*
S-13	SLO-1	*Declaring Structure and accessing*	*Doubly Linked List Deletion*	*Priority Queue*	*Red Black Trees*	*Rehashing*
	SLO-2	*Declaring Arrays of Structures and accessing*	*Doubly Linked List Search*	*Priority Queue - Applications*	*Red Black Trees Insertion*	*Extensible Hashing*
S 14-15	SLO-1	*Lab 3: Implement Structures using Pointers*	*Lab 6: Implementation of Doubly linked List*	*Lab 9: Applications of Stack, Queue*	*Lab 12:Implementation of B-Trees*	*Lab 15 :Implementation of Minimal Spanning Tree*
	SLO-2					

Learning Resources	*1. Seymour Lipschutz, Data Structures with C, McGraw Hill, 2014* *2. R.F.Gilberg, B.A.Forouzan, Data Structures, 2nd ed., Thomson India, 2005* *3. A.V.Aho, J.E Hopcroft , J.D.Ullman, Data structures and Algorithms, Pearson Education, 2003* *4. Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2nd ed., Pearson Education, 2015*	*5. Reema Thareja, Data Structures Using C, 1st ed., Oxford Higher Education, 2011* *6. Thomas H Cormen, Charles E Leiserson, Ronald L Revest, Clifford Stein, Introduction to Algorithms 3rd ed., The MIT Press Cambridge, 2014*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. Nagaveer, CEO, Campus Corporate Connect, nagaveer@campuscorporateconnect.com	*1. Dr. Srinivasa Rao Bakshi, IITM, Chennai, sbakshi@iitm.ac.in*	*1. Mr. K. Venkatesh, SRMIST*
2. Dr. Sricharan Srinivasan, Wipro Technologies, sricharanms@gmail.com	*2. Dr. Ramesh Babu, N , nrbabu@iitm.ac.in*	*2. Dr.Subalalitha C.N, SRMIST*
	3. Dr.Noor Mahammad, IIITDM, Kancheepuram, noor@iiitdm.ac.in	*3. Ms. Femi Ukrit, SRMIST*

Course Code	18CSC202J	Course Name	OBJECT ORIENTED DESIGN AND PROGRAMMING	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18CSS101J	Co-requisite Courses	Nil	Progressive Courses	18CSC207J
Course Offering Department	Computer Science and Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Utilize class and build domain model for real-time programs
CLR-2 :	Utilize method overloading and operator overloading for real-time application development programs
CLR-3 :	Utilize inline, friend and virtual functions and create application development programs
CLR-4 :	Utilize exceptional handling and collections for real-time object oriented programming applications
CLR-5 :	Construct UML component diagram and deployment diagram for design of applications
CLR-6 :	Create programs using object oriented approach and design methodologies for real-time application development

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLO-1 :	Identify the class and build domain model	3	80	70
CLO-2 :	Construct programs using method overloading and operator overloading	3	85	75
CLO-3 :	Create programs using inline, friend and virtual functions, construct programs using standard templates	3	75	70
CLO-4 :	Construct programs using exceptional handling and collections	3	85	80
CLO-5 :	Create UML component diagram and deployment diagram	3	85	75
CLO-6 :	Create programs using object oriented approach and design methodologies	3	80	70

	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 :	H	H	M	-	-	-	-	-	H	H	-	-	M	H	H
CLO-2 :	H	H	H	H	H	-	M	-	H	H	-	-	M	H	H
CLO-3 :	H	H	M	H	H	-	M	-	H	H	-	-	M	H	H
CLO-4 :	H	H	H	-	-	-	-	-	H	M	-	-	M	H	H
CLO-5 :	H	M	M	M	M	M	M	-	H	H	-	M	M	H	H
CLO-6 :	H	H	M	-	-	-	-	-	H	H	-	-	M	H	H

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Comparison of Procedural and Object Oriented Programming	Types of constructor (Default, Parameter)	Feature Inheritance: Single and Multiple	Generic - Templates : Introduction	STL: Containers: Sequence and Associative Container
	SLO-2	OOPS and its features	Static constructor and copy constructor	Inheritance: Multilevel	Function templates	
S-2	SLO-1	I/O Operations, Data Types, Variables, static	Feature Polymorphism: Constructor overloading	Inheritance: Hierarchical	Example programs Function templates	Sequence Container: Vector, List
	SLO-2	Constants, Pointers, Type Conversions	Method Overloading	Inheritance: Hybrid	Class Templates	Sequence Container: Deque, Array
S-3	SLO-1	Features: Class and Objects	Example for method overloading	Inheritance: Example Programs	Class Templates	STL : Stack
	SLO-2	UML Diagrams Introduction	Method Overloading: Different parameter with different return values		Example programs for Class and Function templates	
S 4-5	SLO-1	Lab 1: I/O operations	Lab 4: Constructor and Method overloading	Lab 7: Inheritance and its types	Lab 10: Templates	Lab 13: STL Containers
	SLO-2					
S-6	SLO-1	Feature :Class and Objects	Operator Overloading and types	Advanced Functions: Inline, Friend	Exceptional Handling: try and catch	Associative Containers: Map, Multimap
	SLO-2	Examples of Class and Objects	Overloading Assignment Operator	Advanced Functions: Virtual, Overriding	Exceptional Handling: Multilevel exceptional	
S-7	SLO-1	UML Class Diagram and its components	Overloading Unary Operators	Advanced Function: Pure Virtual function	Exceptional Handling: throw and throws	Iterator and Specialized iterator
	SLO-2	Class Diagram relations and Multiplicity	Example for Unary Operator overloading	Example for Virtual and pure virtual function	Exceptional Handling: finally	Functions of iterator
S-8	SLO-1	Feature Abstraction and Encapsulation	Overloading Binary Operators	Abstract class and Interface	Exceptional Handling: User defined exceptional	Algorithms: find(), count(), sort()
	SLO-2	Application of Abstraction and Encapsulation	Example for Binary Operator overloading	Example Program	Example Programs using C++	Algorithms: search(), merge()

S 9-10	SLO-1 SLO-2	*Lab 2: Classes and Objects, Class Diagram*	*Lab 5: Polymorphism : Operators Overloading*	*Lab 8: Virtual Function and Abstract class*	*Lab 11: Exceptional Handling*	*Lab 15: STL Associative containers and algorithms*
S-11	SLO-1	*Access specifiers – public, private*	*UML Interaction Diagrams*	*UML State Chart Diagram*	*Dynamic Modeling: Package Diagram*	*Function Object : for_each(), transform()*
	SLO-2	*Access specifiers - protected, friend, inline*	*Sequence Diagram*	*UML State Chart Diagram*	*UML Component Diagram*	*Example for Algorithms*
S-12	SLO-1	*UML use case Diagram, use case, Scenario*	*Collaboration Diagram*	*Example State Chart Diagram*	*UML Component Diagram*	*Streams and Files: Introduction*
	SLO-2	*Use case Diagram objects and relations*	*Example Diagram*	*UML Activity Diagram*	*UML Deployment Diagram*	*Classes and Errors*
S-13	SLO-1	*Method, Constructor and Destructor*	*Feature: Inheritance*	*UML Activity Diagram*	*UML Deployment Diagram*	*Disk File Handling Reading Data and Writing Data*
	SLO-2	*Example program for constructor*	*Inheritance and its types*	*Example Activity Diagram*	*Example Package, Deployment, Package*	
S 14-15	SLO-1 SLO-2	*Lab 3: Methods and Constructor, Usecase*	*Lab 6: UML Interaction Diagram*	*Lab 9: State Chart and Activity Diagram*	*Lab12 : UML Component, Deployment, Package diagram*	*Lab15: Streams and File Handling*

Learning Resources	1. *Grady Booch, Robert A. Maksimchuk, Michael W. Engle, Object-Oriented Analysis and Design with Applications, 3rd ed., Addison-Wesley, May 2007* 2. *Reema Thareja, Object Oriented Programming with C++, 1st ed., Oxford University Press, 2015* 3. *Sourav Sahay, Object Oriented Programming with C++, 2nd ed., Oxford University Press, 2017*	4. *Robert Lafore, Object-Oriented Programming in C++, 4th ed., SAMS Publishing, 2008* 5. *Ali Bahrami, Object Oriented Systems Development", McGraw Hill, 2004* 6. *Craig Larmen, Applying UML and Patterns, 3rd ed., Prentice Hall, 2004*

Learning Assessment

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

For the laboratory component the students are advised to take an application and apply the concepts

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. Girish Raghavan, Senior DMTS Member, Wipro Ltd.	*1. Dr. Srinivasa Rao Bakshi, IITM Chennai, sbakshi@iitm.ac.in*	*1. Ms. C.G.Anupama, SRMIST*
Ms. Thamilchelvi, Solutions Architect, Wipro Ltd	*2. Dr. Ramesh Babu, N, IITM Chennai, nrbabu@iitm.ac.in*	*2. Mr. C.Arun, SRMIST*
		3. Mr. Geogen George, SRMIST
		4. Mr. Muthukumaran, SRMIST

Course Code	18CSC203J	Course Name	COMPUTER ORGANIZATION AND ARCHITECTURE	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	18CSC207J
Course Offering Department	Computer Science and Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Utilize the functional units of a computer
CLR-2 :	Analyze the functions of arithmetic Units like adders, multipliers etc.
CLR-3 :	Understand the concepts of Pipelining and basic processing units
CLR-4 :	Study about parallel processing and performance considerations.
CLR-5 :	Have a detailed study on Input-Output organization and Memory Systems.
CLR-6 :	Simulate simple fundamental units like half adder, full adder etc

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 computer hardware and how software interacts with computer hardware	2	80	70	H	H	-	-	-	-	-	-	M	L	-	M	-	-	-
CLO-2 :	Apply Boolean algebra as related to designing computer logic, through simple combinational and sequential logic circuits	3	85	75	H	H	H	-	H	-	-	-	M	L	-	M	-	-	-
CLO-3 :	Analyze the detailed operation of Basic Processing units and the performance of Pipelining	2	75	70	H	H	H	H	-	-	-	-	M	L	-	M	-	-	-
CLO-4 :	Analyze concepts of parallelism and multi-core processors.	3	85	80	H	-	-	H	-	-	-	-	M	L	-	M	-	-	-
CLO-5 :	Identify the memory technologies, input-output systems and evaluate the performance of memory system	3	85	75	H	-	H	H	-	-	-	-	M	L	-	M	-	-	-
CLO-6 :	Identify the computer hardware, software and its interactions	3	85	75	H	H	H	H	H	-	-	-	M	L	-	M	-	-	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Functional Units of a computer	Addition and subtraction of Signed numbers	Fundamental concepts of basic processing unit	Parallelism	Memory systems -Basic Concepts
	SLO-2	Operational concepts	Problem solving	Performing ALU operation	Need, types of Parallelism	Memory hierarchy
S-2	SLO-1	Bus structures	Design of fast adders	Execution of complete instruction, Branch instruction	applications of Parallelism	Memory technologies
	SLO-2	Memory locations and addresses	Ripple carry adder and Carry look ahead adder	Multiple bus organization	Parallelism in Software	RAM, Semiconductor RAM
S-3	SLO-1	Memory operations	Multiplication of positive numbers	Hardwired control	Instruction level parallelism	ROM,Types
	SLO-2	Memory operations	Problem Solving	Generation of control signals	Data level parallelism	Speed,size cost
S 4-5	SLO-1	Lab 1: To recognize various components of PC- Input Output systems Processing and Memory units	Lab4:Study of TASM Addition and Subtraction of 8-bit number	Lab-7: Design of Half Adder Design of Full Adder	Lab-10: Study of Array Multiplier Design of Array Multiplier	Lab-13: Study of Carry Save Multiplication Program to carry out Carry Save Multiplication
	SLO-2					
S-6	SLO-1	Instructions, Instruction sequencing	Signed operand multiplication	Micro-programmed control-	Challenges in parallel processing	Cache memory
	SLO-2	Addressing modes	Problem solving	Microinstruction	Architectures of Parallel Systems - Flynn's classification	Mapping Functions
S-7	SLO-1	Problem solving	Fast multiplication- Bit pair recoding of Multipliers	Micro-program Sequencing	SISD,SIMD	Replacement Algorithms

	SLO-2	*Introduction to Microprocessor*	*Problem Solving*	*Micro instruction with Next address field*	*MIMD, MISD*	*Problem Solving*
S-8	**SLO-1**	*Introduction to Assembly language*	*Carry Save Addition of summands*	*Basic concepts of pipelining*	*Hardware multithreading*	*Virtual Memory*
	SLO-2	*Writing of assembly language programming*	*Problem Solving*	*Pipeline Performance*	*Coarse Grain parallelism, Fine Grain parallelism*	*Performance considerations of various memories*
S 9-10	**SLO-1**	*Lab-2:To understand how different components of PC are connected to work properly*	*Lab 5: Addition of 16-bit number Subtraction of 16-bit number*	*Lab-8: Study of Ripple Carry Adder Design of Ripple Carry Adder*	*Lab-11: Study of Booth Algorithm*	*Lab-14: Understanding Processing unit Design of primitive processing unit*
	SLO-2	*Assembling of System Components*				
S-11	**SLO-1**	*ARM Processor: The thumb instruction set*	*Integer division – Restoring Division*	*Pipeline Hazards-Data hazards*	*Uni-processor and Multiprocessors*	*Input Output Organization*
	SLO-2	*Processor and CPU cores*	*Solving Problems*	*Methods to overcome Data hazards*	*Multi-core processors*	*Need for Input output devices*
S-12	**SLO-1**	*Instruction Encoding format*	*Non Restoring Division*	*Instruction Hazards*	*Multi-core processors*	*Memory mapped IO*
	SLO-2	*Memory load and Store instruction in ARM*	*Solving Problems*	*Hazards on conditional and Unconditional Branching*	*Memory in Multiprocessor Systems*	*Program controlled IO*
S-13	**SLO-1**	*Basics of IO operations.*	*Floating point numbers and operations*	*Control hazards*	*Cache Coherency in Multiprocessor Systems*	*Interrupts-Hardware, Enabling and Disabling Interrupts*
	SLO-2	*Basics of IO operations.*	*Solving Problems*	*Influence of hazards on instruction sets*	*MESI protocol for Multiprocessor Systems*	*Handling multiple Devices*
S 14-15	**SLO-1**	*Lab -3To understand how different components of PC are connected to work properly*	*Lab-6: Multiplication of 8-bit number Factorial of a given number*	*Lab-9: Study of Carry Look-ahead Adder Design of Carry Look-ahead Adder*	*Lab-12: Program to carry out Booth Algorithm*	*Lab-15: Understanding Pipeline concepts Design of basic pipeline.*
	SLO-2	*Disassembling of System Components*				

Learning Resources	1. *Carl Hamacher, ZvonkoVranesic, SafwatZaky, Computer Organization, 5th ed., McGraw-Hill, 2015* 2. *Kai Hwang, Faye A. Briggs, Computer Architecture and Parallel Processing", 3rd ed., McGraw Hill, 2016* 3. *Ghosh T. K., Computer Organization and Architecture, 3rd ed., Tata McGraw-Hill, 2011* 4. *P. Hayes, Computer Architecture and Organization, 3rd ed., McGraw Hill, 2015.*	5. *William Stallings, Computer Organization and Architecture – Designing for Performance, 10th ed., Pearson Education, 2015* 6. *David A. Patterson and John L. Hennessy Computer Organization and Design - A Hardware software interface, 5th ed., Morgan Kaufmann,2014*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. Dr. C. Malathy, SRMIST
		3. Mrs M.S.Abirami, SRMIST

Course Code	18CSC204J	Course Name	DESIGN AND ANALYSIS OF ALGORITHMS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18CSC201J, 18CSC202J	Co-requisite Courses	18CSC207J	Progressive Courses	Nil
Course Offering Department	Computer Science and Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Design efficient algorithms in solving complex real time problems			
CLR-2 :	Analyze various algorithm design techniques to solve real time problems in polynomial time			
CLR-3 :	Utilize various approaches to solve greedy and dynamic algorithms			
CLR-4 :	Utilize back tracking and branch and bound paradigms to solve exponential time problems			
CLR-5 :	Analyze the need of approximation and randomization algorithms, utilize the importance Non polynomial algorithms			
CLR-6 :	Construct algorithms that are efficient in space and time complexities			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 efficient algorithms to reduce space and time complexity of both recurrent and non-recurrent relations	3	80	70	L	H	-	H	L	-	-	-	L	L	-	H	-	-	-
CLO-2 :	Solve problems using divide and conquer approaches	3	85	75	M	H	L	M	L	-	-	-	M	L	-	H	-	-	-
CLO-3 :	Apply greedy and dynamic programming types techniques to solve polynomial time problems.	3	75	70	M	H	M	H	L	-	-	-	M	L	-	H	-	-	-
CLO-4 :	Create exponential problems using backtracking and branch and bound approaches.	3	85	80	M	H	M	H	L	-	-	-	M	L	-	H	-	-	-
CLO-5 :	Interpret various approximation algorithms and interpret solutions to evaluate P type, NP Type, NPC, NP Hard problems	3	85	75	H	H	M	H	L	-	-	-	M	L	-	H	-	-	-
CLO-6 :	Create algorithms that are efficient in space and time complexities by using divide conquer, greedy, backtracking technique	3	80	70	L	H	M	H	L	-	-	-	L	L	-	H	-	-	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Introduction-Algorithm Design	Introduction-Divide and Conquer	Introduction-Greedy and Dynamic Programming	Introduction to backtracking - branch and bound	Introduction to randomization and approximation algorithm
	SLO-2	Fundamentals of Algorithms	Maximum Subarray Problem	Examples of problems that can be solved by using greedy and dynamic approach	N queen's problem - backtracking	Randomized hiring problem
S-2	SLO-1	Correctness of algorithm	Binary Search	Huffman coding using greedy approach	Sum of subsets using backtracking	Randomized quick sort
	SLO-2	Time complexity analysis	Complexity of binary search	Comparison of brute force and Huffman method of encoding	Complexity calculation of sum of subsets	Complexity analysis
S-3	SLO-1	Insertion sort-Line count, Operation count	Merge sort	Knapsack problem using greedy approach	Graph introduction	String matching algorithm
	SLO-2	Algorithm Design paradigms	Time complexity analysis	Complexity derivation of knapsack using greedy	Hamiltonian circuit - backtracking	Examples
S 4-5	SLO-1	Lab 1: Simple Algorithm-Insertion sort	Lab 4: Quicksort, Binary search	Lab 7: Huffman coding, knapsack and using greedy	Lab 10: N queen's problem	Lab 13: Randomized quick sort
	SLO-2					
S-6	SLO-1	Designing an algorithm	Quick sort and its Time complexity analysis	Tree traversals	Branch and bound - Knapsack problem	Rabin Karp algorithm for string matching
	SLO-2	And its analysis-Best, Worst and Average case	Best case, Worst case, Average case analysis	Minimum spanning tree - greedy Kruskal's algorithm - greedy	Example and complexity calculation. Differentiate with dynamic and greedy	Example discussion
S-7	SLO-1	Asymptotic notations Based on growth functions.	Strassen's Matrix multiplication and its recurrence relation	Minimum spanning tree - Prims algorithm	Travelling salesman problem using branch and bound	Approximation algorithm
	SLO-2	$O, O, \Theta, \omega, \Omega$	Time complexity analysis of Merge sort	Introduction to dynamic programming	Travelling salesman problem using branch and bound example	Vertex covering

S-8	SLO-1	*Mathematical analysis*	*Largest sub-array sum*	*0/1 knapsack problem*	*Travelling salesman problem using branch and bound example*	*Introduction Complexity classes*
	SLO-2	*Induction, Recurrence relations*	*Time complexity analysis of Largest sub-array sum*	*Complexity calculation of knapsack problem*	*Time complexity calculation with an example*	*P type problems*
S 9-10	SLO-1	*Lab 2: Bubble Sort*	*Lab 5: Strassen Matrix multiplication*	*Lab 8: Various tree traversals, Krukshall's MST*	*Lab 11: Travelling salesman problem*	*Lab 14: String matching algorithms*
	SLO-2					
S-11	SLO-1	*Solution of recurrence relations*	*Master Theorem Proof*	*Matrix chain multiplication using dynamic programming*	*Graph algorithms*	*Introduction to NP type problems*
	SLO-2	*Substitution method*	*Master theorem examples*	*Complexity of matrix chain multiplication*	*Depth first search and Breadth first search*	*Hamiltonian cycle problem*
S-12	SLO-1	*Solution of recurrence relations*	*Finding Maximum and Minimum in an array*	*Longest common subsequence using dynamic programming*	*Shortest path introduction*	*NP complete problem introduction*
	SLO-2	*Recursion tree*	*Time complexity analysis-Examples*	*Explanation of LCS with an example*	*Floyd-Warshall Introduction*	*Satisfiability problem*
S-13	SLO-1	*Solution of recurrence relations*	*Algorithm for finding closest pair problem*	*Optimal binary search tree (OBST)using dynamic programming*	*Floyd-Warshall with sample graph*	*NP hard problems*
	SLO-2	*Examples*	*Convex Hull problem*	*Explanation of OBST with an example.*	*Floyd-Warshall complexity*	*Examples*
S 14-15	SLO-1	*Lab 3: Recurrence Type-Merge sort, Linear search*	*Lab 6: Finding Maximum and Minimum in an array, Convex Hull problem*	*Lab 9: Longest common subsequence*	*Lab 12: BFS and DFS implementation with array*	*Lab 15: Discussion over analyzing a real time problem*
	SLO-2					

Learning Resources	1. *Thomas H Cormen, Charles E Leiserson, Ronald L Revest, Clifford Stein, Introduction to Algorithms, 3rd ed., The MIT Press Cambridge, 2014* 2. *Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2nd ed., Pearson Education, 2006*	3. *Ellis Horowitz, Sartajsahni, Sanguthevar, Rajesekaran, Fundamentals of Computer Algorithms, Galgotia Publication, 2010* 4. *S. Sridhar, Design and Analysis of Algorithms, Oxford University Press, 2015*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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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		3. Mr. V. Sivakumar, SRMIST
		4. Ms. R. Vidhya, SRMIST

Course Code	18CSC205J	Course Name	OPERATING SYSTEMS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Introduce the key role of an Operating system			
CLR-2 :	Insist the Process Management functions of an Operating system			
CLR-3 :	Emphasize the importance of Memory Management concepts of an Operating system			
CLR-4 :	Realize the significance of Device Management part of an Operating system			
CLR-5 :	Comprehend the need of File Management functions of an Operating system			
CLR-6 :	Explore the services offered by the Operating system practically			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 need of an Operating system	1	80	70	H	H	H	H	H	M	L	M	H	M	M	H	H	H	M
CLO-2 :	Know the Process management functions of an Operating system	1	85	75	H	H	H	H	H	M	L	M	H	M	M	H	H	H	M
CLO-3 :	Understand the need of Memory Management functions of an Operating system	1	75	70	H	H	H	H	H	M	L	M	H	M	M	H	H	H	M
CLO-4 :	Find the significance of Device management role of an Operating system	2	85	80	H	H	H	H	H	M	L	M	H	M	M	H	H	H	M
CLO-5 :	Recognize the essentials of File Management part of an Operating system	2	85	75	H	H	H	H	H	M	L	M	H	M	M	H	H	H	M
CLO-6 :	Gain an insight of Importance of an Operating system through practical	3	80	70	H	H	H	H	H	M	L	M	H	M	M	H	H	H	M

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Operating System Objectives and functions	PROCESS SYNCHRONIZATION : Peterson's solution, Synchronization Hardware	MEMORY MANAGEMENT: Memory Management: Logical Vs Physical address space, Swapping	VIRTUAL MEMORY– Background	STORAGE MANAGEMENT : Mass storage structure – Overview of Mass storage structure – Magnetic Disks
	SLO-2	Gaining the role of Operating systems	Understanding the two-process solution and the benefits of the synchronization hardware	Understanding the basics of Memory management	Understanding the need of demand paging	Understanding the Basics in storage management
S-2	SLO-1	The evolution of operating system, Major achievements	Process synchronization: Semaphores, usage, implementation	Contiguous Memory allocation – Fixed and Dynamic partition	VIRTUAL MEMORY – Basic concepts – page fault handling	Disk Scheduling
	SLO-2	Understanding the evolution of Operating systems from early batch processing systems to modern complex systems	Gaining the knowledge of the usage of the semaphores for the Mutual exclusion mechanisms	Getting to know about Partition memory management and issues: Internal fragmentation and external fragmentation problems	Understanding , how an OS handles the page faults	Understanding the various scheduling with respect to the disk
S-3	SLO-1	OS Design considerations for Multiprocessor and Multicore	Classical Problems of synchronization – Readers writers problem, Bounded Buffer problem	Strategies for selecting free holes in Dynamic partition	Performance of Demand paging	FILE SYSTEM INTERFACE: File concept, File access methods
	SLO-2	Understanding the key design issues of Multiprocessor Operating systems and Multicore Operating systems	Good understanding of synchronization mechanisms	Understanding the allocation strategies with examples	Understanding the relationship of effective access time and the page fault rate	Understanding the file basics
S 4-5	SLO-1	LAB 1 : Understanding the booting process of Linux	LAB4 : System admin commands – Basics	LAB7: Shell Programs – Basic level	LAB10 : Overlay concept	LAB13:Process synchronization
	SLO-2					
S-6	SLO-1	PROCESS CONCEPT– Processes, PCB	Classical Problems of synchronization – Dining Philosophers problem (Monitor)	Paged memory management	Copy-on write	File sharing and Protection
	SLO-2	Understanding the Process concept and	Understanding the synchronization of	Understanding the Paging technique.PMT	Understanding the need for Copy-on write	Emphasis the need for the file sharing and

		Maintanance of PCB by OS	*limited resources among multiple processes*	*hardware mechanism*		*its protection*
S-7	SLO-1	*Threads – Overview and its Benefits*	*CPU SCHEDULING : FCFS,SJF,Priority*	*Structure of Page Map Table*	*Page replacement Mechanisms: FIFO, Optimal, LRU and LRU approximation Techniques*	*FILE SYSTEM IMPLEMENTATION : File system structure*
	SLO-2	*Understanding the importance of threads*	*Understanding the scheduling techniques*	*Understanding the components of PMT*	*Understanding the Pros and cons of the page replacement techniques*	*To get the basic file system structure*
S-8	SLO-1	*Process Scheduling : Scheduling Queues, Schedulers, Context switch*	*CPU Scheduling: Round robin, Multilevel queue Scheduling, Multilevel feedback Scheduling*	*Example : Intel 32 bit and 64 –bit Architectures*	*Counting based page replacement and Page Buffering Algorithms*	*Directory Implementation*
	SLO-2	*Understanding basics of Process scheduling*	*Understanding the scheduling techniques*	*Understanding the Paging in the Intel architectures*	*To know on additional Techniques available for page replacement strategies*	*Understanding the various levels of directory structure*
S 9-10	SLO-1	*LAB2 : Understanding the Linux file system*	*LAB5: System admin commands – Simple task automations*	*LAB 8: Process Creation*	*LAB11: IPC using Pipes*	*LAB14 : Study of OS161*
	SLO-2					
S-11	SLO-1	*Operations on Process – Process creation, Process termination*	*Real Time scheduling: Rate Monotonic Scheduling and Deadline Scheduling*	*Example : ARM Architectures*	*Allocation of Frames - Global Vs Local Allocation*	*FILE SYSTEM IMPLEMENTATION :Allocation methods*
	SLO-2	*Understanding the system calls – fork(),wait(),exit()*	*Understanding the real time scheduling*	*Understanding the Paging with respect to ARM*	*Understanding the root cause of the Thrashing*	*Understanding the pros and Cons of various disk allocation methods*
S-12	SLO-1	*Inter Process communication : Shared Memory, Message Passing ,Pipe()*	*DEADLOCKS: Necessary conditions, Resource allocation graph, Deadlock prevention methods*	*Segmented memory management*	*Thrashing, Causes of Thrashing*	*FILE SYSTEM IMPLEMENTATION :Free space Management*
	SLO-2	*Understanding the need for IPC*	*Understanding the deadlock scenario*	*Understanding the users view of memory with respect to the primary memory*	*Understanding the Thrashing*	*Understanding the methods available for maintaining the free spaces in the disk*
S-13	SLO-1	*PROCESS SYNCHRONIZATION: Background, Critical section Problem*	*Deadlocks :Deadlock Avoidance, Detection and Recovery*	*Paged segmentation Technique*	*Working set Model*	*Swap space Management*
	SLO-2	*Understanding the race conditions and the need for the Process synchronization*	*Understanding the deadlock avoidance, detection and recovery mechanisms*	*Understanding the combined scheme for efficient management*	*Understanding the working set model for controlling the Working set Model*	*Understanding the Low-level task of the OS*
S 14-15	SLO-1	*LAB3: Understanding the various Phases of Compilation of a 'C' Program*	*LAB6 : Linux commands*	*LAB9: Overlay concept*	*LAB12: IPC using shared memory and Message queues*	*LAB15 : Understanding the OS161 filesystem and working with test programs*
	SLO-2					

Learning Resources	1. *Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, Operating systems, 9th ed., John Wiley & Sons, 2013* 2. *William Stallings, Operating Systems-Internals and Design Principles, 7th ed., Prentice Hall, 2012*	3. *Andrew S. Tanenbaum, Herbert Bos, Modern Operating systems, 4th ed., Pearson, 2015* 4. *Bryant O'Hallaxn, Computer systems- A Programmer's Perspective, Pearson, 2015*

Learning Assessment

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts	
1. Mr. Balamurugan, Infosys, balams@gmail.com	*1. Dr. Latha Parthiban, Pondicherry University, lathaparthiban@yahoo.com*	*1. Dr.G.Maragatham, SRMIST*	*3. Ms. Aruna S, SRMIST*
		2. Mr. Eliazer M, SRMIST	

Course Code	18CSC206J	Course Name	SOFTWARE ENGINEERING AND PROJECT MANAGEMENT	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Familiarize the software life cycle models and software development process
CLR-2 :	Understand the various techniques for requirements, planning and managing a technology project
CLR-3 :	Examine basic methodologies for software design, development, testing, closure and implementation
CLR-4 :	Understand manage users expectations and the software development team
CLR-5 :	Acquire the latest industry knowledge, tools and comply to the latest global standards for project management

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLO-1 :	Identify the process of project life cycle model and process	1	85	80
CLO-2 :	Analyze and specify software requirements through a productive working Relationship with project stakeholders	2	80	75
CLO-3 :	Design the system based on Functional Oriented and Object Oriented Approach for Software Design.	3	85	85
CLO-4 :	Develop the correct and robust code for the software products	3	85	85
CLO-5 :	Perform by applying the test plan and various testing techniques	2	85	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
H	H	L	-	-	-	L	-	H	H	M	M	-	-	-
H	H	H	H	H	-	M	-	H	H	H-	M	-	-	-
H	H	M	H	H	M	M	L	H	H	M	-	-	-	-
H	H	H	-	H	-	-	M	H	M	H	-	-	-	-
H	M	M	M	M	M	M	-	H	H	-	M	-	-	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Introduction to Software Engineering	Software Design - Software Design Fundamentals	Software Construction	Introduction to testing	Product Release
	SLO-2	Software Project Management - life cycle activities	Design Standards - Design Type	Coding Standards	Verification	Product Release
S-2	SLO-1	Traditional – Waterfall, V Model	Design model – Architectural design, Software architecture	Coding Framework	Validation	Product Release Management
	SLO-2	Prototype, Spiral, RAD	Software Design Methods	Reviews - Desk checks (Peer Reviews)	Test Strategy	Product Release Management
S-3	SLO-1	Conventional – Agile,	Top Down , Bottom Up	Walkthroughs	Planning	Implementation
	SLO-2	XP, Scrum	Module Division (Refactoring)	Code Reviews, Inspections	Example: Test Strategy and Planning	Implementation
S 4-5	SLO-1	Lab1:Identify the Software Project, Create Business Case, Arrive at a Problem Statement	Lab 4:Prepare Project Plan based on scope, Find Job roles and responsibilities, Calculate Project effort based on resources	Lab 7:State and Sequence Diagram, Deployment Diagram, Sample Frontend Design (UI/UX)	Lab 10: Module Implementation (Phase 2), Scrum Master to Induce New Issues in Agile Development	Lab 13:Manual Testing
	SLO-2					
S-6	SLO-1	Introduction to Requirement Engineering	Module Coupling	Coding Methods	Test Project Monitoring and Control	User Training
	SLO-2	Requirements Elicitation	Component level design	Structured Programming	Test Project Monitoring and Control	Maintenance Introduction
S-7	SLO-1	Software Project Effort and cost estimation	User Interface Design	Object-Oriented Programming	Test Project Monitoring and Control	Maintenance Types - Corrective
	SLO-2	Cost estimation	Pattern oriented design	Automatic Code Generation	Test Project Monitoring and Control	Adaptive
S-8	SLO-1	Cocomo 1 and 2	Web application design	Automatic Code Generation	Test Project Monitoring and Control	Perfective
	SLO-2	Cocomo 1 and 2	Web application design	Automatic Code Generation	Test Project Monitoring and Control	Preventive
S 9-10	SLO-1	Lab 2:Stakeholder and User Description, Identify the appropriate Process Model, Comparative study with Agile Model	Lab 5:Prepare the Work, Breakdown Structure based on timelines, Risk Identification and Plan	Lab 8:Module Description, Module Implementation (phase 1) Using Agile	Lab 11:Module Implementation (Phase 3) Scrum Master to Induce New requirements in Agile Development, Scrum Master to Induce New Issues in Agile Development, Code Documentation	Lab 14:User Manual, Analysis of Costing, Effort and Resources
	SLO-2					

S-11	SLO-1	*Risk Management*	*Design Reuse*	*Software Code Reuse*	*Design –Master test plan, types*	*Maintenance Cost*
	SLO-2	*Risk Management*	*Design Reuse*	*Software Code Reuse*	*Design –Master test plan, types*	*Maintenance Process*
S-12	SLO-1	*Configuration management*	*Concurrent Engineering in Software Design*	*Pair Programming*	*Test Case Management*	*life cycle*
	SLO-2	*Configuration management*	*Concurrent Engineering in Software Design*	*Test-Driven Development*	*Test Case Management*	*Software Release*
S-13	SLO-1	*Project Planning – WBC, planning,*	*Design Life-Cycle Management*	*Configuration Management*	*Test Case Reporting*	*Software Maintenance*
	SLO-2	*scope, risk*	*Design Life-Cycle Management*	*Software Construction Artifacts*	*Test Case Reporting*	*Software Release, Software Maintenance*
S 14-15	SLO-1	*Lab 3:Identify the Requirements, System Requirements, Functional Requirements, Non-Functional Requirements*	*Lab 6:Design a System Architecture, Use Case Diagram, ER Diagram (Database), DFD Diagram (process) (Upto Level 1), Class Diagram (Applied For OOPS based Project), Collaboration Diagram (Applied For OOPS based Project) (Software – Rational Rose)*	*Lab 9:Module Implementation, Scrum Master to Induce New requirements in Agile Development*	*Lab 12:Master Test Plan, Test Case Design (Phase 1)*	*Lab 15: Project Demo and Report Submission with the team*
	SLO-2					

Learning Resources	1. *Roger S. Pressman, Software Engineering – A Practitioner Approach, 6th ed., McGraw Hill, 2005* 2. *Ian Sommerville, Software Engineering, 8th ed., Pearson Education, 2010* 3. *Rajib Mall, Fundamentals of Software Engineering, 4th ed., PHI Learning Private Limited, 2014* 4. *Ramesh, Gopalaswamy, Managing Global Projects, Tata McGraw Hill, 2005*	5. *Ashfaque Ahmed, Software Project Management: a process-driven approach, Boca Raton, Fla: CRC Press, 2012* 6. *Walker Royce, Software Project Management, Pearson Education, 1999* 7. *Jim Smith Agile Project Management: Creating Innovative Products,Pearson 2008*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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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		3. Mr.N.Arivazhagan, SRMIST
		4. Mrs K.R.Jansi, SRMIST

Course Code	18CSC207J	Course Name	ADVANCED PROGRAMMING PRACTICE	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18CSC202J	Co-requisite Courses	18CSC204J	Progressive Courses	Nil
Course Offering Department	Computer Science and Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Create Real-time Application Programs using structured, procedural and object oriented programming paradigms			
CLR-2 :	Create Real-time Application Programs using event driven, declarative and imperative programming paradigms			
CLR-3 :	Create Real-time Application Programs using parallel, concurrent and functional programming paradigms			
CLR-4 :	Create Real-time Application Programs using logic, dependent type and network programming paradigms			
CLR-5 :	Create Real-time Application Programs using symbolic, automata based and graphical user interface program paradigm			
CLR-6 :	Create Real-time Application Programs using different programming paradigms using python language			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 :	Create Programs using structured, procedural and object oriented programming paradigms	3	85	80	H	H	H	H	H	-	-	L	M	M	L	M	-	M	-
CLO-2 :	Create Programs using event driven, declarative and imperative programming paradigms	3	85	80	H	H	H	H	H	-	-	L	M	M	L	M	-	-	-
CLO-3 :	Create Programs using parallel, concurrent and functional programming paradigms	3	85	80	H	H	H	H	H	-	-	L	M	M	L	M	-	-	-
CLO-4 :	Create Programs using logic, dependent type and network programming paradigms	3	85	80	H	H	H	H	H	-	-	L	M	M	L	M	-	-	-
CLO-5 :	Create Programs using symbolic, automata based and graphical user interface programming paradigms	3	85	80	H	H	H	H	H	-	-	L	M	M	L	M	-	-	-
CLO-6 :	Create Programs using different programming paradigms using python language	3	85	80	H	H	H	H	H	-	-	L	M	M	L	M	-	-	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Structured Programming Paradigm	Event Driven Programming Paradigm	Parallel Programming Paradigm	Logic Programming Paradigm	Symbolic Programming Paradigm
	SLO-2	Programming Language Theory	Event Object, handler, bind	Multi-threading, Multi-Processing	First-class function, Higher-order function, Pure functions, Recursion	Symbolic Maths, algebraic manipulations, limits, differentiation, integration, series
S-2	SLO-1	Bohm-Jacopini structured program theorem	Keypress events, Mouse events	Serial Processing, Parallel Processing	Packages: Kanren, SymPy	SymPy usage for symbolic maths
	SLO-2	Sequence, selection, decision, iteration, recursion	Automatic events from a timer	Multiprocessing module in Python	PySWIP, PyDatalog	Equation Solving, Matrices
S-3	SLO-1	Other languages: C, C++, Java, C#, Ruby	Other languages: Algol, Javascript, Elm	Process class, Pool class	Other languages: Prolog, ROOP, Janus	Other languages: Aurora, LISP, Wolfram
	SLO-2	Demo: Structured Programing in Python	Demo: Event Driven Programming in Python	Demo: Parallel Programming in Python	Demo: Logic Programming in Python	Demo: Symbolic Programming in Python
S 4-5	SLO-1	Lab 1: Structured Programming	Lab 4: Event Driven Programming	Lab 7: Parallel Programming	Lab 10: Logic Programming	Lab 13: Symbolic Programming
	SLO-2					
S-6	SLO-1	Procedural Programming Paradigm	Declarative Programming Paradigm	Concurrent Programming Paradigm	Dependent Type Programming Paradigm	Automata Based Programming Paradigm
	SLO-2	Routines, Subroutines, functions	Sets of declarative statements	Parallel Vs Concurrent Programming	Logic Quantifier: for all, there exists	Finite State Machine, deterministic finite automation (dfa), nfa
S-7	SLO-1	Using Functions in Python	Object attribute, Binding behavior	threading, multiprocessing	Dependent functions, dependent pairs	State transitions using python-automaton
	SLO-2	logical view, control flow of procedural programming in various aspects	Creating Events without describing flow	concurrent.futures, gevent, greenlets, celery	Relation between data and its computation	Initial state, destination state, event (transition)
S-8	SLO-1	Other languages: Bliss, ChucK, Matlab	Other languages: Prolog, Z3, LINQ, SQL	Other languages: ANI, Plaid	Other Languages: Idris, Agda, Coq	Other languages: Forth, Ragel, SCXML
	SLO-2	Demo: creating routines and subroutines using functions in Python	Demo: Declarative Programming in Python	Demo: Concurrent Programming in Python	Demo: Dependent Type Programming in Python	Demo: Automata Based Programming in Python

S 9-10	SLO-1 SLO-2	*Lab 2: Procedural Programming*	*Lab 5: Declarative Programming*	*Lab 8: Concurrent Programming*	*Lab 11: Dependent Type Programming*	*Lab 14: Automata Programming*
S-11	SLO-1	*Object Oriented Programming Paradigm*	*Imperative Programming Paradigm*	*Functional Programming Paradigm*	*Network Programming Paradigm*	*GUI Programming Paradigm*
	SLO-2	*Class, Objects, Instances, Methods*	*Program State, Instructions to change the program state*	*Sequence of Commands*	*Socket Programming: TCP & UDP Connection oriented, connectionless*	*Graphical User Interface (GUI)*
S-12	SLO-1	*Encapsulation, Data Abstraction*	*Combining Algorithms and Data Structures*	*map(), reduce(), filter(), lambda*	*Sock_Stream, Sock_Dgram, socket(), bind(), recvfrom(), sendto(), listen()*	*Tkinter, WxPython, JPython*
	SLO-2	*Polymorphism, Inheritance*	*Imperative Vs Declarative Programming*	*partial, functools*	*Server-Client; send(), recv(), connect(), accept(), read(), write(), close()*	*WxWidgets, PyQT5*
S-13	SLO-1	*Constructor, Destructor*	*Other languages: PHP, Ruby, Perl, Swift*	*Other languages: F#, Clojure, Haskell*	*Other languages: PowerShell, Bash, TCL*	*Other languages: GTK, java-gnome*
	SLO-2	*Example Languages: BETA, Cecil, Lava Demo: OOP in Python*	*Demo: Imperative Programming in Python*	*Demo: Functional Programming in Python*	*Demo: Socket Programming in Python*	*Demo: GUI Programming in Python*
S 14-15	SLO-1 SLO-2	*Lab 3: Object Oriented Programming*	*Lab 6: Imperative Programming*	*Lab 9: Functional Programming*	*Lab 12: Network Programming*	*Lab 15: GUI Programming*

Learning Resources	1. *Elad Shalom, A Review of Programming Paradigms throughout the History: With a suggestion Toward a Future Approach, Kindle Edition, 2018* 2. *John Goerzen, Brandon Rhodes, Foundations of Python Network Programming: The comprehensive guide to building network applications with Python, 2nd ed., Kindle Edition, 2010* 3. *Elliot Forbes, Learning Concurrency in Python: Build highly efficient, robust and concurrent applications, Kindle Edition, 2017*	4. *Amit Saha, Doing Math with Python: Use Programming to Explore Algebra, Statistics, Calculus and More, Kindle Edition, 2015* 5. *Alan D Moore, Python GUI Programming with Tkinter: Develop responsive and powerful GUI applications with Tkinter, Kindle Edition, 2018* 6. *https://www.scipy-lectures.org/*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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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		3. Ms. K. Sornalakshmi, SRMIST
		4. Mr. C. Arun, SRMIST

ACADEMIC CURRICULA

Professional Core Courses

ELECTRICAL & ELECTRONICS ENGINEERING

Regulations - 2018

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

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

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

Kattankulathur, Kancheepuram, Tamil Nadu, India

Course Code	18EEC201J	Course Name	ANALYSIS OF ELECTRIC CIRCUITS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18EES101J	Co-requisite Courses		Progressive Courses	
Course Offering Department	Electrical and Electronics Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Analyze real-time circuits using mesh and nodal analysis and network reduction			
CLR-2 :	Utilize solutions of AC circuits including series and parallel resonance			
CLR-3 :	Utilize network theorems on DC & AC circuits			
CLR-4 :	Examine circuits at transient condition			
CLR-5 :	Solve 3 phase circuits, coupled and tuned circuits			
CLR-6 :	Enrich the concepts of AC and DC circuits using different analysis			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 circuit parameters, analyze circuits using mesh and nodal analysis and network reduction	3	75	75	H	H	-	-	-	-	-	-	M	M	-	-	M	M	-
CLO-2 :	Evaluate solution methods of AC circuits including series and parallel resonance	3	75	75	H	H	-	-	M	-	-	-	M	M	-	-	M	M	-
CLO-3 :	Calculate solutions of network theorems for DC and AC circuits	3	75	75	H	H	-	-	-	-	-	-	M	M	-	-	M	M	-
CLO-4 :	Analyze the transients of RLC circuits	3	75	75	H	H	M	-	M	-	-	-	M	M	-	-	M	M	-
CLO-5 :	Analyze 3 phase circuits, coupled, tuned circuits and two port networks.	3	75	75	H	H	M	-	-	-	-	-	M	M	-	-	M	M	-
CLO-6 :	Evaluate AC and DC circuits under different cases	3	75	75	H	H	M	-	M	-	-	-	M	M	-	-	M	M	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Introduction to two terminal circuit passive elements	Introduction to AC circuits	Superposition theorem in DC circuits	Introduction: Exponentially increasing functions	Analysis of balanced three-phase 3 wire circuits
	SLO-2	Characteristics of two terminal circuit passive elements	Phasors	Problems in Superposition theorem in DC circuits	Exponentially Decreasing functions	Problems in balanced three-phase 3 wire circuits
S-2	SLO-1	Circuit Reduction Techniques	Impedance	Superposition theorem in AC circuits	RL free circuits	Analysis of unbalanced three-phase circuits
	SLO-2	Problems in Circuit Reduction Techniques	Admittance	Problems in Superposition theorem in AC circuits	RL Driven circuits	Problems in unbalanced three-phase circuits
S-3	SLO-1	Combination of Sources	Calculation of Power and Power Factor	Reciprocity theorems in AC circuits	Transients in RL circuit with DC excitation	Two-wattmeter method of measuring three-phase power
	SLO-2	Source Transformation	Problems in Power and Power Factor	Problems in Reciprocity theorems in AC circuits	Transients in RL circuit with AC excitation	Problems in Two-wattmeter method of measuring three-phase power
S 4-5	SLO-1	Lab 1: Circuit reduction and basic laws	Lab 4: Determine Power and Power Factor	Lab 7: Verify Superposition and Reciprocity Theorems	Lab 10: Analyze Time domain of RL transient circuit	Lab 13: Measure power in 3 phase circuits using two wattmeter method
	SLO-2					
S-6	SLO-1	Mesh current analysis of DC circuits with dependent sources	Steady state analysis of RL circuits	Thevenin's theorem in DC circuits	RC free circuits	Analysis of coupled circuits
	SLO-2	Problems in Mesh current analysis of DC circuits with dependent sources	Steady state analysis of RC circuits	Norton theorem in DC circuits	RC driven circuits	Problems in coupled circuits
S-7	SLO-1	Mesh analysis in DC circuits with current sources	Steady state analysis of RLC circuits	Thevenin's theorem in AC circuits	Transients in RC circuit with DC excitation	Analysis of tuned circuits
	SLO-2	Problems in Mesh analysis in DC circuits with current sources	Phasor diagram of RLC circuits	Problems in Thevenin's theorem in AC circuits	Transients in RC circuit with AC excitation	Problems in tuned circuits
S-8	SLO-1	Nodal Voltage analysis of DC circuits with dependent sources	Series resonance circuits	Norton's theorem in AC circuits	Laplace transforms	Introduction to Two port networks

	SLO-2	*Problems in Nodal Voltage analysis of DC circuits with dependent sources*	*Problems in Series resonance circuits*	*Problems in Norton's theorem in AC circuits*	*Transform impedance*	*Analysis of Two port networks*
S 9-10	SLO-1	*Lab 2: Mesh analysis in DC circuits*	*Lab 5: Real time Data Acquisition*	*Lab 8: Verify Thevenin's and Norton's theorems*	*Lab 11: Analyze Time domain of RC transient circuit*	*Lab 14: Analysis in tuned circuits*
	SLO-2					
S-11	SLO-1	*Supermesh method for mesh analysis*	*Parallel resonance circuits*	*Millman's theorem in AC circuits*	*Transients in RLC circuit with DC excitation*	*Impedance parameters*
	SLO-2	*Problems in Supermesh method for mesh analysis*	*Problems in Parallel resonance circuits*	*Problems in Millman's theorem in AC circuits*	*Problems in Transients in RLC circuit with DC excitation*	*Problems in impedance parameters*
S-12	SLO-1	*Nodal analysis in DC circuits with voltage sources*	*Mesh analysis in AC circuits*	*Maximum Power Transfer Theorem in DC circuits*	*Transients in RLC circuit with AC excitation*	*Admittance parameters*
	SLO-2	*Problems in Nodal analysis in DC circuits with voltage sources*	*Problems in Mesh analysis in AC circuits*	*Problems in Maximum Power Transfer Theorem in DC circuits*	*Problems in Transients in RLC circuit with AC excitation*	*Problems in admittance parameters*
S-13	SLO-1	*Supernodal method for nodal analysis*	*Nodal analysis in AC circuits*	*Maximum Power Transfer Theorem in AC circuits*	*Circuit transients using Laplace transform*	*Hybrid parameters*
	SLO-2	*Problems in Supernodal analysis*	*Problems in Nodal analysis in AC circuits*	*Problems in Maximum Power Transfer Theorem in AC circuits*	*Problems in Circuit transients using Laplace transform*	*Inverse Hybrid parameters*
S 14-15	SLO-1	*Lab 3: Nodal analysis in DC circuits*	*Lab 6: Study of series and parallel resonance circuits*	*Lab 9: Verify maximum power transfer theorem*	*Lab 12: Analyze Time domain of RLC transient circuits*	*Lab 15: Determine hybrid parameters*
	SLO-2					

Learning Resources	1. *Sudhakar A, Shyam Mohan S.P, Circuits and Networks Analysis and Synthesis, 4th ed., Tata McGraw Hill, 2010* 2. *William H. Hayt, Jack E. Kemmerly, Steven M. Durbin, Engineering circuit analysis, 8th ed., McGraw Hill, 2012* 3. *Jegatheesan R, Analysis of Electric Circuits, McGraw Hill, 2014*	4. *John Bird, Electric circuit theory and technology, 5th ed., Taylor and Francis, 2013* 5. *https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-071j-introduction-to-electronics-signals-and-measurement-spring-2006/lecture-notes/*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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 . Roosefart Mohan, Nelcast Limited, chennai,roosefart@gmail.com	*1. Dr. D. Devaraj, Kalasalingam Academy of Research and Education, deva230@yahoo.com*	*1. Dr. R. Jegatheesan, SRMIST*
2.Mr. Muralikrishna, National Instruments, emkkrishnan@gmail.com	*2. Dr. B. ChittiBabu, IIITD, Kanchipuram, chittibabu@gmail.com*	*2. Dr. J. Preetha Roselyn, SRMIST*

Course Code	18EEC202T	Course Name	ELECTROMAGNETIC THEORY	Course Category	C	Professional Core	L	T	P	C
							3	1	0	4

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Utilize the concepts of Electromagnetic theory for practical applications
CLR-2 :	Utilize knowledge about the static electric field and its applications.
CLR-3 :	Utilize knowledge on static magnetic field
CLR-4 :	Utilize parameters involved in time varying field and Maxwell's equations
CLR-5 :	Enrich in the field of Electromagnetic waves
CLR-6 :	Create a mindset to solve various engineering problems in the field of electromagnetism

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 basic laws of electromagnetics and coordinate systems	2	80	75	M	M	-	-	-	-	-	-	M	M	-	-	M	M	-
CLO-2 :	Solve the Electric field parameters for simple configuration under static condition	3	80	75	H	H	M	L	-	-	-	-	M	M	-	-	M	M	-
CLO-3 :	Examine the Magnetic field for simple configuration under static condition	3	80	75	H	H	M	L	-	-	-	-	M	M	-	-	M	M	-
CLO-4 :	Extend the basics of electromagnetic theory on time varying electric and magnetic field	3	80	75	H	H	M	L	M	-	-	-	M	M	-	-	M	M	-
CLO-5 :	Analyze propagation of electromagnetic waves	3	80	75	H	H	M	L	-	-	-	-	M	M	-	-	M	M	-
CLO-6 :	Apply electromagnetic concepts to solve real time problems	3	75	75	H	H	M	L	M	-	-	-	M	M	-	-	M	M	-

Duration (hour)		12	12	12	12	12
S-1	SLO-1	Vector analysis for three-dimensional Euclidean space	Current density, Ohms Law in point form	Fundamentals of Magnetostatics (B, H)	Faraday's law of Electromagnetic induction	Wave parameters- velocity, intrinsic impedance- propagation constants
	SLO-2	Stokes and Divergence theorem	Continuity of current equation	Magnetic field due to straight conductor	Motional and transformer EMF	Uniform plane waves
S-2	SLO-1	Three orthogonal coordinate systems –Cartesian system	Boundary conditions of perfect dielectric materials	B and H for a circular loop	Displacement current and conduction current	Electromagnetic Wave equation for free space,
	SLO-2	Cylindrical and spherical coordinate system	Boundary condition between conductor and dielectric, conductor and free space.	Magnetic field due to infinite sheet of current.	Point form of Maxwell's equation, Integral form of Maxwell's equations	Equation for lossy dielectric medium
S-3	SLO-1	Conversion from one coordinate to another coordinate system	Permittivity of dielectric materials	Magnetic materials, permeability	Phasor representation of time harmonic field	Wave equation for lossless dielectrics and conductors
	SLO-2	Solutions of Coulomb's law	Dielectric strength and dielectric polarization	Magnetic dipole	Energy in quasi-stationary Electromagnetic Fields	Skin effect and skin depth calculations
S-4	SLO-1	Tutorial: Quantitative analysis of coordinate system	Tutorial: Quantitative analysis of boundary condition problem	Tutorial: Quantitative analysis of B and H calculations	Tutorial: Quantitative analysis of Maxwell's Equation	Tutorial: Quantitative analysis of Electromagnetic Wave Equation
	SLO-2					
S-5	SLO-1	Fundamentals of electrostatics	Capacitance of a two-wire line.	Magnetization and Magnetic susceptibility	Magnetic Potential	Standing wave
	SLO-2	Electric field intensity (E) andflux density (D) due to point, line and surface charge	Solution of Laplace and Poisson's equation	Magnetic field in multiple media – Boundary conditions	Potential for time varying fields	Plane wave reflection and refraction
S-6	SLO-1	D and E for volume charge distribution	Applications of Laplace and Poisson's equation	Magnetic potential – Scalar and Vector potential. Magnetic diffusion	MagNet software	The incidence of plane wave at the boundary between two regions
	SLO-2	Electric field due to dipole	Uniqueness theorem	Magnetic force and stress tensor	MagNet software for 3D electromagnetic field simulations	Fresenel's coefficient
S-7	SLO-1	Applications of Gauss law's	Duality theorem	Inductance calculation for a solenoid and toroid	Case study on real time applications of Maxwell's equations	Goos-Hanchen's effect

	SLO-2	*Electric Potential and its calculation for different configurations*	*Method of images*	*Inductance of a coaxial cable*	*Problems on time varying field*	*Snell's law*
S-8	SLO-1	*Tutorial: Quantitative analysis forD, E and potential calculation*	*Tutorial: Quantitative analysis of capacitance calculations and Laplace equations*	*Tutorial: Quantitative analysis of magnetic boundary conditions*	*Tutorial: Quantitative analysis of Poynting vectors and magnetic potential*	*Tutorial: Quantitative analysis of Electromagnetic boundary conditions*
	SLO-2					
S-9	SLO-1	*Force on a moving charge and differential current element*	*Sketches of fields and field plotting.*	*Inductance derivation for two wire transmission line*	*Case study of Parallel Particle Tracing for Steady-State and Time-Varying Flow Fields*	*Reflection coefficient*
	SLO-2	*Magnetic field and induced emf in rotating machines*	*Finite difference method (FDM)*	*Problems on Inductance calculations*	*Applications of Poynting theorem*	*Transmission coefficient*
S-10	SLO-1	*Mutipole concept*	*FDM to a solution of region and boundary conditions*	*Energy density in magnetic field*	*Electromagnetic Wave Equations*	*Quantitative analysis of wave parameters*
	SLO-2	*Multipole of electrostatic expansion*	*Quantitative analysis of FDM*	*The finite element analysis- an introduction*	*Solutions of Helmholtz's equation*	*Brewster angle*
S-11	SLO-1	*Quadrupole and octupole*	*Method of moment for Electrostatic field*	*Finite element method (FEM) for magnetostatic field*	*Prototype using the concept of EM theory*	*Critical angle*
	SLO-2	*Example for multipole expansion*	*Case study on dust cloud ignition caused by static electricity*	*Case study on super conducting disk in an external magnetic field.*	*Minor Project presentation*	*Case study on fault calculations using EM wave equations*
S-12	SLO-1	*Tutorial: quantitative analysis of force, current and torque*	*Tutorial: Quantitative analysis of Electrostatic field calculations*	*Tutorial: quantitative analysis of magnetostatic field*	*Tutorial: quantitative analysis of electromagnetic field*	*Tutorial: Quantitative analysis of EM wave coefficients*
	SLO-2					

Learning Resources	1. *William Hayt, Engineering Electromagnetics, 7th ed., McGraw Hill, 2014* 2. *Matthew. N.O. Sadiku, Elements of Electromagnetics, 4th ed., Oxford University Press, 2010* 3. *David J. Griffths, Introduction to Electrodynamics, 4th ed., Pearson publication, 2013*	4. *Joseph A Edminister, Theory and Problem of Electromagnetics, Schaum's outline series McGraw Hill, 2006* 5. *https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-632-electromagnetic-wave-theory-spring-2003/index.htm*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. Paramasivam, Danfoss, Industries Pvt Ltd, paramsathya@yahoo.com	*1. Dr. K. S. Swarup, IIT Madras, ksswarup@iitm.ac.in*	*1. Mrs. R. Rajarajeswari, SRMIST*
2. Mr.J. Sasikumar,Philips India Limited, Chennai	*2. Dr. A. Venkadesan, NIT, Pondicherry, venkadesan@nitpy.ac.in*	*2. Mrs. D. Anitha, SRMIST*

Course Code	18EEC203J	Course Name	DIGITAL SYSTEM DESIGN	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18EES101J	Co-requisite Courses		Progressive Courses	
Course Offering Department	Electrical and Electronics Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Utilize digital systems			
CLR-2 :	Utilize combinational logic circuits			
CLR-3 :	Design and implement sequential logic circuits			
CLR-4 :	Implement different logic functions using transistor and MOSFET			
CLR-5 :	Analyze the types of PLD's and VHDL programming			
CLR-6 :	Analyze and design digital logic circuits			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 :	Simplify Boolean expression	2	75	75	H	M	M	M	-	-	-	-	M	M	-	-	L	M	-
CLO-2 :	Solve problems in combinational logic circuits	3	75	75	H	M	M	M	-	-	-	-	M	M	-	-	L	M	-
CLO-3 :	Construct sequential circuits for given requirement and verify them in laboratory	3	75	75	H	M	M	M	-	-	-	-	M	M	-	-	L	M	-
CLO-4 :	Analyze IC characteristics operation of logic gates and their families	2	75	75	H	M	L	L	-	-	-	-	M	M	-	-	L	M	-
CLO-5 :	Implement digital circuit using PLA, PAL, PROM. Write programs using VHDL	3	75	75	H	L	L	L	L	-	-	-	M	M	-	-	M	M	-
CLO-6 :	Apply the concepts of digital systems and experimentally validate them	3	75	75	H	M	M	M	L	-	-	-	M	M	-	-	L	M	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Minterms, Canonical SOP form	Binary multiplier	Introduction to latches/Flip flop	Introduction to asynchronous sequential circuit	Memory organization and operation
	SLO-2	Simplification of switching function using K maps-SOP method	Binary divider	Flip flop: SR flip flop	Steps involved in design of asynchronous sequential circuit	Classification of memories ROM, PROM, EPROM, RAM
S-2	SLO-1	Simplification of Incompletely specified function using K maps- SOP method	Arithmetic logic unit (ALU)	Flip flops: D flip flop	Merger graph	Content addressable memory, Charge decoupled device memory
	SLO-2	Simplification of switching function with Don't care using K maps-SOP method	Elementary ALU design	Flip flops: JK & T flip flops	Problems in design of asynchronous sequential circuit	Commonly used memory chips
S-3	SLO-1	Maxterms, Canonical POS form	Multiplexer	Realization of D, JK, T flip flops using SR flip flops	Cycles	Programmable Logic Array(PLA)
	SLO-2	Simplification of switching function using K maps-POS method	Implementation of Boolean expression using multiplexer	Realization of D flip flop using T flip flop, Realization of T flip flop using D flip flop, Realization of JK flip flops using D flip flop	Critical and non-critical Races, Hazards	Implementation of Boolean function using PLA
S 4-5	SLO-1	Lab 1: Simplification of switching function using K maps and implementation using logic gates	Lab 4: Realization of MUX, Realization of Boolean expression using MUX	Lab 7: Realization of one flip flop using another flip flop	Lab 10: Design and implementation of Hazard free circuit	Lab 13: Realize Boolean algebra using PLA
	SLO-2					
S-6	SLO-1	Quine-McCluskey method for 4 variable problem	Demultiplexer	Design of synchronous sequential circuits-Moore Model using D flip flop	Problems in design of asynchronous sequential circuit including races	Programmable Array Logic (PAL)
	SLO-2	Quine-McCluskey method for4 variable problem with Don't care	Implementation of Boolean expression using demultiplexer	Design of synchronous sequential circuits-Moore Model using JK flip flop	Analysis of asynchronous sequential circuits	Implementation of Boolean function using PAL
S-7	SLO-1	Quine-McCluskey method for5 variable problem	Decoders,	Design of synchronous sequential circuits-Moore Model using T flip flop	Analysis of asynchronous sequential machines with latches	Complex programmable logic device (CPLD), FPGA
	SLO-2	Quine-McCluskey method for5 variable problem with Don't care	BCD to 7 segment decoders, drivers for display devices	Design of synchronous sequential circuits-Mealy Model using D flip flop	Asynchronous up Counters, Asynchronous down Counters design	Introduction to VHDL programming

S-8	SLO-1	*Adder: Half adder, Full adder*	*Encoder*	*Design of synchronous sequential circuits- Mealy Model using JK flip flop*	*Design of asynchronous up/down counter*	*VHDL design flow*
	SLO-2	*Subtractor: Half subtractor, Full subtractor*	*Priority encoder*	*Design of synchronous sequential circuits- Mealy Model using T flip flop*	*Design of asynchronous MOD-n Counter*	*VHDL types and operators*
S 9-10	SLO-1	*Lab 2: Realization of combinational circuits: Half adder, Full adder, Half subtractor, Full subtractor*	*Lab 5: Design of BCD to 7 segment decoders*	*Lab 8: Design and implementation of synchronous sequential circuits*	*Lab 11: Design of asynchronous Counters*	*Lab 14: Verification of gates using FPGA*
	SLO-2					
S-11	SLO-1	*Parallel binary adder and parallel binary subtractor*	*Parity generator*	*Analysis of synchronous sequential circuits using D,T flip flops*	*Digital logic families: Characteristics of Digital logic families*	*Structural and Behavioral Modelling*
	SLO-2	*Parallel adder/subtractor*	*Parity checker*	*Analysis of synchronous sequential circuits using JK flip flop*	*TTL Logic, Schottky TTL Logic, CMOS Logic*	*Data flow Modelling*
S-12	SLO-1	*Carry look ahead adder*	*Code Converter: Binary to Grey*	*Synchronous counters: up, down, up-down counters*	*ECL logic*	*Packages, subroutines*
	SLO-2	*BCD adder*	*Code Converter: Grey to Binary*	*MOD-n, Random counters*	*Interfacing CMOS with TTL*	*Test bench*
S-13	SLO-1	*Magnitude Comparator for 1,2-bit Comparator*	*Code Converter: BCD to Excess 3*	*Shift registers, Serial to parallel converter, Parallel to serial converter, Universal shift register*	*Tristate logic*	*Simple VHDL program: Combinational logic circuits*
	SLO-2	*Magnitude Comparator for 4-bit Comparator*	*Code Converter: Excess 3 to BCD*	*Ring counter, Johnson counter*	*Comparison between various logic circuits*	*Simple VHDL program: counters*
S 14-15	SLO-1	*Lab 3: Realization of BCD adder and 2-bit Magnitude Comparator*	*Lab 6: Realization of Code Converters*	*Lab 9: Design of Synchronous Counters, Design of shift registers and ring counters*	*Lab 12: Mini Project Presentation: Realization of digital control circuits*	*Lab 15: Verification of Combinational logic circuits using FPGA*
	SLO-2					

Learning Resources	1. *M. Morris Mano, Michael D. Ciletti, Digital Design: With an Introduction to Verilog HDL, VHDL and System Verilog, 6th ed., Pearson, 2018* 2. *Thomas L.Floyd, Digital Fundamentals, 11th ed., Pearson India, 2014*	3. *Charles H. Roth, Lizy K. John, Digital System Design Using VHDL, 2nd ed., Cengage learning, 2012* 4. *https://ocw.mit.edu/courses/electrical-engineering-and-computer-science*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (100% weightage)								Final Examination	
		CLA – 1 (20%)		CLA – 2 (30%)		CLA – 3 (30%)		CLA – 4 (20%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. Roosefart Mohan, Nelcast Limited, Chennai, roosefart@gmail.com	*1. Dr. D. Devaraj, Kalasalingam Academy of Research and Education, deva230@yahoo.com*	*1. Dr. C. S. Boopathi, SRMIST*
2. Mr. Muralikrishna, National Instruments, emkkrishnan@gmail.com	*2. Dr. B. ChittiBabu, IIITD, Kanchipuram, chittibabu@gmail.com*	*2. Ms. D. Anitha, SRMIST*

Course Code	18EEC204J	Course Name	ELECTRICAL MACHINES I	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18EES101J	Co-requisite Courses		Progressive Courses	
Course Offering Department	Electrical and Electronics Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Analyze the characteristics of different types of DC generators			
CLR-2 :	Identify the working, starting and speed control of DC motors			
CLR-3 :	Analyze transformers and derive its equivalent circuit			
CLR-4 :	Test DC machines and transformers as per standard practice			
CLR-5 :	Model DC machines			
CLR-6 :	Analyze the performance of the DC machine and transformer			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	Analyze the principle and fundamentals of DC generator	2	75	75	H	L	-	-	-	-	-	-	M	M	-	-	M	M	-
CLO-2 :	Analyze the principle and fundamentals of DC motor	2	75	75	H	L	-	-	-	-	-	-	M	M	-	-	M	M	-
CLO-3 :	Identify the different types of transformers and analyze its performance using equivalent circuit	2	75	75	H	M	-	-	-	-	-	-	M	M	-	-	M	M	-
CLO-4 :	Investigate and interpret the performance of DC machines and transformers performing suitable tests	3	75	75	H	M	-	-	-	-	-	M	M	M	-	-	M	M	M
CLO-5 :	Analyze DC machines by mathematical modeling	3	75	75	H	M	L	L	L	-	-	-	M	M	-	-	M	M	-
CLO-6 :	Evaluate characteristics of transformers, DC Machines and evaluate their performance by applying various testing methods	3	75	75	H	M	L	L	L	-	-	L	M	M	-	-	M	M	L

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Energy in magnetic system	Torque equation of DC motor	Transformers: Types and Construction	Testing of DC machines: Brake test	Modeling of dc machines: Basic two pole DC machine
	SLO-2	Field energy and mechanical force	Emf equation of DC motor	Principle of operation, emf equation	Swinburne's test	Analysis of DC machine using Primitive two axis machine equation
S-2	SLO-1	Single excited systems	Voltage equation of various types of DC motor	Ideal transformer and Practical transformer on no load	Problems in Swinburne's test	Modelling of voltage equation
	SLO-2	Multiple excited systems	Current equation of various types of DC motor	Practical transformer on load	Retardation test	Modelling of torque equation
S-3	SLO-1	Torque and Force equations	Speed equation and regulation of DC motor	Equivalent circuit of transformer	Hopkinson's test	Mathematical model of separately excited DC machine
	SLO-2	Energy conversion via electric fields	Power flow in DC motor, Losses & efficiency	Transformer regulation, losses, efficiency	Problems in Hopkinson's test	Problems in mathematical model of separately excited DC machine
S 4-5	SLO-1	Lab 1: Demo on Single & Multiple excited systems	Lab 4: Load test on DC motors	Lab 7: Load test on single-phase transformer	Lab 10: Swinburne's test and Hopkinson's test on DC machine	Lab 13: Study of impulse test in transformer
	SLO-2					
S-6	SLO-1	Dynamic equation of electromechanical systems	Review of mechanical starter- 3-point starter	Phasor diagram of transformer	Open circuit test on single phase transformer	Mathematical model of shunt connected DC machine
	SLO-2	DC generator- lap and wave winding, Major considerations in design of windings	4-point starter, 2-point starter	EMF in power transformers	Short circuit test on single phase transformer	Problems in mathematical model of shunt connected DC machine
S-7	SLO-1	DC generator-EMF equation-circuit model	Electronic soft starters for DC motor with energy saving	All day efficiency, Per unit representation of transformer	Sumpner's test	Mathematical model of series connected DC machine
	SLO-2	Methods of excitation	Speed control: Field control, Armature control	Three phase transformers connections, Scott connection	Equivalent circuit, efficiency and regulation from OC & SC test	Problems in mathematical model of series connected DC machine

S-8	SLO-1	*Losses in DC generator*	*Speed control: voltage control*	*Phasing of transformer*	*Equivalent circuit, efficiency and regulation from Sumpner's test*	*Mathematical model of compound connected DC machine*
	SLO-2	*Power flow in DC generator, efficiency*	*Problems in DC motors*	*Parallel operation of single phase and three phase transformers*	*Problems in OC & SC test*	*Problems in Mathematical model of compound connected DC machine*
S 9-10	SLO-1	*Lab 2: Open circuit and load characteristics of Separately Excited DC generator*	*Lab 5: Speed Control of DC Motor: Field control, Armature control*	*Lab 8: Load test on three phase transformer*	*Lab 11: Open circuit and short circuit test and Sumpner's test on single phase transformer*	*Lab 14: Study of zero sequence impedance and noise level test in transformer*
	SLO-2					
S-11	SLO-1	*Effect of armature flux on field flux in DC generator*	*Speed control: Thyristor control*	*Auto transformer*	*Routine test on transformer*	*Time domain model of shunt connected DC machine*
	SLO-2	*Use of compensating windings, Ampere-Turns calculations*	*Speed control: Converters control*	*Tap changing transformers- tertiary winding*	*Dielectric and parametric test on transformer*	*State equations of shunt connected DC machine*
S-12	SLO-1	*Commutation in DC generator, construction of commutator,*	*Speed control: choppers control*	*Variable frequency transformer, audio frequency transformer*	*Type test on transformer*	*Problems in state equations of shunt connected DC machine*
	SLO-2	*Methods to improve commutation*	*Braking of DC motors*	*Phase shifting transformer, dry type transformer*	*Temperature rise and impulse test on transformer*	*Time domain model of permanent magnet DC machine*
S-13	SLO-1	*Voltage and current equation, Residual voltage, Critical Resistance*	*Permanent magnet DC motor*	*Grounding transformer, traction transformer*	*Unbalance current, magnetic balance test on transformer*	*State equations of permanent magnet DC machine*
	SLO-2	*Problems in DC generator*	*Problems in speed control*	*Welding transformer, rectifier transformer*	*Zero sequence impedance and noise level test on transformer*	*Problemsin state equations of permanent magnet DC machine*
S 14-15	SLO-1	*Lab 3: Open circuit and load characteristics of Self Excited DC generator*	*Lab 6: Speed Control of DC Motor: Thyristor, converter and chopper control*	*Lab 9: Parallel operation of single phase and three phase transformers*	*Lab 12: IEC/IEEE standard practice on transformer testing*	*Lab 15: Simulation of separately and self-excited DC machine*
	SLO-2					

Learning Resources	1. *D. P. Kothari, I. J. Nagrath, Electrical Machines, 5th ed.,Tata-McGraw Hill, 2017* 2. *A. E. Fitzgerald, C. Kingsley, Electric Machinery, 6th ed., McGraw Hill Education, 2013*	3. *Paul C. Krause, Oleg Wasynezuk, Scott D. Sudhoff, Analysis of electric machinery and Drive systems 3rd ed., IEEE Series, John Wiley & Sons, 2013* 4. *https://ocw.mit.edu/courses/electrical-engineering-and-computer-science*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (100% weightage)								Final Examination	
		CLA – 1 (20%)		CLA – 2 (30%)		CLA – 3 (30%)		CLA – 4 (20%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. S. Paramasivam, Danfoss Industries Pvt Ltd, paramsathya@yahoo.com	*1. Dr. D. Devaraj, Kalasalingam Academy of Research and Education, deva230@yahoo.com*	*1. Dr. C. S. Boopathi, SRMIST*
2.Mr. Muralikrishna, National Instruments, emkkrishnan@gmail.com	*2. Dr. B. ChittiBabu, IIITD, Kanchipuram, chittibabu@gmail.com*	*2. Dr. K. Vijayakumar, SRMIST*

Course Code	18EEC205J	Course Name	ELECTRICAL MACHINES II	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18EES101J	Co-requisite Courses		Progressive Courses	
Course Offering Department	Electrical and Electronics Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Identify the need of rotating magnetic field in three phase induction motor and draw its equivalent circuit			
CLR-2 :	Evaluate performance of three phase induction motor using circle diagram, identify its starting, speed control methods			
CLR-3 :	Develop an equivalent circuit of single phase induction motor and explain the operation of single phase AC machines			
CLR-4 :	Construct an equivalent circuit and phasor diagram of an alternator and obtain its voltage regulation			
CLR-5 :	Analyze the working and characteristics of salient pole alternator and synchronous motor			
CLR-6 :	Utilize the construction, operation and performance of AC machines			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 working of three phase induction motor, its torque slip characteristics and hence obtain its equivalent circuit	2	75	75	H	H	M	-	-	-	-	-	M	M	-	-	L	M	-
CLO-2 :	Identify the starting and speed control methods of three phase induction motor and evaluate its performance	3	75	75	H	H	M	-	-	-	-	-	M	M	-	-	M	M	-
CLO-3 :	Analyze the different single phase AC machines and model a single-phase induction motor	3	75	75	H	M	L	-	-	-	-	-	M	M	-	-	L	M	-
CLO-4 :	Model alternators and compute its voltage regulation	3	75	75	H	H	M	-	-	-	-	-	M	M	-	-	L	M	-
CLO-5 :	Identify the operation and control of salient pole alternator and synchronous motor	2	75	75	H	L	L	-	-	-	-	-	M	M	-	-	M	M	-
CLO-6 :	Analyze the performance of an AC machine by modeling and by carrying out laboratory experiments	3	75	75	H	M	M	-	-	-	-	-	M	M	-	-	L	M	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Review of poly phase distributed AC winding, Production of EMF	Construction of circle diagram for 3-phase induction motor	Constant magnetic field, Pulsating magnetic field	Alternators- Constructional features and types, Short pitch and full-pitch coils	Salient pole synchronous machine
	SLO-2	Flux and mmf waves in induction motor	Performance calculation from circle diagram	Alternating current in winding with spatial displacement	Concentrated and distributed winding, Coil span factor, Winding distribution factor	Blondel's two reaction theory
S-2	SLO-1	Constructional details of three-phase induction motor	Problems in circle diagram	Magnetic field produced by single winding-fixed current and alternating current	Air gap MMF distribution with fixed current	Phasor diagram using Xd, Xq
	SLO-2	Principle of operation of three-phase induction motor	Determination of maximum quantities from circle diagram	Pulsating fields produced by spatially displaced windings	Air gap MMF distribution with sinusoidal current	Slip test, Voltage regulation using slip test
S-3	SLO-1	Slip, Effect of slip on rotor parameters	Need for speed control	Windings spatially shifted by 90 degrees	EMF equation of alternator	Power output of Salient pole synchronous machine
	SLO-2	Torque equation, Starting torque equation, Maximum torque	Speed control of three-phase induction motor: Stator side	Addition of pulsating magnetic fields	Armature reaction, Alternator on load, phasor diagram	Problems in voltage regulation
S 4-5	SLO-1	Lab 1: Load test on 3 phase induction motor	Lab 4: Speed control of three-phase induction motor: stator side	Lab 7: Demo of spatially displaced windings	Lab 10: Load test on 3 phase alternators	Lab 13: Determination of Xd and Xq of salient pole machine
	SLO-2					
S-6	SLO-1	Torque-slip characteristics, Generation and breaking region in Torque-slip characteristics	Speed control of three-phase induction motor: rotor side	Constructional detail of single phase induction motor	Equivalent circuit and phasor diagram	Synchronous motor: Principle of operation, Methods of starting
	SLO-2	Starting characteristics of 3 phase induction motor, Effect of Rotor resistance on Torque-slip characteristics	Speed control by solid state devices	Double revolving field theory	Synchronous Impedance, voltage regulation	Torque and power equations
S-7	SLO-1	Power Stages	Necessity of Starters	Torque equation	Pre-determination of voltage regulation using EMF method	Synchronous motor on load, Synchronous motor on constant excitation variable load

	SLO-2	*Relation between rotor input, rotor copper losses and rotor output*	*Types of starters*	*Torque- speed characteristics*	*Problems in EMF method*	*Synchronous motor on constant load variable excitation, 'V', inverted 'V' curves*
S-8	SLO-1	*Problems in power stages*	*Induction generator, Self-excited Induction generator*	*No load blocked rotor tests*	*Pre-determination of voltage regulation using MMF method*	*Synchronous condenser, Hunting and its suppression*
	SLO-2	*No load and blocked rotor tests*	*Doubly-Fed Induction generator*	*Equivalent circuit*	*Problems in MMF method*	*Short circuit transient in synchronous machine*
S 9-10	SLO-1 SLO-2	*Lab 2: No load and blocked rotor test on 3-phase squirrel cage induction motor*	*Lab 5: Speed control of three-phase induction motor on rotor side*	*Lab 8: No load and blocked rotor test on 1-phase induction: To draw equivalent circuit*	*Lab 11: Voltage regulation of alternators by EMF and MMF methods*	*Lab 14: Determination of 'V' and inverted 'V' curves in synchronous motor*
S-11	SLO-1	*Steady state analysis-Equivalent circuit*	*Harmonics in induction motor*	*Making single phase induction self-starting*	*Pre-determination of voltage regulation using ZPF method*	*Capability curves in synchronous machine*
	SLO-2	*Motor efficiency, rotor efficiency*	*Crawling, Cogging*	*Shaded pole induction motor*	*Problems in ZPF method*	*Positive, Negative and Zero sequence reactance of synchronous machines*
S-12	SLO-1	*Equivalent circuit from No load and blocked rotor tests*	*Electric Braking: Regenerative braking, Plugging Braking*	*Linear Induction motor, Universal motor*	*Pre-determination of voltage regulation using ASA method*	*Synchronous induction motor*
	SLO-2	*Problems in no load and blocked rotor test*	*Electric Braking: AC, DC dynamic braking*	*Reluctance motor*	*Problems in ASA method*	*Brushless DC motor*
S-13	SLO-1	*Double cage rotor*	*Slip power recovery scheme*	*AC series motor, Repulsion motor*	*Parallel operation of alternators, Load sharing*	*Permanent Magnet Synchronous Motor*
	SLO-2	*Equivalent circuit of double cage rotor, Performance calculation*	*Difference in starting and blocked rotor characteristics*	*Stepper motor*	*Voltage and frequency control, Synchronization to infinite bus-bar*	*Tacho generator*
S 14-15	SLO-1 SLO-2	*Lab 3: No load and blocked rotor test on 3-phase slip ring induction motor*	*Lab 6: Characteristics of 3 phase Induction generator*	*Lab 9: Load test on single phase induction motor*	*Lab 12: Voltage regulation of alternators by ZPF method, Synchronization and parallel operation of alternators*	*Lab 15: Determination of Positive, Negative and Zero sequence reactance of synchronous machines*

Learning Resources	1. *H.Wayne Beaty&Jame. L.Kirtley.Jr, Electric Motor Handbook, McGraw-Hill, USA, 1st Edition, 1998* 2. *M.G.Say, The Performance and Design of Alternating Current machines, Tata-McGraw Hill, 1st Edition, 2004*	3. *J. B. Gupta, Theory & Performance of Electrical Machines, 15th ed., S. K. Kataria & Sons, 2015* 4. *https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-685-electric-machines-fall-2013/index.htm*

Learning Assessment

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

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. S. Paramasivam, Danfoss Industries Pvt Ltd, paramsathya@yahoo.com	*1. Dr. D. Devaraj, Kalasalingam Academy of Research and Education, deva230@yahoo.com*	*1. Dr. C. S. Boopathi, SRMIST*
2. Mr. Muralikrishna, National Instruments, emkkrishnan@gmail.com	*2. Dr. R. Ramesh, CEG, rramesh@annauniv.edu*	*2. Dr. K. Vijayakumar, SRMIST*

Course Code	18EEC206J	Course Name	ANALOG ELECTRONICS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18EES101J	Co-requisite Courses		Progressive Courses	
Course Offering Department	Electrical and Electronics Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Know the basic amplifier circuits.
CLR-2 :	Acquire knowledge on different power amplifiers.
CLR-3 :	Construct different waveform generating circuits.
CLR-4 :	Discuss the basics of operational amplifiers.
CLR-5 :	Understand different analog to digital and digital to analog converters
CLR-6 :	Design amplifier circuits using transistor and operational amplifiers.

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 amplifier circuits using small signal model and hybrid model	2	75	75	H	H	H	H	-	-	L	-	M	M	-	-	M	H	-
CLO-2 :	Recognize the different power amplifiers	2	75	75	H	H	H	H	-	-	-	-	M	M	-	-	M	H	-
CLO-3 :	Design oscillators and multivibrators.	3	75	75	H	H	H	M	-	-	-	-	M	M	-	-	M	M	-
CLO-4 :	Apply different operational amplifiers.	2	75	75	H	M	M	-	-	-	-	-	M	M	-	-	M	M	-
CLO-5 :	Evaluate filters and converter circuits	3	75	75	H	H	H	M	H	-	-	-	M	M	-	-	M	M	-
CLO-6 :	Demonstrate electronic modern tools in various electronic fields.	2	75	75	H	H	H	M	M	-	L	-	M	M	-	-	M	M	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	BJT -Biasing methods -Base bias, base bias with emitter feedback	Power amplifiers: Types. Determine efficiency for class A, B power amplifier	Oscillators and classification of oscillators	Introduction to Linear Integrated Technology	Filters basics and types
	SLO-2	Base bias with collector feedback and voltage divider bias	Frequency response of RC coupled class A amplifier	Design and Analysis of RC Phase shift oscillator	Fabrication process for Integrated Circuits	Design of I and II Order LPF
S-2	SLO-1	Emitter bias using BJT in CE configuration	Frequency response of Transformer coupled class A amplifier.	Operation of Hartley's oscillator	Dc characteristics of op amp and input bias current.	Design of I Order HPF
	SLO-2	Transistor biasing stability using BJT in CE configuration	Operation of Class B push pull power amplifier	Analysis of Hartley's oscillator	Input offset voltage, Thermal Drift	Design of II Order HPF
S-3	SLO-1	Operation of BJT as an amplifier	Operation of Differential amplifier	Operation of Armstrong oscillator	AC characteristics of op-amp and Frequency Compensation	Design of BPF and BRF
	SLO-2	CE, CB, CC Amplifier –Evaluation of h-parameters	Analysis of Differential amplifier	Operation of UJT Relaxation oscillator	Slew rate	Switched variable filters and state variable filters.
S 4-5	SLO-1	Lab 1: Determination of hybrid parameters of a CE amplifier.	Lab 4: Determination of gain of an amplifier.	Lab 7: RC Phase shift oscillator	Lab 10: and AC characteristics of IC 741 Op-amp	Lab 13: Design of Low pass and High Pass Filters.
	SLO-2					
S-6	SLO-1	Small signal analysis of CE Amplifier	Self–biased active load differential amplifier	Operation of Cross Coupled oscillator	Inverting amplifier and Non-inverting amplifier	Oscillators- Wein bridge Oscillator using IC 741.
	SLO-2	Small signal analysis of CB and CC amplifier	Source degenerated common source amplifier	Integrators	Summer and Subtractor.	Amplitude control and Quadrature Control Oscillator
S-7	SLO-1	Large signal analysis of CE Amplifier	Classification of class C power amplifiers (Tuned amplifiers)	Differentiators	Voltage follower and ac amplifiers	Introduction to simple MOSFET based op-amp circuits.
	SLO-2	Large signal analysis of CB and CC amplifier.	Frequency response of Single,Double and Staggered Tuned Class C power amplifier	Schmitt trigger	V to I and I to V converters	Analog to Digital converters, classification. Counter and Sigma Delta type ADC.
S-8	SLO-1	JFET –Common source (CS) amplifier - operation	Cascode and Cascade circuits	Multivibrator, Classification Operation of Astable Multivibrator	Instrumentation amplifier	Successive approximation type ADC

	SLO-2	*CS Amplifier – small signal analysis*	*Feedback amplifiers –Barkhausen criterion and Types of feedback amplifier*	*Analysis of Astable Multivibrator*	*Log and Antilog amplifiers*	*Digital to Analog converters and Pulse width modulator DAC*
S 9-10	SLO-1 SLO-2	*Lab 2: Analysis of JFET amplifier*	*Lab 5: Frequency response of RC coupled amplifier*	*Lab 8: AstableMultivibrator*	*Lab 11: Applications of op-amp*	*Lab 14: Wein bridge oscillator using IC 741.*
S-11	SLO-1	*JFET – Common Drain (CD) Amplifier – operation*	*Analysis of voltage series feedback amplifier*	*Operation of Monostable Multivibrator.*	*Comparators and classification of comparators*	*R -2R Ladder DAC*
	SLO-2	*Small signal analysis of MOSFET*	*Analysis of voltage shunt feedback amplifier*	*Analysis of Monostable Multivibrator.*	*Applications of Comparators : Summer, Subtractor, Voltage follower*	*Binary coded DAC*
S-12	SLO-1	*Biasing of MOSFET*	*Analysis of current series amplifier*	*Operation of Bistable Multivibrator.*	*Basics of IC 555 Timer and Pin Details*	*Case study: Minor project on any advanced application based circuit using IC 741 or IC 555 Timer or IC 723.*
	SLO-2	*CD Amplifier – small signal analysis*	*Analysis of current shunt feedback amplifier*	*Analysis of Bistable Multivibrator.*	*Astable operation using IC 555 Timer with applications*	
S-13	SLO-1	*Problems on biasing of circuits.*	*Problems on power amplifiers.*	*Voltage and time-based circuits.*	*Monostable operation using IC 555 Timer with applications*	*Case study: Minor project on any advanced application based circuit using IC 741 or IC 555 Timer or IC 723.*
	SLO-2	*Problems on hybrid parameters*	*Problems on feedback amplifiers*	*Series and shunt voltage regulator*	*Voltage regulator using IC 723*	
S 14-15	SLO-1 SLO-2	*Lab 3: Analysis of MOSFET amplifier*	*Lab 6: Frequency response of Class C Power amplifier*	*Lab 9: Transistor series voltage regulator*	*Lab 12: Voltage Regulator Using IC 723*	*Lab 15: R -2R Ladder DAC*

Learning Resources

1. *Jacob Millman, Christos C.Halkias, SatyabrataJit, Millman's Electronic Devices and Circuits, 4th ed., Tata McGraw Hill, 2015*
2. *Boylestead, Nashelsky, Electronic Devices and Circuit Theory, 11th ed., Pearson, 2015*
3. *David A. Bell, Electronic Devices and Circuits, 5th ed., Prentice Hall, 2004*
4. *Sergio Franco, Design with operational amplifiers and Analog Integrated circuits, 5th ed., McGraw-Hill, 2014*
5. *Roy Choudhary and Shail Jain, Linear Integrated Circuits, 4th ed., New Age International Publishers, 2014*
6. *https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-002-circuits-and-electronics-spring-2007/syllabus/*

Learning Assessment

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

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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2. Mr. B. Nliranjithkumar, BEL, Chennai., niranjithkumarb@bel.co.in	*2. Dr. S. Kamalakannan, Anna University, kamalakannan1612@gmail.com*	*2. Dr. K. Mohanraj, SRMIST*

Course Code	18EEC207J	Course Name	ELECTRICAL AND ELECTRONICS MEASUREMENTS AND INSTRUMENTATION	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Utilize the knowledge of various types of measuring instruments, DC and AC bridge.			
CLR-2 :	Utilize the working of analog meters for power, energy and harmonic measurements			
CLR-3 :	Utilize different measuring and display devices			
CLR-4 :	Compare the measurement of non- electrical quantities.			
CLR-5 :	Analyze the functions of biomedical instruments and data acquisition system			
CLR-6 :	Utilize the knowledge about measurements, measuring instruments for practical applications			

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 problems in measuring instruments and bridges	3	75	75	H	L	-	-	L	-	-	-	M	M	-	-	L	M	-
CLO-2 :	Apply the different analog meters for power, energy and harmonic measurements.	2	75	75	H	L	-	-	-	-	-	-	M	M	-	-	L	M	-
CLO-3 :	Design the operation of different measuring and display devices	2	75	75	H	L	-	-	-	-	-	-	M	M	-	-	L	L	-
CLO-4 :	Identify the measurement of non- electrical quantities.	2	75	75	H	-	-	-	L	-	-	-	M	M	-	-	L	L	-
CLO-5 :	Describe the working of biomedical instruments and data acquisition system	2	75	75	H	-	-	-	-	-	-	-	M	M	-	-	L	M	-
CLO-6 :	Interpret the acquired knowledge of measuring instruments	2	75	75	H	L	-	-	L	-	-	-	M	M	-	-	L	M	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Functional elements of instrument	Special type of transformers -Current Transformer	Construction and working of synchro scope – Western type	Methods of pressure measurements- Dead-weight gauges and Manometers	Over view of biomedical measurements
	SLO-2	Static characteristics of measurement	Potential Transformer- Measurement of voltage	Nalder-Lipman type	Pressure measuring system	Sources of bio electric potentials, Electrodes
S-2	SLO-1	Dynamic characteristics of measurement	Principle of operation, construction, Torque equation of induction type single phase energy meter	General principle and performance equations of Ballistic Galvanometer	Elastic transducer, Vibrating cylinder	Measurement of blood pressure-direct methods
	SLO-2	Errors in measurement	Three phase energy meter	D'Arsonval Galvanometer	Resonant transducer.	Working of X- ray Instrumentation
S-3	SLO-1	Kelvin's Double Bridge, measurement of Low value of Resistances	Creeping adjustments, testing of energy meters	General principle and working of Hall effect sensors	Measurement of Flow: Flow visualization from Pitot-static tube, Yaw tube.	Applications of X- ray Instrumentation
	SLO-2	Wheat -stone Bridge, measurement of Medium value of Resistances.	Calibration of energy meter using direct loading.	Encoder-Laser based methods.	Positive displacement method, Obstruction methods.	Working and applications of Electrocardiograph (ECG)
S 4-5	SLO-1 SLO-2	Lab 1: Measurement of R, L and C using bridge circuit	Lab 4: Measurement of power and energy	Lab 7: Measurement of liquid flow rate	Lab 10: Measurement of water level using capacitive Transducer	Lab 13: Real time monitoring of ECG wave analysis using simulator
S-6	SLO-1	Maxwell's Inductance Bridge, Measuring Unknown value of Inductance	Digital energy meter	Graphical methods of measurement: Cathode ray oscilloscope	Drag effect methods, hot-wire anemometers.	Block diagram of data acquisition system
	SLO-2	Anderson's Bridge, measurement of Un known value of Inductance.	Net metering	Digital storage oscilloscope	Measuring Devices: Vacuum and sound	Block diagram of Signal conditioning
S-7	SLO-1	Schering's Bridge measurement of Un known value of Capacitance.	Measurement of reactive power using wattmeter in single phase circuit.	Storage devices: Strip chart recorder	McLeod gauge, Knudsen gauge	Telemetry and working.
	SLO-2	Principle of operation of Thermal type instruments	Measurement of reactive power using wattmeter in Poly phase circuits	X-Y recorder	Diaphragm and ionization gauges	Respiratory instrumentation – Mechanism of respiration, spirometry

S-8	SLO-1	*Principle of operation, construction, working of single phase power factor meter*	*Measurement of Volt Ampere reactive power using VAR meter*	*Principle of operation and applications of Phase sequence indicator*	*Motion measurement-Fundamentals standards.*	*Working of different types of Pacemakers*
	SLO-2	*Three phase power factor meter*	*Principle of operation, and construction of Maximum demand indicator*	*Principle of operation and applications of Display devices: LED, LCD, Dot matrix display*	*Temperature measurement using Liquid in glass thermometers*	*Applications of Pacemakers*
S 9-10	SLO-1	*Lab 2: Power factor measurement*	*Lab 5: Measurement of power and energy*	*Lab 8: Measurement of harmonics using Power quality analyser.*	*Lab 11: Measurement of temperature to estimate the response time using temperature measuring instruments*	*Lab 14: Study of Pacemaker Module*
	SLO-2					
S-11	SLO-1	*Solving Problems in error measurements*	*Solving Problems in single phase energy meter*	*Solving Problems in Phase sequence indicator.*	*Solving Problems in transducers*	*Interfacing instruments –General purpose interfacing bus (GPIB)*
	SLO-2	*Solving Problems in bridge circuits*	*Solving Problems in three phase energy meter*	*Solving Problems in Galvanometer*	*Solving Problems in Pressure measurement.*	*Working of GPIB Hardware Components*
S-12	SLO-1	*Principle of operation, construction, Torque equation of Dynamometer type instruments*	*Frequency meters, Electrical resonance type*	*Measurement of LCD screen size*	*Measurement of Pressure thermometers*	*GPIB / SCPI Programming Elements and specifications*
	SLO-2	*Principle of operation of Rectifier type instruments*	*Frequency meters - Mechanical Resonance Type.*	*Operation of an analogue actuator: the DC Servo motor*	*Properties of analogue sensors for temperature*	*Interfacing instruments –USB*
S-13	SLO-1	*Principle of operation and applications of Digital voltmeter.*	*Principle of operation of spectrum analyser*	*Radio frequency identification (RFID) reader*	*Properties of analogue sensors for pressure*	*Instrumentation for medical imaging*
	SLO-2	*Principle of operation and applications of Digital Multimeter.*	*Principle of operation of Harmonic analyser*	*Data loggers*	*Laser based measurement of liquid temperature*	*Instrumentation for Therapeutic Devices*
S 14-15	SLO-1	*Lab 3: Demo on Universal bridge*	*Lab 6: Demo on Frequency meter*	*Lab 9: Identification of phase sequence using Synchroscope*	*Lab 12: Study of temperature and pressure sensor*	*Lab 15: Analysis of Instrumentation for medical imaging*
	SLO-2					

Learning Resources	1. *Ernest O Doebelin, Dhanesh N Manik, Measurements Systems Application and Design, 5th ed., McGraw Hill, 2006* 2. *Sawhney A. K, A Course in Electrical and electronic Measurement and Instrumentation, Dhanpat Rai & Sons, 2015* 3. *Rajendra Prasad, Electrical Measurements & Measuring instruments, 10th ed., Khanna Publishers, 1989*	4. *Albert D Halfride & William D Cooper, Modern Electronic Instrumentation and Measurement Techniques, Pearson, 2015* 5. *John G Webster, Medical instrumentation: Application and design ,4th ed., Wiley, 2010* 6. *https://ocw.mit.edu/courses/electrical-engineering-and-computer-science*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (100% weightage)								Final Examination	
		CLA – 1 (20%)		CLA – 2 (30%)		CLA – 3 (30%)		CLA – 4 (20%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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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Course Code	18EEC208T	Course Name	GENERATION, TRANSMISSION AND DISTRIBUTION	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Utilize the basics of electric power generation, transmission and distribution			
CLR-2 :	Solve the various transmission line parameters for single and three phase transmission system			
CLR-3 :	Analyze the performance of transmission line and to learn the different voltage compensation techniques			
CLR-4 :	Utilize insulators, cables and estimate the string efficiency			
CLR-5 :	Analyze the basics of substation components and DC distribution systems			
CLR-6 :	Create overall structure of power system starting from generation to power transmission and distribution			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLO-1 :	Identify the layout of various energy sources and its economics of power generation	2	80	75
CLO-2 :	Calculate the line parameter for single and multi-phase power transmission system	3	80	75
CLO-3 :	Compute the performance of various types of transmission lines	3	80	75
CLO-4 :	Acquire knowledge on insulators, cables and evaluate stress and sag	3	80	75
CLO-5 :	Identify the substation components and compute the DC distribution systems	3	80	75
CLO-6 :	Design a power system using components like generators, transmission lines and distributors	3	80	75

Program Learning Outcomes (PLO)														
1	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
H	M	M	-	-	-	M	-	-	-	-	-	H	M	H
H	H	M	M	M	-	M	-	-	-	-	-	M	M	M
H	H	H	M	-	-	-	-	M	M	-	-	H	M	M
H	M	H	M	-	-	-	-	-	-	-	-	H	H	M
H	H	M	M	-	-	-	-	-	-	-	-	H	M	M
H	H	M	M	M	-	M	-	M	M	-	-	H	M	M

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Sources of energy	Calculate Resistance in a single-phase transmission line	Analyze performance of short line	Classify insulators for transmission and distribution purpose	Classification, major components of substations, Bus-bar arrangements
	SLO-2	Structure of power system	Calculate Inductance in a single-phase transmission line	Analyze performance of medium transmission line (end condenser method)	Voltage distribution in insulator string	Substation bus schemes- single bus, double bus with double breaker
S-2	SLO-1	Basic layout of PV power generation	Calculate Capacitance in a single-phase transmission line	Calculate efficiency,regulation of voltage for medium line by end condenser method	Improvement of string efficiency	Double bus with single breaker
	SLO-2	Basic layout of wind power generation	Calculate Inductance and capacitance of three phase transmission lines	Analyze Performance of medium line using T method	Calculation of voltage distribution and string efficiency	Main and transfer bus schemes
S-3	SLO-1	Basic layout of Ocean Thermal Energy Conversion (OTEC)	Calculate Inductance and capacitance in a Symmetrically spaced conductor	Calculation of efficiency and regulation of voltage for medium line by T method	Testing of insulators	Double bus-bar scheme with bypass isolators
	SLO-2	Types of OTEC	Calculate inductance and capacitance in an Unsymmetrical spaced conductor (transposed)	Analyze Performance of medium line using πmethod	Construction features of LT and HT cables, Insulation resistance	Introduction to substation earthing
S-4	SLO-1	Basic layout of Biomass power plant	Calculate inductance of Single circuit lines	Calculation of efficiency and regulation of voltage for medium line by π method	Calculate Capacitance, dielectric stress	Substation safety
	SLO-2	Load curve & Load duration curve	Calculate capacitance of Single circuit lines	Analyze Performance of long line using Rigorous method	Grading cables	Qualitative treatment to neutral grounding
S-5	SLO-1	Calculation of total power generation	Calculate inductance in double circuit lines	Ferranti effect – surge impedance	Fault in underground cables	Feeders, service mains and distributors
	SLO-2	Load, demand and diversity factors	Calculate capacitance in double circuit lines	Attenuation constant and phase constant	Location of fault in underground cables	DC Distribution

S-6	SLO-1	*Plant capacity and plant use factors*	*Calculate inductance in Stranded and bundled conductors*	*Real power flow in transmission lines*	*Tan δ and power loss*	*Types of DC distributors*
	SLO-2	*Calculation of Plant capacity and plant use factors*	*Calculate capacitance in Stranded and bundled conductors*	*Reactive power flow in transmission lines*	*Thermal characteristics of cables*	*Quantitative analysis of radial distribution fed at one end*
S-7	SLO-1	*Choice of type of generation, choice of size and number of units*	*Application of self GMD*	*Power circle diagrams*	*Calculate Stress of towers with equal heights*	*Quantitative analysis of radial distribution fed at both the ends*
	SLO-2	*Cost of energy generated*	*Application of mutual GMD*	*Receiving end power circle diagrams for finding the maximum power transfer*	*Calculate Sag of towers with equal heights*	*Quantitative analysis of Ring main distribution*
S-8	SLO-1	*Tariffs*	*Skin and Proximity effect*	*Series compensation*	*Calculate Stress of towers with unequal heights*	*Design of rural distribution, planning and design of town electrification schemes*
	SLO-2	*Types of tariffs*	*Inductive interference, Corona*	*Shunt compensation*	*Calculate Sag of towers with unequal heights*	*Kelvin's law for the design of feeders and limitations*
S-9	SLO-1	*Transmission systems*	*Implementation of distribution system using software*	*Seminar Presentations on ABCD constants*	*Effect of wind on overhead transmission line*	*Smart grid*
	SLO-2	*Distribution systems*	*Implementation of distribution system using software*	*Seminar Presentation on surge impedance loading*	*Effect of ice loading on overhead transmission line*	*Power system restructuring*

Learning Resources	1. *D.P. Kothari, I.J. Nagrath Power System Engineering Mc Graw-Hill Publishing company limited, New Delhi, 2nd ed., 2008* 2. *C. L. Wadwa, Electric Power Systems, 7th ed., New Age International Publishers,2016*	3. *Luces M. Fualkar berry, Walter Coffer Electrical Power Distribution and Transmission, Pearson Education, 2007* 4. *S.N.Singh, Electric power generation, transmission and distribution, 2nd ed., PHI, 2011* 5. *https://ocw.mit.edu/courses/electrical-engineering-and-computer-science*

Learning Assessment

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

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ACADEMIC CURRICULA

Professional Core Courses

ELECTRONICS AND COMMUNICATION ENGINEERING

Regulations - 2018

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

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

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

Kattankulathur, Kancheepuram, Tamil Nadu, India

Course Code	18ECC102J	Course Name	ELECTRONIC DEVICES	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18EES101J	Co-requisite Courses	Nil	Progressive Courses	18ECC201J
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Provide a basis for understanding semiconductor material, how a pn junction is formed and its principle of operation			
CLR-2 :	Explain the importance of diode in electronic circuits by presenting appropriate diode applications			
CLR-3 :	Discuss the basic characteristics of several other types of diodes that are designed for specific applications			
CLR-4 :	Describe the basic structure, operation and characteristics of BJT, and discuss its use as a switch and an amplifier.			
CLR-5 :	Describe the basic structure, operation and characteristics of MOSFET, and discuss its use as a switch and an amplifier.			
CLR-6 :	Use modern engineering tools such as PSPICE to carry out design experiments and gain experience with instruments and methods used by technicians and electronic engineers			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLO-1 :	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and special diodes	1	90	80
CLO-2 :	Demonstrate important applications of semiconductor diodes and special diodes.	2	80	75
CLO-3 :	Review bipolar transistor construction, operation, characteristics and parameters, as well as its application in amplification and switching.	1	90	80
CLO-4 :	Review field-effect transistor construction, operation, characteristics and parameters, as well as its application in amplification and switching.	1	80	75
CLO-5 :	Build a circuit, then make functional measurements to understand the operating characteristics of the device / circuit.	3	80	75
CLO-6 :	Solve specific design problem, which after completion will be verified using modern engineering tools such as PSPICE.	3	90	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: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	H	-	-	-	-	-	-	-	-	-	-	M	-	-	-
CLO-2 :	-	-	-	-	-	-	-	-	-	-	-	M	-	-	-
CLO-3 :	H	-	-	-	-	-	-	-	-	-	-	M	-	-	-
CLO-4 :	H	-	-	-	-	-	-	-	-	-	-	M	-	L	-
CLO-5 :	-	-	-	-	H	-	-	-	-	-	-	-	L	L	-
CLO-6 :	-	-	-	-	H	-	-	L	H	M	-	M	-	-	-

Duration (hour)		Semiconductor Diodes	Diode Circuits	Special Diodes	Bipolar Junction Transistors	MOS Field-Effect Transistors
		15	15	15	15	15
S-1	SLO-1	Basic semiconductor theory: Intrinsic & extrinsic semiconductors	HWR operation, Efficiency and ripple factor	Backward diode	Physical structure	Physical structure
	SLO-2	Current flow in semiconductors	Problem solving	Varactor diode	Device operation of BJT	Device operation of E-MOSFET & D-MOSFET
S-2	SLO-1	PN junction theory: Equilibrium PN junction	Center-Tapped Transformer FWR operation, Efficiency and ripple factor	Step recovery diode	Current-Voltage characteristics of CE BJT configuration	I-V characteristics of E-MOSFET
	SLO-2	Forward biased PN junction	Problem solving	Point-contact diode	Current-Voltage characteristics of CE BJT configuration	Problem solving
S-3	SLO-1	Reverse biased PN junction	Bridge FWR operation, Efficiency and ripple factor	Metal-semiconductor junction: Structure, Energy band diagram	Current-Voltage characteristics of CB BJT configuration	Derive drain current
	SLO-2	Relation between Current and Voltage	Problem solving	Forward & Reverse Characteristics of Schottky Diode	Current-Voltage characteristics of CB BJT configuration	Problem solving
S 4-5	SLO-1	Lab 1: PN Junction Diode Characteristics	Lab 4: Diode clipping and clamping circuits	Lab 7: Series and Shunt Regulators	Lab 10: BJT and MOSFET Switching Circuits	Lab 13: Repeat Experiments
	SLO-2					
S-6	SLO-1	Calculate depletion width	Filters: Inductor & Capacitor Filters	Tunnel Diode	Current-Voltage characteristics of CC BJT configuration	Derive transconductance
	SLO-2	Calculate barrier potential	Problem solving	Tunnel Diode	Current-Voltage characteristics of CC BJT configuration	Problem solving
S-7	SLO-1	Derive diode current equation	Filters: LC & CLC Filters	Gunn Diode	BJT as an amplifier	CMOS FET

	SLO-2	*Derive diode current equation*	*Problem solving*	*Gunn Diode*	*BJT as a switch*	*MOSFET as an amplifier*
S-8	SLO-1	*Effect of Capacitance in PN junction: Transition Capacitance*	*Diode Clippers*	*IMPATT Diode*	*BJT circuit models - h-parameter*	*MOSFET as a switch*
	SLO-2	*Diffusion Capacitance*	*Problem solving*	*IMPATT Diode*	*BJT circuit models - hybrid-π parameter*	*Problem solving*
S 9-10	SLO-1 SLO-2	*Lab 2: Zener diode characteristics*	*Lab 5: BJT Characteristics*	*Lab 8: MOSFET Characteristics*	*Lab 11: Photoconductive Cell, LED, and Solar Cell Characteristics*	*Lab-14: Model Examination*
S-11	SLO-1	*Energy band structure of PN Junction Diode*	*Diode Clampers*	*PIN Diode*	*BJT biasing circuits and stability analysis: Base bias and emitter bias*	*Biasing Circuits for MOSFET: Gate Bias*
	SLO-2	*Ideal diode and its current-voltage characteristics*	*Problem solving*	*PIN Photodiode*	*Problem solving*	*Problem Solving*
S-12	SLO-1	*Terminal characteristics & parameters*	*Voltage Multipliers*	*Avalanche photodiode*	*Voltage-divider bias*	*Self-bias*
	SLO-2	*Diode modeling*	*Zener diode: Characteristics, breakdown mechanisms*	*Laser diode*	*Problem solving*	*Problem Solving*
S-13	SLO-1	*DC load line and analysis*	*Zener resistances and temperature effects Zener diode as voltage regulator*	*Problem solving*	*Collector-feedback bias*	*Voltage-divider bias*
	SLO-2	*Problem solving*	*Problem solving*	*Problem solving*	*Problem solving*	*Problem Solving*
S 14-15	SLO-1 SLO-2	*Lab 3: Diode rectifier circuits*	*Lab 6: BJT Biasing Circuits*	*Lab 9: MOSFET Biasing Circuits*	*Lab 12: Simulation experiments using PSPICE*	*Lab 15: End-Semester Practical Examination*

Learning Resources	1. *David A. Bell, Electronic Devices and Circuits, 5th ed., Oxford University Press, 2015* 2. *Donald Neamen, Electronic Circuits: Analysis and Design, 3rd ed., McGraw-Hill Education, 2011* 3. *Adel S. Sedra, Kenneth C. Smith, Microelectronic Circuits: Theory and Applications, OUP, 2014* 4. *Thomas L. Floyd, Electronic Devices", 9th ed., Pearson Education, 2013*	5. *Robert L. Boylestad, Louis Nashelsky, Electronic Devices and Circuit Theory, 11th ed., Pearson Education, 2013* 6. *Muhammad Rashid, Microelectronic Circuits: Analysis & Design, 2nd ed., Cengage Learning, 2010* 7. *Muhammed H Rashid, Introduction to PSpice using OrCAD for circuits and electronics, 3rd ed., Pearson, 2004* 8. *Laboratory Manual, Department of ECE, SRM University*

Learning Assessment

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

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

Course Designers

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

Course Code	18ECC103J	Course Name	DIGITAL ELECTRONIC PRINCIPLES	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18EES101J	Co-requisite Courses	Nil	Progressive Courses	18ECC203J
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Understand binary codes, digital arithmetic operations and able to simplify Boolean logic expressions			
CLR-2 :	Describe how basic TTL and CMOS gates operate at the component level			
CLR-3 :	Able to design simple combinational logics using basic gates and MSI circuits			
CLR-4 :	Familiarize with basic sequential logic components: flip-flops, registers, counters and their usage, and able to design and analyze sequential logic circuits and Finite State Machines.			
CLR-5 :	Know how to implement logic circuits using PLDs.			
CLR-6 :	Use modern engineering tools such as PSPICE / Logisim to carry out design experiments and gain experience with instruments and methods used by technicians and electronic engineers			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Have a thorough understanding of the fundamental concepts and techniques used in digital electronics.	1	90	75	H	-	-	-	-	-	-	-	-	-	-	M	-	-	-
CLO-2 :	Understand the basic electronics of various logic families and able to use Integrated Circuits.	1	80	70	H	-	-	-	-	-	-	-	-	-	-	M	-	-	-
CLO-3 :	Understand, analyze, design and troubleshoot various combinational logic circuits.	2,3	90	75		M	H	-	H	-	-	-	-	-	-	M	-	-	-
CLO-4 :	Understand, analyze, design and troubleshoot various clocked sequential logic circuits.	2,3	90	75		M	H	-	H	-	-	-	-	-	-	M	-	-	-
CLO-5 :	Analyze, design and implement various digital logic circuits using PLDs	2,3	80	75	-	M	H	-	H	-	-	-	-	-	-	-	-	-	-
CLO-6 :	Solve specific design problem, which after completion will be verified using modern engineering tools such as PSPICE / Logisim	3	90	75	-	M	H	-	H	-	-	L	H	M	L	M	M	-	L

Duration (hour)		Binary Codes, Digital Arithmetic and Simplification of Boolean Functions	Logic Families	Combinational Systems	Sequential Systems	Memory and Programmable Logic
		15	15	15	15	15
S-1	SLO-1	Binary Codes, Digital Arithmetic and Simplification of Boolean Functions	Introduction	Binary arithmetic units	Flip-flop and Latch: SR latch,	RAM Memory decoding
	SLO-2	Error detecting codes	TTL Logic Family	Adder	JK flip-flop, T flip-flop, D flip-flop	ROM
S-2	SLO-1	Error correcting code	Totem-pole TTL	Design of Half adder	Master-slave RS flip-flop	Programmable Logic Devices (PLDs): Basic concepts
	SLO-2	Hamming Code	open-collector and tristate TTL	Design of Full adder	Master-slave JK flip-flop	PROM
S-3	SLO-1	Arithmetic number representation	Schottkey TTL, standard TTL characteristics	Subtractor	Registers & Counters	PROM as PLD
	SLO-2	Binary arithmetic	Metal Oxide Semiconductor logic families	Design subtractor using logic gates	Shift registers (SISO, SIPO, PISO, PIPO)	Programmable Array Logic (PAL)
S 4-5	SLO-1	LAB 1: Study of logic gates	LAB 4: Design and implement encoder and decoder using logic gates	LAB 7: Implement combinational logic functions using standard ICs	LAB 10: Design and implement Synchronous Counters	LAB 13: Construct combinational circuit using Logisim
	SLO-2					
S-6	SLO-1	Hexadecimal arithmetic	N-MOS	n-bit parallel adder & subtractor	Universal shift register	Programmable Array Logic (PAL)
	SLO-2	Hexadecimal arithmetic	P-MOS	look ahead carry generator	Counters: Asynchronous/Ripple counters	Programmable Logic Array (PLA)

S-7	SLO-1	*BCD arithmetic simplification*	*CMOS logic circuits*	*Decoder*	*Synchronous counters, Modulus-n Counter*	*Programmable Logic Array (PLA)*
	SLO-2	*Minimization of Boolean Functions: Algebraic simplification*	*Characteristics of MOS logic*	*Encoder*	*Ring counter, Johnson counter*	*Design combinational circuits using PLD's*
S-8	SLO-1	*Problems on Algebraic simplification*	*Compare MOS logic circuits(CMOS) with TTL digital circuit*	*Multiplexer*	*Up-Down counter*	*Design combinational circuits using PLD's*
	SLO-2	*Karnaugh map simplification*	*Electrical characteristics*	*Demultiplexer*	*Mealy and Moore model*	*Design combinational circuits using PLD's*
S 9-10	SLO-1 SLO-2	*LAB 2: Design and implement Adder and Subtractor using logic gates*	*LAB 5: Design and implement Multiplexer and Demultiplexer using logic gates*	*LAB 8: Verify characteristic table of flip-flops*	*LAB 11: Construct and verify shift registers*	*LAB 14: Model Practical Examination*
S-11	SLO-1	*Problems on Karnaugh map simplification*	*Fan-out*	*Code converters*	*Synchronous (Clocked) sequential circuits*	*Design of combinational circuits using PLD's*
	SLO-2	*Problems on Karnaugh map simplification*	*Propagation Delay*	*Magnitude comparators*	*Synchronous (Clocked) sequential circuits*	*Design sequential circuits using PLD's*
S-12	SLO-1	*Quine McCluskey*	*Power dissipation*	*Magnitude comparators*	*Synchronous (Clocked) sequential circuits*	*Design sequential circuits using PLD's*
	SLO-2	*Tabulation method*	*Noise margin*	*Parity generators (Odd parity)*	*Analyze and design synchronous sequential circuits*	*Design sequential circuits using PLD's*
S-13	SLO-1	*Problems on Quine McCluskey or Tabulation method.*	*Supply voltage levels*	*Parity generators (Even parity)*	*State reduction*	*Design sequential circuits using PLD's*
	SLO-2	*Exercise problems using Tabulation method*	*Operational voltage levels*	*Implementation of combinational logic by standard IC's.*	*State assignment*	*Design sequential circuits using PLD's*
S 14-15	SLO-1 SLO-2	*Lab 3: Design and Implement 2-bit Magnitude Comparator using logic gates*	*LAB-6: Design and implement code converters using logic gates*	*LAB 9: Construct and verify 4-bit ripple counter, Mod-10/Mod-12 ripple counters*	*Lab 12: Construct mini project work*	*LAB 15: University Practical Exam*

Learning Resources	1. *Morris Mano M, Michael D. Ciletti, Digital Design with an Introduction to the Verilog HDL, 5th ed., Pearson Education, 2014* 2. *Charles H Roth (Jr), Larry L. Kinney, Fundamentals of Logic Design, 5th ed., Cengage Learning India Edition, 2010* 3. *Thomas L. Floyd, Digital Fundamentals, 10th ed., Pearson Education, 2013*	4. *Ronald J. Tocci, Digital System Principles and Applications, 10th ed., Pearson Education, 2009* 5. *Donald P Leach, Albert Paul Malvino, Goutam Saha, Digital Principles and Applications, 6th ed., Tata-Mcgraw Hill, 2008* 6. *LAB MANUAL, Department of ECE, SRM University*

Learning Assessment

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

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

Course Designers

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Course Code	18ECC104T	Course Name	SIGNALS AND SYSTEMS	Course Category	C	Professional Core	L	T	P	C
							3	1	0	4

Pre-requisite Courses	18EES101J	Co-requisite Courses	Nil	Progressive Courses	18ECC204J
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Understand the fundamentals of signals, systems and their classification
CLR-2 :	Learn the methods of representing the continuous signal and its properties
CLR-3 :	Educate about system modeling through Laplace transform and Convolution integral for continuous time systems
CLR-4 :	Learn about discrete time signals and its properties
CLR-5 :	Understand the concept of Z-Transform for the analysis of DT system
CLR-6 :	Learn about continuous and discrete signals and its properties

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1 Level of Thinking (Bloom)	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 :	Acquire knowledge of various classifications of Signals and Systems	2	85	65	H	M	-	M	-	-	-	-	-	-	-	-	M	H	M
CLO-2 :	Analyze Periodic and Aperiodic for Continuous time Signals using Fourier series and Fourier Transform	3	85	65	M	H	M	H	-	-	-	-	-	-	-	-	M	-	H
CLO-3 :	Analyze and characterize the Continuous time system through Laplace transform and Convolution integral.	3	85	65	M	H	M	H	-	-	-	-	-	-	-	-	M	-	H
CLO-4 :	Analyze and characterize the Discrete time signals and system through DTFT, Convolution sum	3	85	65	H	H	M	M	-	-	-	-	-	-	-	-	M	-	H
CLO-5 :	Analyze and characterize the Discrete time system using Z transform	2	85	65	H	M	H	M	-	-	-	-	-	-	-	-	M	-	H
CLO-6 :	Understand the properties and modeling of continuous and discrete time signals	3	85	65	H	H	M	M	-	-	-	-	-	-	-	-	M	-	H

		Classification of Signals and Systems	Analysis of Continuous Time Signals	Analysis of LTI CT System	Analysis of DT Signals and Systems	Analysis of LTI DT System using Z-Transform
Duration (hour)		12	12	12	12	12
S-1	SLO-1	Introduction to signals and systems	Introduction to Fourier series	System modeling	Representation of sequences	Z transform – introduction
	SLO-2	Requirements of signal and system analysis in communication	Representation of Continuous time Periodic signals	Description of differential equations	Discrete Time Fourier Transform (DTFT) – Existence	Region of convergence of finite duration sequences-properties.
S-2	SLO-1	Continuous time signals (CT signals)	Fourier series: Trigonometric representation	Solution of Differential equation using classical method	DTFT of standard signals	Unilateral and bilateral z transforms
	SLO-2	Discrete time signals (DT signals)	Fourier series: Trigonometric representation	Differential equation: Zero state response	Properties of DTFT	Properties of z transform
S-3	SLO-1	Representation of signals: Step, Ramp, Pulse, Impulse	Fourier series: Cosine representation	Differential equation: Zero Input response	Problems on Properties of DTFT	Practice problems
	SLO-2	Representation of signals: Sinusoidal, Exponential	Fourier series: Cosine representation	Total Response using classical method	Inverse DTFT	Practice problems
S-4	SLO-1	Basic operation on the signals	Symmetry conditions	Impulse response	Impulse response of a system with DTFT	Relation between DTFT and Z transform
	SLO-2	Problems on signal operations	Properties of Continuous time Fourier series	Step response	Frequency response of a system with DTFT	Practice problems
S-5	SLO-1	Classification of CT and DT signals: Periodic & Aperiodic signals.	Practice problems on Fourier series	Frequency response	Step response	condition for causality in Z domain-Problems
	SLO-2	Classification of CT and DT signals: Deterministic & Random signals.	Practice problems on Fourier series	Practice problems on solution of differential equation	Practice problems	condition for stability in Z domain-Problems
S-6	SLO-1	Energy signal	Gibb's Phenomenon	Convolution integral	Solution of linear constant coefficient difference equations	Inverse Z transform

	SLO-2	*Power signal*	*Parseval's relation for power signals*	*Properties of convolution*	*Problems with and without Initial conditions*	*Power series expansion*
S-7	SLO-1	*Even & Odd signals*	*Power density spectrum,*	*Graphical method of convolution*	*Solution of difference equations using classical method*	*Inverse Z transform with Partial fraction*
	SLO-2	*Even & Odd signals*	*Frequency spectrum.*	*Practice Problems*	*Zero input response , Zero state response, Total response*	*Inverse Z transform with Partial fraction*
S-8	SLO-1	*CT systems and DT systems*	*Fourier transform: Introduction*	*Analysis using Laplace transform*	*Practice problems*	*Residue method*
	SLO-2	*Classification of systems: Static & Dynamic*	*Representation of Continuous time signals*	*ROC and Convergence of Laplace Transform*	*Practice problems*	*Convolution method*
S-9	SLO-1	*Superposition theorem*	*Properties of Continuous time Fourier transform*	*Properties of Laplace transform*	*DFT and IDFT*	*Analysis and characterization of DT system using Z-transform*
	SLO-2	*Linear & Nonlinear system*	*Properties of Continuous time Fourier transform*	*Problems on properties of Laplace transform*	*Properties of DFT*	*Analysis and characterization of DT system using Z-transform*
S-10	SLO-1	*Time-variant & Time-invariant system*	*Parseval's relation for energy signals*	*Inverse Laplace transform*	*Practice problems*	*Practice problems*
	SLO-2	*Time-invariant system*	*Energy density spectrum*	*Problems*	*Convolution sum*	*Practice problems*
S-11	SLO-1	*Causal system*	*Practice problems on Fourier Transform*	*Analysis of LTI system using Laplace transform*	*Convolution properties*	*Realization of Discrete time system- Direct form I, Direct Form II*
	SLO-2	*Noncausal system*	*Practice problems on Fourier Transform*	*Analysis LTI system using Laplace transform-Problems*	*Linear Convolution,-Tabulation method, Matrix method*	*Realization of Discrete time system-Parallel and cascade form*
S-12	SLO-1	*Stable & Unstable,LTI System*	*Practice problems on properties of Fourier Transform*	*Analysis LTI system using Fourier transform*	*Linear convolution-Graphical method*	*Practice problems*
	SLO-2	*Unstable, LTI System*	*Practice problems on properties of Fourier Transform*	*Analysis LTI system using Fourier transform-Problems*	*Circular convolution-concentric circle method, matrix method*	*Practice problems*

Learning Resources	1. *Alan V Oppenheim, Ronald W. Schafer Signals & Systems, 2nd ed., Pearson Education, 2015* 2. *P.Ramakrishna Rao, Shankar Prakriya, Signals & Systems, 2nd ed., McGraw Hill Education, 2015* 3. *Simon Haykin, Barry Van Veen, Signals and Systems, 2nd ed., John Wiley & Sons Inc., 2007*	4. *Lathi B.P, Linear Systems & Signals, 2nd ed., Oxford Press, 2009* 5. *John G. Proakis, Manolakis, Digital Signal Processing, Principles, Algorithms and Applications, 4th ed., Pearson Education, 2007*

Learning Assessment

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

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

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

Course Code	18ECC105T	Course Name	ELECTROMAGNETICS AND TRANSMISSION LINES	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses	18EES101J, 18PYB101J	Co-requisite Courses	Nil	Progressive Courses	18ECC206T
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Clark's Table, IS : 456-2000		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Gain knowledge on the basic concepts and insights of Electric field			
CLR-2 :	Gain knowledge on the basic concepts and insights of Magnetic field and Emphasize the significance of Maxwell's equations.			
CLR-3 :	Interpret the wave propagation in guided waveguide.			
CLR-4 :	Acquire the fundamental knowledge on Transmission Line Theory.			
CLR-5 :	Acquire the knowledge on transmission line parameter calculation and impedance matching concepts.			
CLR-6 :	Acquire knowledge on theoretical concepts and analysis techniques to find solutions for problems related to electromagnetic wave propagation and Transmission line Theory.			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Apply the concepts and knowledge to solve problems related to electric field.	2	80	70	M	H													
CLO-2 :	Interpret and apply the concepts of Magnetic field and Maxwell's equations in the real world application.	2	80	70	H	M													
CLO-3 :	Understand the phenomenon of guided wave propagation and its mode of propagation.	1	80	70	H	M													
CLO-4 :	Realize the importance of transmission line theory applicable to low frequency transmission lines.	1	80	70	M	H													
CLO-5 :	Solve transmission line parameter and impedance matching through analytical and graphical methods.	2	80	70	M	H													
CLO-6 :	Understand how electromagnetic waves are generated using Maxwell's equations and how Transmission lines are used to transfer electromagnetic energy from one point to another with minimum losses over a wideband of frequencies.	2	80	70	M	H										H			L

Duration (hour)		Electrostatics	Magnetostatics and Maxwells Equations	Electromagnetic Waves and Waveguides	Transmission Line Theory	Transmission Line Calculator and Impedance Matching
		9	9	9	9	9
S-1	SLO-1	Introduction	Energy density in electrostatic field	Introduction	Transmission line parameters	Introduction
	SLO-2	Rectangular co-ordinate	Problem discussion.	Waves in general	Transmission line parameters	Smith chart Introduction
S-2	SLO-1	Cylindrical & Spherical Co-ordinate	Biot savart law-Magnetic field intensity due to Infinite line charge	Plane wave in lossless dielectric	Transmission line equivalent circuit	Reflection coefficient, Standing wave ratio Input impedance calculation in smith chart
	SLO-2	Review of vector calculus	H- due finite and semi finite line charge	Plane wave in free space	Explanation	Practice problems.
S-3	SLO-1	Coulomb's Law and field intensity	Ampere's circuital law& application: Infinite line current	Plane wave in good conductor	Transmission line equation derivation	Single stub matching Introduction
	SLO-2	Problem based on coulomb's law	Infinite Sheet current	Problems based on plane waves in lossless, free space and good conductor	Problem discussion.	Procedure for single stub matching
S-4	SLO-1	Electric field due to continuous charge distribution-.Concept	Infinitely long coaxial Transmission line	Rectangular waveguide	Transmission line characteristics: lossless line	Problems solving in smith chart
	SLO-2	Derivation of E due Infinite Line charge	Problem based on ACL.	Rectangular waveguide-Problems	Distortionless line.	Problems solving in smith chart
S-5	SLO-1	Electric field due to sheet charge	Magnetic flux density	Transverse Electric (TE) mode	Input impedance derivation	Impedance matching using Quarter wave transformer
	SLO-2	Problem based on sheet charge	Problem based on magnetic field and flux.	Transverse Electric (TE) mode-problems	Problems for input impedance calculation.	Problems.

S-6	SLO-1	*Electric field due to volume charge*	*Maxwell's equation for static field*	*Transverse Electric (TE) mode*	*Standing wave ratio*	*Single stub tuner*
	SLO-2	*Electric flux density*	*Faraday's law*	*Transverse Electric (TE) mode-Problems*	*Calculation of standing wave ratio.*	*Problem discussion*
S-7	SLO-1	*Gauss law application-point charge*	*Transformer EMF*	*Wave propagation in guide*	*Reflection coefficient*	*Slotted Line (Impedance Measurement)*
	SLO-2	*Electric flux due infinite line charge*	*Motional EMF*	*Problem discussion*	*Problem discussion.*	*Problem discussion*
S-8	SLO-1	*Electric flux due sheet charge*	*Displacement current.*	*Power Transmission*	*Shorted line, open circuited line*	*Transmission Lines as circuit Elements*
	SLO-2	*Electric flux due coaxial cable*	*Maxwell's equation in time varying field*	*Calculation of Pavg and Ptotal*	*Matched line*	*Problem discussion*
S-9	SLO-1	*Relation between E&V*	*Time varying potential concepts*	*Power attenuation*	*Power calculations*	*Additional smith chart problem solving.*
	SLO-2	*Electric dipole and flux lines*	*Time varying potential derivation.*	*Calculation of αTE and αTE*	*Problem discussion.*	*Additional smith chart problem solving.*

Learning Resources	*1. Matthew N. O. Sadiku., S. V. Kulkarni, Elements of Electromagnetics, 6th ed., Oxford University Press, 2015* *2. G. S. N. Raju, Electromagnetic Field Theory and Transmission Lines, Pearson Education, 2006* *3. Nannapaneni Narayana Rao, Principles of Engineering Electromagnetics,6th ed., Pearson Education, 2016*	*4. William H. Hayt,Jr., John A.Buck., Engineering Electromagnetics, 8th ed., Tata McGraw-Hill 2012* *5. John D.Ryder, Networks, Lines and Fields, PHI, 2009*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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*	*1. Dr. P. Eswaran, SRMIST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECC201J	Course Name	ANALOG ELECTRONIC CIRCUITS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18ECC102J	Co-requisite Courses	18ECC202J	Progressive Courses	18ECE201J
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Understand the operation and design of BJT amplifier circuits for a given specification			
CLR-2 :	Understand the operation and design of MOSFET amplifier circuits for a given specification			
CLR-3 :	Understand the effects of negative feedback on amplifier circuits, and analyze the different RC and LC oscillator circuits to determine the frequency of oscillation			
CLR-4 :	Understand the operation and design of various types of power amplifier circuits.			
CLR-5 :	Understand how matched transistor characteristics are used in the IC design and to be able to design BJT and MOSFET current sources.			
CLR-6 :	Gain hands-on experience to put theoretical concepts learned in the course to practice.			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Analyze and design bipolar amplifier circuits to meet certain specifications, and to Analyze the frequency response of amplifier circuits, taking into account various circuit capacitors, to determine the bandwidth of the circuit.	2,3	80	70	L	M	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Analyze and design MOSFET amplifier circuits to meet certain specifications, and to Analyze the frequency response of amplifier circuits, taking into account various circuit capacitors, to determine the bandwidth of the circuit.	2,3	80	70	L	M	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	Understand the characteristics and principles of feedback amplifier circuits and oscillator circuits to analyze and design circuits to meet certain specifications.	2,3	80	70	L	M	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	Analyze three principle classes of power amplifiers, and determine the maximum possible conversion efficiency of each type of power amplifier	2,3	80	70	L	M	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-5 :	Present the basic circuit building blocks that are used in the design of IC amplifiers, namely current mirrors and sources	2,3	80	70	L	M	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-6 :	Analyze and design analog electronic circuits using discrete components, and take measurement of various analog circuits to compare experimental results in the laboratory with theoretical analysis.	3	90	80	-	-	H	-	M	-	-	L	M	-	-	M	H	L	-

Duration (hour)		BJT Amplifiers	FET Amplifiers	Feedback amplifies & Oscillators	Oscillators & Power Amplifiers	IC Biasing & Amplifiers with Active Load
		15	15	15	15	15
S-1	SLO-1	Overview of DC analysis of BJT circuits	Overview of FET DC circuit analysis	Basic feedback concepts, general feedback structure	Crystal Oscillators	BJT current sources: Cascode current source, Widlar current source
	SLO-2	Overview of BJT models	Problem solving	Properties of negative feedback	Problem solving	Multi-transistor current source Problem solving
S-2	SLO-1	AC load line analysis	Graphical analysis, load lines, and small-signal models	Feedback Topologies: Voltage-Series & Current-Series feedback connections	Negative-resistance oscillator	FET current sources: 2-transistor MOSFET current source
	SLO-2	Problem solving	Problem solving	Problem solving	Problem solving	Problem solving
S-3	SLO-1	AC analysis of Common-Emitter BJT amplifier config. using hybrid-π model	AC analysis of Common-Source MOSFET amplifier configuration	Feedback Topologies: Voltage-Shunt & Current-Shunt feedback connections	Power Amplifiers: Definitions and amplifier types	FET current sources: Cascode current mirror and Wilson current mirror
	SLO-2	Problem solving	Problem solving	Problem solving	Q point placement	Problem solving
S 4-5	SLO-1 SLO-2	Lab 1: Learning to design amplifier and oscillator circuits	Lab 4: Design & analyze differential amplifier with resistive load	Lab 7: Design and analyze RC oscillators	Lab 10: BJT & FET Current Sources	Lab 13: Design and analyze differential amplifier with active load
S-6	SLO-1	AC analysis of Common-Base BJT	AC analysis of Common-Gate MOSFET	Practical Feedback Amplifier Circuits	Maximum dissipation hyperbola	Analysis of CE BJT amplifier circuit with

		amplifier configuration using hybrid-π model	*amplifier configuration*			*active load*
	SLO-2	*Problem solving*	*Problem solving*	*Problem solving*	*Heat sink*	*Problem solving*
S-7	SLO-1	*AC analysis of Common-Collector BJT amplifier config. using hybrid-π model*	*AC analysis of Common-Drain MOSFET amplifier configuration*	*Oscillators: Principles of Oscillation*	*Class A amplifier*	*Analysis of CS FET amplifier circuit with active load*
	SLO-2	*Problem solving*	*Problem solving*	*Types of Oscillators*	*Problem solving*	*Problem solving*
S-8	SLO-1	*Multi-stage amplifier configurations: CE - CE, CE - CC amplifiers*	*BiFET amplifier configuration*	*Audio Frequency Oscillators: RC Phase-Shift Oscillator*	*Class B and Class AB push-pull amplifiers*	*DC and small-signal analysis of basic BJT differential pairs*
	SLO-2	*Problem solving*	*Problem solving*	*Problem solving*	*Problem solving*	*Problem solving*
S 9-10	SLO-1	*Lab 2: Design and analyze BJT amplifier configurations*	*Lab 5: Design and analyze negative feedback amplifier configurations*	*Lab 8: Design and analyze LC oscillators*	*Lab 11: Design and analyze BJT CE amplifier with active load*	*Lab 14: Model Practical Examination*
	SLO-2					
S-11	SLO-1	*Multi-stage amplifier configurations: CE - CB, and CC - CC amplifiers*	*Low Frequency response analysis of a basic FET CS amplifier*	*Audio Frequency Oscillators: Wein Bridge Oscillator*	*Class C amplifiers*	*DC and small-signal analysis of basic FET differential pairs*
	SLO-2	*Problem solving*	*Problem Solving*	*Problem Solving*	*Problem solving*	*Problem solving*
S-12	SLO-1	*Low Frequency response analysis of a basic BJT CE amplifier*	*High Frequency response analysis of a basic FET CS amplifier*	*Radio Frequency Oscillators: Hartley Oscillator*	*Class D and Class E amplifiers*	*Analysis of BJT differential amplifier with active load*
	SLO-2	*Problem Solving*	*Problem Solving*	*Problem solving*	*Amplifier distortions*	*Problem solving*
S-13	SLO-1	*High Frequency response analysis of a basic BJT CE amplifier*	*Design problems in MOSFET amplifier configurations*	*Radio Frequency Oscillators: Colpitts & Clapp Oscillators*	*IC Biasing & Amplifiers with Active Load: BJT current sources: 2- & 3-transistor current sources*	*Analysis of FET differential amplifier with active load*
	SLO-2	*Problem Solving*	*Operational voltage levels*	*Problem solving*	*Problem solving*	*Problem solving*
S 14-15	SLO-1	*Lab 3: Design and analyze multistage amplifier configurations*	*Lab 6: Design and analyze MOSFET amplifier configurations*	*Lab 9: Classes of power amplifier (efficiency calculation)*	*Lab 12: Design and analyze FET CS amplifier with active load*	*Lab 15: End Semester Practical Examination*
	SLO-2					

Learning Resources	1. *David A. Bell, Electronic Devices and Circuits, 5th ed., Oxford University Press, 2015* 2. *Donald Neamen, Electronic Circuits: Analysis and Design, 3rd ed., McGraw-Hill Education, 2011* 3. *Muhammad Rashid, Microelectronic Circuits: Analysis & Design, 2nd ed., Cengage Learning, 2010* 4. *Adel S. Sedra, Kenneth C. Smith, Microelectronic Circuits: Theory and Applications, OUP, 2014*	5. *Robert L. Boylestad, Louis Nashelsky, Electronic Devices and Circuit Theory, 11th ed., Pearson Education, 2013* 6. *Albert P. Malvino, David J. Bates, Electronic Principles, 8th ed., Tata McGraw Hill, 2015*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
r. Level 1	Remember	*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.,

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Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	*2. Dr. M. Sangeetha, SRMIST*

Course Code	18ECC202J	Course Name	LINEAR INTEGRATED CIRCUITS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18ECC102J	Co-requisite Courses	18ECC201J	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Study the basic principles, configurations and practical limitations of op-amp			
CLR-2 :	Understand the various linear and non-linear applications of op-amp			
CLR-3 :	Understand the operation and analysis of op-amp oscillators, single chip oscillators and frequency generators			
CLR-4 :	Identify the active filter types, filter response characteristics, filter parameters and IC voltage regulators.			
CLR-5 :	Gain knowledge on data converter terminology, its performance parameters, and various circuit arrangements for A/D and D/A conversions.			
CLR-6 :	Gain hands-on experience to put theoretical concepts learned in the course to practice.			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Infer the DC and AC characteristics of operational amplifiers and its effect on output and their compensation techniques	3	80	70	H	M	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Elucidate and design the linear and non-linear applications of an opamp and special application ICs	3	85	75	M	M	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	Explain and compare the working of multivibrators using special application IC 555 and general purpose opamp	3	75	70	L	M	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	Classify and comprehend the working principle of data converters and active filters	3	85	80	L	M	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-5 :	Illustrate the function of application specific ICs such as Voltage regulators, PLL and its application in communication	3	85	75	L	M	H	-	-	-	-	-	-	-	-	-	M	-	H
CLO-6 :	Analyze and design electronic circuits and systems using linear ICs, and take measurement of various analog circuits to compare experimental results in the laboratory with theoretical analysis	3	85	75		H	H	-	M	-	-	-	M	-	-	-	H	L	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Op-amp symbol, terminals, packages	Basic op-amp circuits: Inverting & Non-inverting voltage amplifiers	Waveform Generators: Sine-wave Generators - Design	Filters: Comparison between Passive and Active Networks	Digital to Analog Conversion: DAC Specifications
	SLO-2	Op-amp-Specifications	Voltage follower	Implementation & Solving problems	Active Network Design	Solving problems
S-2	SLO-1	Block diagram Representation of op-amp	Summing, scaling & averaging amplifiers,	Square Wave generators- Design	Filter Approximations	Weighted Resistor DAC
	SLO-2	Ideal op-amp & practical op-amp - Open loop & closed loop configurations	AC amplifiers	Implementation & Solving problems	Design of LPF & Solving problems	Solving problems
S-3	SLO-1	DC performance characteristics of op-amp	Linear Applications: Instrumentation Amplifiers	Triangle wave generators	Design of HPF & Solving problems	R-2R Ladder DAC
	SLO-2	Solving Problems	Instrumentation Amplifiers, Solving Problems	Saw-tooth Wave generators.	Design of BPF& Solving problems	Solving problems
S 4-5	SLO-1	Lab-1:Basic op-amp circuits	Lab 4: Comparators	Lab 7: Waveform generators: using op-amp & 555 Timer	Lab 10: Design of LPF, HPF, BPF and Band Reject Filters	Lab 13: Flash Type ADC
	SLO-2					
S-6	SLO-1	AC performance characteristics of op-amp	V-to-I Converters	IC 555 Timer: Circuit schematic	Design of Band Reject Filters	Inverted R-2R Ladder DAC
	SLO-2	Solving Problems	I-to-V converters	Operation and its applications	Solving problems	Monolithic DAC
S-7	SLO-1	Frequency response	Differentiators	IC 555 Timer: Monostable operation	State Variable Filters – All Pass Filters,	Analog to Digital conversion: ADC specifications
	SLO-2	Frequency response	Integrators	Applications & Solving problems	Solving problems	Solving problems

S-8	SLO-1	*Frequency compensation*	*Non-linear Applications: Precision Rectifiers*	*IC 555 Timer: Astable operation*	*Switched Capacitor Filters.*	*Ramp Type ADC*
	SLO-2	*Frequency compensation*	*Wave Shaping Circuits (Clipper and Clampers)*	*Applications & Solving problems*	*Solving problems*	*Solving problems*
S 9-10	SLO-1 SLO-2	*Lab 2: Integrators and Differentiators*	*Lab 5: Wave shaping circuits*	*Lab 8: Waveform generators: using op-amp & 555 Timer*	*Lab 11: IC Voltage regulators*	*Lab 14: Simulation experiments using EDA tools*
S-11	SLO-1	*Basic op-amp internal schematic*	*Log and Antilog Amplifiers,*	*PLL: Operation of the Basic PLL*	*Voltage Regulators: Basics of Voltage Regulator*	*Successive Approximation ADC*
	SLO-2	*operations of blocks*	*Analog voltage multiplier circuit and its applications,*	*Closed loop analysis of PLL*	*Specifications and characteristic parameters*	*Solving problems*
S-12	SLO-1	*Basic op-amp internal schematic*	*Operational Trans-Conductance Amplifier (OTA)*	*Voltage Controlled Oscillator*	*Linear Voltage Regulators using Op-amp,*	*Dual Slope ADC*
	SLO-2	*operations of blocks*	*Comparators : operation*	*Solving problems*	*IC Regulators (78xx, 79xx, LM 317, LM 337, 723),*	*Flash Type ADC,*
S-13	SLO-1	*Review of data sheet of an op-amp.*	*Comparators applications*	*PLL applications*	*Switching Regulators -operation*	*Solving problems on Flash Type ADC,*
	SLO-2	*Solving Problems*	*Sample and Hold circuit.*	*Solving problems*	*Types*	*Monolithic ADC*
S 14-15	SLO-1 SLO-2	*Lab 3: Rectifiers*	*Lab 6: Waveform generators: using op-amp & 555 Timer*	*Lab 9: Design of LPF, HPF, BPF and Band Reject Filters*	*Lab 12: R-2R ladder DAC*	*Lab 15: Simulation experiments using EDA tools*

Learning Resources

1. *Ramakant A. Gayakwad, Op-Amps and Linear Integrated Circuits, 4th ed., Prentice Hall, 2000*
2. *David A. Bell, Operational Amplifiers and Linear ICs, 3rd ed., OUP, 2013*
3. *Roy Choudhury, Shail Jain, Linear Integrated Circuits, 4th ed., New Age International Publishers, 2014*
4. *Robert F. Coughlin, Frederick F. Driscoll, Operational-Amplifiers and Linear Integrated Circuits, 6th ed., Prentice Hall, 2001*
5. *Sergio Franco, Design with operational amplifier and analog integrated circuits, McGraw Hill, 1997*
6. *LABORATORY MANUAL, Department of ECE, SRM University*
7. *David A Bell, Laboratory Manual for Operational Amplifiers & Linear ICs, 2nd ed., D.A. Bell, 2001*
8. *David La Lond, Experiments in Principles of Electronic Devices and Circuits, Delmar Publishers, 1993*
9. *Muhammed H Rashid, Introduction to PSpice using OrCAD for circuits and electronics, 3rd ed., Pearson, 2004*
10. *L. K. Maheshwari, M. M. S. Anand, Laboratory Experiments and PSPICE Simulations in Analog Electronics, PHI, 2006*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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.,

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ACADEMIC CURRICULA

Professional Core Courses

MECHANICAL ENGINEERING

Regulations - 2018

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

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

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

Kattankulathur, Kancheepuram, Tamil Nadu, India

Course Code	18MEC101T	Course Name	THERMODYNAMICS	Course Category	C	Professional Core	L	T	P	C
							3	1	0	4

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Identify the fundamental concepts of thermodynamic systems and energy transfer
CLR-2 :	Utilize thermodynamic laws and their applications
CLR-3 :	Utilize the concept of entropy and availability
CLR-4 :	Utilize the evaluation of properties of pure substances and vapour power cycles
CLR-5 :	Utilize the evaluation of properties of gas and gas mixtures
CLR-6 :	Utilize the thermodynamic relations and its significance

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 concept of thermodynamic properties to quantify energy transfer	3	90	80	H	H	M	M	M	L	L	L	M	M	M	M	M	M	M
CLO-2 :	Apply thermodynamic laws to analyze various thermodynamic systems	3	90	80	H	H	M	M	M	L	L	L	M	M	M	M	M	M	M
CLO-3 :	Apply the concept of entropy and availability to thermodynamic systems and to do exergy analysis	3	90	80	H	H	M	M	M	L	L	L	M	M	M	M	M	M	M
CLO-4 :	Evaluate the properties of pure substances and analyze vapour power cycles	3	90	80	H	H	M	M	M	L	L	L	M	M	M	M	M	M	M
CLO-5 :	Evaluate the properties of gas and gas mixtures	3	90	80	H	H	M	M	M	L	L	L	M	M	M	M	M	M	M
CLO-6 :	Apply the knowledge of thermodynamic relations to evaluate non measurable properties	3	90	80	H	M	M	M	M	L	L	L	M	M	M	M	M	M	M

Duration (hour)		12	12	12	12	12
S-1	SLO-1	Thermodynamic system and Control volume	Limitations of first law	Clausius theorem	Pure substances, Phase change phenomenon of a pure substance	Properties of ideal gases
	SLO-2	Thermodynamic properties, State, Process and Cycle	Cyclic heat engine, Energy reservoirs,	Concept of entropy, T-s diagram	Property diagrams for phase change process	Properties of real gases
S-2	SLO-1	Thermodynamic equilibrium, Quasi-static process	Refrigerator and heat pump	Clausius inequality, Entropy principle	T-v, P-v,P-T diagram, P-v-T surface, Critical point and Triple point	Equation of state
	SLO-2	Pure substance , State postulate	Thermal efficiency and COP	Application of the concept of Clausius theorem	T-s and h-s diagram, Dryness fraction,	Vander Waal's equation of state
S-3	SLO-1	Concept of temperature, Zeroth law of thermodynamics,	Kelvin-Planck statement and Clausius statement of second law	Clausius inequality on solving problems of heat engines, heat pump and refrigerators.	Use of Steam tables,Mollier chart	Compressibility factor, compressibility chart
	SLO-2	Work and heat interaction	Equivalence of the two statements	Evaluation of change in entropy for solids and liquids	Identification of states & Determination of properties	Problem solving on evaluation of properties of ideal gas and real gas.
S-4	SLO-1	Path function and point function.	Tutorials on Second law of thermodynamics	Tutorials on change in entropy for solids and liquids	Tutorials on calculation of steam properties	Tutorials on properties of ideal gas and real gas.
	SLO-2	pdVwork for various quasi-static processes	Tutorials on Second law of thermodynamics	Tutorials on change in entropy for solids and liquids	Tutorials on calculation of steam properties	Tutorials on properties of ideal gas and real gas.
S-5	SLO-1	Tutorials on Work and Heat Transfer.	Reversible and irreversible process	Evaluation of change in entropy for ideal gases undergoing various processes	Rankine cycle	Properties of mixture of gases
	SLO-2	other types of work transfer including flow work	Causes of irreversibility	Evaluation of change in entropy for ideal gases undergoing various processes	Operation of Rankine cycle	Dalton's law of partial pressures
S-6	SLO-1	First law of thermodynamics for a closed system	Carnot cycle	Available and unavailable energy	Analysis of Rankine cycle	Amagat's law of additive volumes
	SLO-2	Concept of total energy E	Working of a Carnot engine	Dead state	Analysis of Rankine cycle	Internal energy, enthalpy
S-7	SLO-1	Various modes of energy	Thermal efficiency of a Carnot heat engine	Availability	Problems solving on Rankine cycle	specific heats and entropy of gas mixtures

	SLO-2	*Tutorials on first law for a closed system*	*Tutorials on Carnot engines*	*Irreversibility*	*Problems solving on Rankine cycle*	*Problem solving on evaluation of properties of gas mixtures*
S-8	SLO-1	*Tutorials on first law: Constant volume, constant pressure, process in which PV=C*	*Reversed Carnot cycle*	*Tutorials on change in entropy for ideal gases*	*Tutorials on Rankine cycle with different turbine inlet conditions*	*Tutorials on properties of gas mixtures*
	SLO-2	*Tutorials on first law: Polytropic, adiabatic process, Combination of different process*	*Carnot's theorem*	*Tutorials on change in entropy for ideal gases*	*Tutorials on Rankine cycle with different turbine inlet conditions*	*Tutorials – Mixing of gases*
S-9	SLO-1	*Internal energyand Enthalpy, specific heats*	*Thermodynamic temperature scale.*	*Availability of energy entering a system*	*Reheat Rankine cycle*	*Maxwell's relations*
	SLO-2	*Process and cycle*	*Efficiency of Carnot heat engine*	*Availability of energy entering a system*	*Operation of reheat Rankine cycle*	*T-ds relations*
S-10	SLO-1	*First law applied to flow processes*	*COP of Carnot refrigerator*	*Problems solving on Availability of a closed system*	*Analysis of reheat Rankine cycle*	*Equations for dH and dU.*
	SLO-2	*Derivation of general energy equation for a control volume*	*Carnot heat pump, COP*	*Problems solving on Availability of a closed system*	*Concept of regeneration in Rankine cycle*	*Clausius-Clapeyron Equation*
S-11	SLO-1	*Application of SFEE to various steady flow devices*	*Tutorials on combined heat engine & refrigerator/heat pump system*	*Availability in a steady flow process*	*Problem solving on reheat Rankine cycle*	*Joule-Thomson experiment*
	SLO-2	*Problem solving on first law applied to flow processes*	*Tutorials on combined heat engine & refrigerator/heat pump system*	*Problem solving on availability*	*Problem solving on reheat Rankine cycle*	*Joule -Thomson coefficient.*
S-12	SLO-1	*Tutorial on first law applied to various steady flow devices*	*Tutorials on combined heat engine & refrigerator/heat pump system*	*Tutorials on availability*	*Tutorials on reheat Rankine cycle*	*Tutorials on Thermodynamic relations*
	SLO-2	*Tutorial on first law applied to various steady flow devices*	*Tutorials on combined heat engine & refrigerator/heat pump system*	*Tutorials on availability*	*Tutorials on reheat Rankine cycle*	*Tutorials on Thermodynamic relations*

Learning Resources	1. *Mahesh M. Rathore, Thermal Engineering, Tata McGraw Hill Education, 2012* 2. *Yunus. ACengel., Michael A Boles, Thermodynamics – An Engineering Approach, 8th ed., Tata McGraw Hill- Education, 2015* 3. *Nag. P.K, Engineering Thermodynamics, 5th ed., Tata McGraw Hill Education, 2013* 4. *R. K. Rajput, Thermal Engineering, 10th ed., Laxmi Publications (P) Ltd, New Delhi, 2017*	5. *Michael J Moran, and Howard N Shapiro, Fundamentals of Engineering Thermodynamics, 8th ed., John Wiley & Sons, New York, 2015* 6. *Claus Borgnakke, Richard E. Sonntag, Fundamentals of Thermodynamics, 7th ed., Wiley, 2009* 7. *Ramalingam. K. K, Steam tables, Sci.Tech Publishers, 2009*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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	*1. Dr. R Velraj, IES,CEG, Anna University, Chennai, velrajr@annauniv.edu*	*1. Mr. V Thirunavukkarasu, SRMIST*
2. Dr.A.Velayutham, DRDO, Avadi, velayudham.a@cvrde.drdo.in	*2. Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	*2. Dr. M. Cheralathan, SRMIST*

Course Code	18MEC102T	Course Name	FLUID MECHANICS	Course Category	C	Professional Core	L	T	P	C
							3	1	0	4

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Utilize the properties of fluid and pressure measurement techniques using manometer
CLR-2 :	Utilize the basic equations of fluid mechanics to solve fluid flow problems
CLR-3 :	Utilize the applications of dimensional and model analysis
CLR-4 :	Identify the working principle and design of hydraulic turbines and pumps
CLR-5 :	Utilize the concept of boundary layer, lift and drag forces
CLR-6 :	Identify the behavior of fluids at rest as well as in motion

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1 Level of Thinking (Bloom)	Learning 2 Expected Proficiency (%)	Learning 3 Expected Attainment (%)
CLO-1 :	Identify the properties of fluid	2	85	80
CLO-2 :	Solve the fluid flow problems	3	85	80
CLO-3 :	Apply the mathematical techniques for practical fluid flow problem	3	85	80
CLO-4 :	Identify the energy exchange process in fluid machinery	3	85	80
CLO-5 :	Identify the boundary layer theory and flow over submerged bodies	2	85	80
CLO-6 :	Analyze the dynamics of fluid flows and their governing parameters	3	85	80

		Program Learning Outcomes (PLO) 1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	13 PSO - 1	14 PSO - 2	15 PSO - 3
CLO-1 :	Identify the properties of fluid	H	H	H	H	M	L	L	L	M	L	-	H	L	H	L
CLO-2 :	Solve the fluid flow problems	H	H	H	H	M	L	L	L	M	L	-	H	L	H	L
CLO-3 :	Apply the mathematical techniques for practical fluid flow problem	H	H	H	H	M	L	L	L	M	L	-	H	L	H	L
CLO-4 :	Identify the energy exchange process in fluid machinery	H	H	H	H	M	L	L	L	M	L	-	H	L	H	L
CLO-5 :	Identify the boundary layer theory and flow over submerged bodies	H	H	H	H	M	L	L	L	M	L	-	H	L	H	L
CLO-6 :	Analyze the dynamics of fluid flows and their governing parameters	H	H	H	H	M	L	L	L	M	L	-	H	L	H	L

Duration (hour)		12	12	12	12	12
S-1	SLO-1	Types of Fluids, Properties of fluid	Types of fluid flow	Dimensional analysis	Hydraulic machines	Boundary layer
	SLO-2	Density, Specific weight, Specific volume,	Lagrangian and Eulerian approach of study	Dimensions, Dimensional Homogeneity	Turbines and Pumps	Laminar boundary layer
S-2	SLO-1	Specific gravity, Vapor pressure	Velocity of Fluid particles	Buckingham's pi theorem	Classification of turbines and pumps	Turbulent boundary layer
	SLO-2	Viscosity: Dynamic and Kinematic viscosity	Acceleration of Fluid particles	Model analysis	Pelton turbine-Working principle	Boundary layer thickness
S-3	SLO-1	Newton's law of viscosity	Continuity equation	Advantages and applications	Velocity triangle	Displacement thickness
	SLO-2	Surface tension and Capillarity	Continuity equation in three dimensions	Similitude, Dimensionless numbers	Design parameters, Performance	Problem solving on boundary layer thickness
S-4	SLO-1	Tutorials on fluid properties	Tutorials on Velocity, Acceleration and Continuity equation	Tutorials on Buckingham's pi theorem	Tutorials on Pelton turbine	Tutorials on Boundary layer thickness
	SLO-2	Tutorials on fluid properties	Tutorials on Velocity, Acceleration and Continuity equation	Tutorials on Buckingham's pi theorem	Tutorials on Pelton turbine	Tutorials on Boundary layer thickness
S-5	SLO-1	Bulk modulus of elasticity and Compressibility	Fluid Dynamics	Model laws- Reynold's, Froude	Francis turbine-Working principle	Momentumthickness
	SLO-2	Fluid statics: Pascal'slaw	Euler equation of motion	Model laws- Euler	Velocity triangle	Energy thickness
S-6	SLO-1	Hydrostatic law	Bernoulli's equation	Tutorials on Reynold's and Froude model laws	Kaplan turbine-Working principle	Drag force on a flat plate due to boundary layer
	SLO-2	Manometers: Types	Applications of bernoulli's equation	Weber and Mach model laws	Velocity triangle	von Karman momentum integral equation

S-7	SLO-1	*Piezometer*	*Venturimeter*	*Laminar flow-Reynold's experiment*	*Cavitation in turbines*	*Separation of boundary layer*
	SLO-2	*Applications and Limitation*	*Orificemeter*	*Hagen poiseuille law*	*Problem solving on Turbine performances*	*Problem Solving on momentum integral equation*
S-8	SLO-1	*Tutorials on laws of fluid statics*	*Tutorials on Venturimeter and Orificemeter*	*Tutorials on major and minor losses*	*Tutorials on Francis and Kaplan turbine*	*Tutorial problems on momentum integral equation*
	SLO-2	*Tutorials on laws of fluid statics*	*Tutorials on Venturimeter and Orificemeter*	*Tutorials on major and minor losses*	*Tutorials on Francis and Kaplan turbine*	*Tutorial problems on momentum integral equation*
S-9	SLO-1	*U-Tube manometer*	*Pitot tube*	*Turbulent flow-Darcy equation*	*Reciprocating pump*	*Forces exerted by a flowing fluid on a stationary body*
	SLO-2	*Problem Solving on U-tube manometer*	*Nozzle flow meter*	*Minor loss due to sudden enlargement*	*Single and double acting pumps-working principle*	*Separation of flow over bodies*
S-10	SLO-1	*Single column manometer*	*Bernoulli's equation for real fluid*	*Minor loss due to sudden contraction*	*Centrifugal pump - Working principle*	*Streamlined and bluff bodies*
	SLO-2	*Differential U-tube manometer*	*Types of flow lines, Stream line*	*entrance and exit of pipe*	*Velocity triangle, Design parameters*	*Development of lift on a circular cylinder*
S-11	SLO-1	*Inverted differential U-tube manometer*	*Streak line and Path line*	*Flow through pipes in series*	*Cavitation in pumps*	*Development of lift on an aerofoil*
	SLO-2	*Problem solving in differential manometer*	*Impulse Momentum equation*	*Flow through pipes in parallel*	*Performance curves on turbines and pumps*	*Problem Solving on lift and drag forces*
S-12	SLO-1	*Tutorials on differential manometer*	*Tutorials on finding force exerted by fluid on pipe bend*	*Tutorials on major and minor losses*	*Tutorials on centrifugal pump*	*Tutorials on lift and drag forces*
	SLO-2	*Tutorials on differential manometer*	*Tutorials on finding force exerted by fluid on pipe bend*	*Tutorials on major and minor losses*	*Tutorials on centrifugal pump*	*Tutorials on lift and drag forces*

Learning Resources	1. *Rajput. R. K, A text book of Fluid Mechanics and Hydraulic Machines, S.Chand & Company Ltd., 6th ed., 2015* 2. *Bansal. R. K, A text book of Fluid Mechanics and Hydraulics Machines, Laxmi publications (P) Ltd., 9thed., 2015* 3. *Modi P.N, Seth S.M, Hydraulics and Fluid Mechanics, Standard Book House,15thed., 2002*	4. *White. F. M, Fluid Mechanics, Tata McGraw-Hill, 7th ed., 2011* 5. *Streeter. V. L, Wylie. E. B, Fluid Mechanics , McGraw Hill,5thed., 1984* 6. *Modi P.N, Seth S.M, Hydraulics and Fluid Mechanics, Standard Book House,15thed., 2002*

Learning Assessment

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

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.R.Kalimuthu, ISRO, Mahendragiri, r_kalimuthu@vssc.gov.in	*1. Dr. R Velraj, IES, CEG, Anna University, Chennai, velrajr@annauniv.edu*	*1. Mr. V. Rajasekar, SRMIST*
2. Dr.A.Velayutham, DRDO, Avadi, velayudham.a@cvrde.drdo.in	*2. Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	*2. Dr. K. Suresh Kumar, SRMIST*

Course Code	18MEC103T	Course Name	MANUFACTURING TECHNOLOGY	Course Category	C	Professional Core	L	T	P	C
							3	1	0	4

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Utilize the Concepts of casting Technology
CLR-2 :	Identify the Mechanical working of metals
CLR-3 :	Identify the Theory of metal cutting
CLR-4 :	Utilize machine tools principles and its application in manufacturing industry
CLR-5 :	Identify the various metal joining process for the assembly operations.
CLR-6 :	Utilize principles and techniques of casting, forming, joining and finishing operations and determine their suitability

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 metal casting processes and to recognize the various casting techniques to apply for making the product	2	90	85	H	L	M	M	-	-	-	-	M	-	-	-	H	L	H
CLO-2 :	Identify metal forming processes and sheet metal techniques to apply the techniques for any fabrication work	2	90	85	H	M	M	M	-	-	-	-	M	-	-	-	H	L	H
CLO-3 :	Use the theory behind the metal cutting operation and acquire the knowledge about cutting tool and cutting fluids	2	90	85	H	M	M	M	-	-	-	-	M	-	-	-	H	L	H
CLO-4 :	Identify machine parts and operations of milling, shaping, slotting, planning and broaching machines	2	90	85	H	L	M	L	-	-	-	-	M	-	-	-	H	L	H
CLO-5 :	Identify various metal joining process and its application in various industrial sectors	2	90	85	H	L	H	H	-	-	-	-	M	-	-	-	H	L	H
CLO-6 :	Identify manufacturing processes, tools, environment and suitable manufacturing processes for fabrication work	2	90	85	H	M	M	M	-	-	-	-	M	-	-	-	H	L	H

Duration (hour)		12	12	12	12	12
S-1	SLO-1	Introduction to Casting	Introduction to Hot Working	Orthogonal cutting	Introduction to Gear Manufacturing	Types of Welding Processes, Types of Joints, Types of Welds,
	SLO-2	Patterns and its types and Materials	Cold Working	Oblique cutting	Machining and Generating Processes	Power Density, Heat Balance in Fusion Welding
S-2	SLO-1	Pattern Allowances	Hot and Cold Rolling	Classification of cutting tools	Classification of Milling Machines and its basic construction,	General Technology of Arc Welding
	SLO-2	Moulding and its types,	Types of rolling; Two, three, four, multi and Universal rolling	Single point cutting tools	Types of cutters in Milling machines	consumable and non-consumable electrodes Oxy-fuel Gas Welding
S-3	SLO-1	Moulding sand	Open die and Closed die forging	Multipoint cutting tools	Types of milling operations; (up and down, peripheral, face milling	Fundamentals of Shielded Metal Arc Welding
	SLO-2	Design of Gating system	Wire drawing	Tool signature for single point cutting tool	Simple and differential Indexing methods and its calculations	Gas Metal Arc Welding, and Submerged Arc Welding
S-4	SLO-1	Tutorial for design of gating system	Tutorial Session	Tutorial on Numerical in cutting force calculation	Tutorial 10 Numerical in indexing methods	Tutorial Session
	SLO-2	Tutorial for design of gating system	Tutorial Session	Tutorial on Numerical in cutting force calculation	Tutorial 10 Numerical in indexing methods	Tutorial Session
S-5	SLO-1	Numerical problems on pouring time	Hot, Cold wire drawing	Mechanics of orthogonal cutting	Shaping and slotting Machine	Fundamentals of Gas tungsten arc welding
	SLO-2	Numerical problems on Caine's rule	Forward, backward and tube extrusion	Force relationship	Description and Operations	Resistance welding, and Plasma arc welding
S-6	SLO-1	Numerical Problems on Riser design	Shearing, Piercing	Merchant Circle	Planing; Double house and open side	Parametric considerations in solid-state welding
	SLO-2	Numerical Problems on Riser design	Trimming and Stretch forming	Merchant Circle	Quick return mechanism, Work and tool holding Devices	Difference between fusion welding and solid-state process

S-7	SLO-1	*Cores*	*Theory of Bending, Bending length*	*Determination of shear angle*	*Boring machine and its Specification, operations*	*Forge Welding, Roll Welding, Explosion Welding, Ultrasonic welding*
	SLO-2	*Core making*	*Bending force calculations*	*Determination of shear angle*	*Jig boring machine*	*Friction welding and Friction stir welding, Friction surfacing and processing*
S-8	SLO-1	*Tutorial on Numerical in riser design and pouring time*	*Tutorial on Numerical in bending force calculation*	*Tutorial on Numerical in Merchant circle*	*Tutorial on Discussion about mechanism of special purpose machine*	*Tutorial Session*
	SLO-2	*Tutorial on Numerical in riser design and pouring time*	*Tutorial on Numerical in bending force calculation*	*Tutorial on Numerical in Merchant circle*	*Tutorial on Discussion about mechanism of special purpose machine*	*Tutorial Session*
S-9	SLO-1	*Shell casting*	*Drawing*	*Chip formation*	*Specification of Broaching machine, its types and operations; internal, surface*	*Basic Solidification Concepts, Grain structure*
	SLO-2	*Investment Casting*	*Blank size and and drawing force calculations*	*Cutting tool materials*	*Tool nomenclature of broaching tool*	*Post-Solidification Phase Transformations, CCT diagram*
S-10	SLO-1	*Die casting*	*Tube forming, Embossing and coining*	*Tool wear calculation*	*Grinding process, Types of Grinding machines*	*Residual Stresses and Distortion, weld defects, Inspection and Testing Methods,*
	SLO-2	*Centrifugal Casting*	*Progressive dies*	*Taylor tool life calculation*	*Surface, Cylindrical and Centerless Grinding*	*factors of weldability, Types of weldability test techniques,*
S-11	SLO-1	*Casting defects*	*Compound and Combination dies*	*Machinability*	*Grinding Wheel and its types, Grinding specifications and type of abrasive bonds*	*Introduction on brazing and soldering methods*
	SLO-2	*Remedies for defects*	*Defects in forming*	*Cutting Fluids*	*Lapping, Buffing, Honing, and Super finishing*	*filler materials*
S-12	SLO-1	*Tutorial Session*	*Tutorial Session*	*Tutorial Session*	*Tutorial Session*	*Tutorial Session*
	SLO-2	*Tutorial Session*	*Tutorial Session*	*Tutorial Session*	*Tutorial Session*	*Tutorial Session*

Learning Resources	1. *SeropeKalpakjian, Steven R Schmid Manufacturing Engineering and Technology, 7th ed., Pearson, 2018* 2. *Mikell P. Groover, Fundamentals of Modern Manufacturing Materials, Processes, and Systems, 4th ed., John Wiley & Sons, 2010* 3. *Roy A. Lindberg, Processes and materials of manufacture, Boston: Allyn and Bacon, Pearson education, 2006* 4. *A.C. Davies, The science and practice of welding, Vol. 1 and 2, 10th ed., Cambridge University Press, 2002*	5. *John A. Schey, Introduction to manufacturing processes, 3rd ed., McGraw-Hill, 2000* 6. *Sindo Kou, Welding Metallurgy, 2nd ed., John Wiley & Sons, 2003.* 7. *John C. Lippold, Welding Metallurgy and Weldability, John Wiley & Sons, 2015* 8. *Welding Handbook – Volume 1 to 5, 9th ed., American Welding Society.2013*

Learning Assessment

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

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. R. Kalimuthu, ISRO, Mahendragiri, r_kalimuthu@vssc.gov.in, rkpearls@yahoo.com	*1. Dr. P. Hariharan, Anna University, hari@annauniv.edu, hariharan2311@gmail.com*	*1. Dr. M. Prakash, SRMIST*
2. Dr. A. Velayutham, DRDO, Avadi, velayudham.a@cvrde.drdo.in	*2. Dr. N. Arunachalam, IIT Madras, chalam@iitm.ac.in*	*2. Dr. Manidipto Mukherjee, SRMIST*

Course Code	18MEC104L	Course Name	FLUID DYNAMICS LABORATORY	Course Category	C	Professional Core	L	T	P	C
							0	0	2	1

Pre-requisite Courses	Nil	Co-requisite Courses	18MEC102T	Progressive Courses	Nil
Course Offering Department	Mechanical Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Practice working of flow measuring devices
CLR-2 :	Practice Kinematics and dynamics of fluid flow in pipes
CLR-3 :	Identify the various energy losses in pipes
CLR-4 :	Identify the performance of pumps
CLR-5 :	Analyze the performance of turbines
CLR-6 :	Analyze fluid flow concepts, working principles of flow meters, energy heads and losses, performance of pumps, turbines

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1 Level of Thinking (Bloom)	Learning 2 Expected Proficiency (%)	Learning 3 Expected Attainment (%)
CLO-1 :	Practice the concept of flow measurement devices	3	95	85
CLO-2 :	Analyze the different type of energy heads	3	95	85
CLO-3 :	Evaluate the various energy losses in pipe	3	95	85
CLO-4 :	Analyze the performance of pumps	3	95	85
CLO-5 :	Analyze the performance of turbines	3	95	85
CLO-6 :	Analyze fluid flow concepts, working principles of flow meters, energy heads and losses, performance of pumps, turbines	3	95	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	14 PSO - 2	15 PSO - 3
CLO-1 :	H	H	H	H	M	L	L	L	M	M	M	M	L	L	L
CLO-2 :	H	H	H	H	M	L	L	L	M	M	M	M	L	L	L
CLO-3 :	H	H	H	H	M	L	L	L	M	M	M	M	L	L	L
CLO-4 :	H	H	H	H	M	L	L	L	M	M	M	M	L	L	L
CLO-5 :	H	H	H	H	M	L	L	L	M	M	M	M	L	L	L
CLO-6 :	H	H	H	H	M	L	L	L	M	M	M	M	L	L	L

Duration (hour)		6	6	6	6	6
S-1	SLO-1	Flow measurement using Orificemeter	Flow visualization using Reynolds apparatus	Study of major Energy loss in a pipe	Study of Kaplan turbine Test Rig	Study of Submersible Pump Test Rig
	SLO-2					
S-2	SLO-1	Determine the co-efficient of discharge of Orifice meter	Free and forced vortex flow visualization	Determine friction factor at a given pipe	Performance test on Kaplan turbine	Performance test on Submersible pump
	SLO-2					
S-3	SLO-1	Flow measurement using Venturimeter	Obtain surface profile of forced vortex and find the depth of the forced vortex curve	Study of Pelton turbine	Study of Francis turbine Test Rig	Study of Reciprocating Pump Test Rig
	SLO-2					
S-4	SLO-1	Determine the co-efficient of discharge of Venturimeter	Verify Bernoulli's theorem	Performance test on Pelton turbine	Performance test on Francis turbine	Performance test on Reciprocating pump
	SLO-2					
S-5	SLO-1	Flow measurement using Pitot tube/ Visualization of cavitation in pipe flow	Determine total heads of fluids at given points in the pipe	Study on impact of jet of water on vanes	Study of Centrifugal Pump Test Rig	Study of Jet pump/ Performance test on Gear Pump Test Rig
	SLO-2					
S-6	SLO-1	Determine velocity at a point by using Prandtl type Pitot tube	Study of Minor losses &Determine minor losses due to pipe fittings	Determine co-efficient of impact of jet of water on different vanes	Performance test on Centrifugal pump	Performance test on Jet pump Performance test on Gear pump
	SLO-2					

Learning Resources	
	1. Robert W. Fox, Alan T. McDonald, Philip J. Pritchard, Introduction to Fluid Mechanics, 8th ed., Wiley, 2013
	2. P.N. Modi, S.M. Seth, Hydraulics& Fluid Mechanics Including Hydraulics Machines, 20th ed., Standard Book House,2018
	3. Frank M.White, Fluid Mechanics,7th ed., McGraw-Hill, 2018
	4. K L Kumar, Engineering Fluid Mechanics, 10th ed., S Chand & Co., 2015
	5. Laboratory Manual

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	*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	18MEC105L	Course Name	MANUFACTURING PROCESS LABORATORY	Course Category	C	Professional Core	L	T	P	C
							0	0	2	1

Pre-requisite Courses	Nil	Co-requisite Courses	18MEC103T	Progressive Courses	Nil
Course Offering Department	Mechanical Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Practice Various types of lathe operations
CLR-2 :	Practice the Production of flat surface and contour shapes on the given component
CLR-3 :	Practice basic Gear making processes
CLR-4 :	Practice Surface finishing process
CLR-5 :	Practice and Preparation of Sand Mould
CLR-6 :	Utilize machines like lathe, CNC Lathe, Shaper, Slotter, Milling, CNC MIlling, Gear hobbing, grinding and sand moulding

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 :	Machine using lathe to create new components according to specified dimensions	3	85	80	H	H	H	L	H	L	H	L	L	H	L	H	L	L	L
CLO-2 :	Produce the flat surface and contour shapes on the given component	3	90	85	H	M	L	L	H	L	L	L	L	H	L	H	L	L	L
CLO-3 :	Practice basic Gear Making Processes	3	95	90	M	L	H	H	L	L	L	L	H	H	L	H	L	L	L
CLO-4 :	Practice Surface Finish Process	3	85	80	H	L	H	L	L	L	H	H	L	L	L	H	L	L	L
CLO-5 :	Practice casting and molding	3	95	90	M	H	H	L	L	L	H	L	L	L	L	L	L	L	L
CLO-6 :	Practice machines like lathe, CNC Lathe, Shaper, Slotter, Milling, CNC MIlling, Gear hobbing, grinding and sand moulding	3	90	85	H	M	H	M	M	L	M	M	M	M	L	H	L	L	L

Duration (hour)		6	6	6	6	6
S-1	SLO-1	Perform plain turning in lathe	Perform eccentric turning in lathe	Perform V block shaping in shaper machine	Helical Gear cutting in Hobbing machine	Grinding of single point cutting tool in Tool and Cutter grinding machine
	SLO-2					
S-2	SLO-1	Perform step turning in lathe	Perform Taper boring in lathe	Perform V block shaping in shaper machine.	Helical Gear cutting in Hobbing machine	Grinding of single point cutting tool in Tool and Cutter grinding machine
	SLO-2					
S-3	SLO-1	Perform chamfering in lathe	Perform Knurling in lathe	Perform Polygon milling in milling machine	Perform surface grinding in Grinding machine	Preparation of Sand mold using solid/split pattern with loose-piece pattern
	SLO-2					
S-4	SLO-1	Perform taper turning by compound rest/offset method in lathe	Perform plain turning in CNC Lathe	Perform Polygon milling in milling machine	Perform surface grinding in Grinding machine	Preparation of Sand mold using solid/split pattern with loose-piece pattern
	SLO-2					
S-5	SLO-1	Perform drilling in lathe	Perform step turning in CNC Lathe	Spur Gear cutting in milling machine	Perform cylindrical grinding in Grinding machine	Preparation of Sand mold using solid/split pattern with loose-piece pattern
	SLO-2					
S-6	SLO-1	Perform external and internal thread cutting in lathe	Performing chamfering in CNC Lathe	Spur Gear cutting in milling machine	Perform cylindrical grinding in Grinding machine	Preparation of Sand mold using solid/split pattern with loose-piece pattern
	SLO-2					

Learning Resources	
	1. Chapman.W.A.J, Workshop Technology, Vol. I and II, Arnold Publisher, 2001 2. Hajra Choudhary.S.K., Hajra Choudhary.A.K, Elements of Manufacturing Technology Vol II, Media Publishers, 2007
	3. James Madison, CNC Machining Hand Book, Industrial Press Inc., New York, 1996 4. Laboratory Manual

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	*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. P. Hariharan, Anna University,* hari@annauniv.edu, *hariharan2311@gmail.com*	*1. Mr. S. Sakthivel, SRMIST*
2. Dr. A. Velayutham, DRDO, Avadi, velayudham.a@cvrde.drdo.in	*2. Dr. N. Arunachalam, IIT Madras, chalam@iitm.ac.in*	*2. Mr. Sundar Singh Sivam S.P, SRMIST*

Course Code	18MEC106T	Course Name	MECHANICS OF SOLIDS	Course Category	C	Professional Core	L	T	P	C
							3	1	0	4

Pre-requisite Courses	18MES201T	Co-requisite Courses	Nil	Progressive Courses	18MEC208T, 18MEE305T
Course Offering Department	Mechanical Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Utilize concepts of stress and strain
CLR-2 :	Analyze bending and shear stresses in beams
CLR-3 :	Utilize concepts to design shafts
CLR-4 :	Analyze of slope and deflection in beams
CLR-5 :	Utilize concepts to design column and cylinders
CLR-6 :	Utilize concepts of stress, strain, slope and deflection in beams and design of shaft, column and cylinders

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1 Level of Thinking (Bloom)	2 Expected Proficiency (%)	3 Expected Attainment (%)	PLO 1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	13 PSO - 1	14 PSO - 2	15 PSO - 3
CLO-1 :	Identify concepts of stress and strain	3	85	80	H	H	L	L	L	L	L	L	L	L	L	L	L	M	L
CLO-2 :	Analyze bending and shear stresses developed in beams	3	85	80	H	H	L	L	L	L	L	L	L	L	L	L	L	M	L
CLO-3 :	Apply the concepts necessary to design of shafts	3	85	80	H	H	H	L	L	L	L	L	L	L	L	L	L	M	L
CLO-4 :	Analyze the slope and deflection in beams	3	85	80	H	H	L	L	L	L	L	L	L	L	L	L	L	M	L
CLO-5 :	Apply the concepts necessary to design of column and cylinders	3	85	80	H	H	H	L	L	L	L	L	L	L	L	L	L	M	L
CLO-6 :	Analyze the stresses, slope and deflection in beams and apply the concepts to design of shaft, column and cylinders	3	85	80	H	H	H	L	L	L	L	L	L	L	L	L	L	M	L

Duration (hour)		12	12	12	12	12
S-1	SLO-1	Concept of stress and strain, Hooke's law	Introduction to types of beams and loads	Theory of pure torsion	Introduction, Beam deflection	Columns and struts
	SLO-2	Tensile, compressive and shear stresses, Poisson's ratio	Shear force, bending moment diagram for cantilever beam: (a) due to pure point load	shear stress in terms of torque in a circular shaft	Relation between deflection, slope, radius of curvature, shear force, bending moment	Members subjected to combined bending and axial loads
S-2	SLO-1	Stress-strain diagram Elastic constants and their relationship	(b) due to pure Uniformly Distributed Load (c) pure Uniformly Varying Load	Strength, Stiffness of shaft, Torsional rigidity & power transmitted	Problems on Relations	Expression for crippling load with different end conditions based on Euler's theory
	SLO-2	Volumetric strain	Problems on Shear force and bending moment diagrams for cantilever beam	Problems on solid shaft, finding dimensions	Problems on Relations	Problems on crippling load with different end conditions based on Euler's theory
S-3	SLO-1	Bars of uniform and varying sections subjected to single loads	Shear force, bending moment diagram for simply supported beam: (a) due to pure point load	Torque expression for (a) solid circular shaft subjected to torsion	Slope and deflection of cantilever beam with (a) a point load	Expression for crippling load by Rankine's theory
	SLO-2	Bars of uniform and varying sections subjected to multiple loads	(b) due to pure Uniformly Distributed Load (c) pure Uniformly Varying Load	(b) hollow circular shaft subjected to torsion.	(b) Uniformly Distributed Load	Problems on crippling load by Rankine's theory
S-4	SLO-1	Tutorial on stress, strain, Hooke's law, elastic constants and volumetric strain	Tutorial on Shear force, bending moment diagrams for simply supported beam	Tutorial on hollow shaft (a) finding dimensions,	Tutorial on Slope, deflection of cantilever beam with (a) a point load	Tutorial on crippling load by Rankine's theory
	SLO-2	Tutorial on bars of uniform and varying sections subjected to single, multiple loads	Tutorial on Shear force, bending moment diagrams for simply supported beam	(b) percentage of material savings	(b) Uniformly Distributed Load	Tutorial on crippling load by Rankine's theory
S-5	SLO-1	Analysis of bars of composite sections	Shear force, bending moment diagram for overhanging beam due to(a)pure point load	Circular shafts in series	Slope and deflection of simply supported beam with (a) a point load	Thin cylindrical shells subjected to internal pressure
	SLO-2	Analysis of bars of composite sections	(b)pure Uniformly Distributed Load (c) pure Uniformly Varying Load	Circular shafts in parallel	(b) a Uniformly Distributed Load (Double integration method)	Change in dimensions of thin cylindrical shells due to internal pressure
S-6	SLO-1	Problems on Analysis of bars of composite sections	Problems on Shear force and bending moment diagrams for overhanging beam	Problems on Circular shafts in series and parallel	Problems on Slope and deflection of simply supported beam with (a) a point load	Problems on thin cylindrical shells subjected to internal pressure

	SLO-2	*Problems on Analysis of bars of composite sections*	*Problems on Shear force and bending moment diagrams for overhanging beam*	*Problems on Circular shafts in series and parallel*	*(b) Uniformly Distributed Load (Double integration method)*	*change in dimensions of thin cylindrical shells due to internal pressure*
S-7	SLO-1	*Concept of Thermal stresses in simple bars*	*Theory of ure bending derivation,*	*Concepts on Strain energy due to torsion*	*Slope and deflection of simply supported beam with (a) a point load*	*Thin spherical shells subjected to internal pressure*
	SLO-2	*Concept of Thermal stresses in composite bars*	*Bending stress in beams of regular sections*	*Concepts on Strain energy due to torsion*	*(b) Uniformly Distributed Load (Macaulay's method)*	*Change in dimensions of thin spherical shells*
S-8	SLO-1	*Tutorial. on Thermal stresses in simple and composite bars*	*Tutorial on Bending stress in beams of regular sections*	*Tutorial on Strain energy due to torsion*	*Tutorial on Slope, deflection of simply supported beam with point load, Uniformly Distributed Load*	*Tutorial on thin spherical shells subjected to internal pressure, change in dimensions of thin spherical shells due to internal pressure*
	SLO-2					
S-9	SLO-1	*Principal plane, principal stress, Direct stress in two mutually perpendicular directions*	*Bending stress in beams having I- section*	*Solid circular shaft subjected to combined bending and torsion*	*Slope and deflection of cantilever beam with (a) a point load*	*Lame's theory on stresses in thick cylinders*
	SLO-2	*Direct stress in two mutually perpendicular directions accompanied by a simple shear stress*	*Bending stress in beams having T- section*	*Hollow circular shaft subjected to combined bending and torsion*	*(b) Uniformly Distributed Load (Moment area method)*	*Lame's theory on stresses in thick cylinders*
S-10	SLO-1	*Problems on Direct stress in two mutually perpendicular directions*	*Problems on bending stress in beams having I and T sections*	*Problems on circular shaft subjected to combined bending and torsion*	*Slope and deflection of simply supported beam with (a) point load*	*Problems on Lame's theory on stresses in thick cylinders*
	SLO-2	*Problems on Direct stress in two mutually perpendicular directions*	*Problems on bending stress in beams having I and T sections*	*Problems on circular shaft subjected to combined bending and torsion*	*(b) Uniformly Distributed Load (Moment area method)*	*Problems on Lame's theory on stresses in thick cylinders*
S-11	SLO-1	*Mohr's circle: direct stress in tow mutually perpendicular directions without shear stress*	*Derivation of shear stress distribution in beams of different sections*	*Composite solid circular shaft*	*Castigliano's theorem*	*Stresses in compound thick cylinder and Shrink fit*
	SLO-2	*Mohr's circle: direct stress in two mutually perpendicular directions with shear stress*	*Derivation of shear stress distribution in beams having I and T sections*	*Composite hollow circular shaft*	*Maxwel's reciprocal theorem*	*Problems on stresses in compound thick cylinder*
S-12	SLO-1	*Tutorial on direct stress in two mutually perpendicular directions*	*Tutorial on shear stress distribution in beams of different sections such as I and T*	*Tutorial on composite circular shafts*	*Tutorial on Castigliano's and Maxwel's reciprocal theorem*	*Tutorial on stresses in compound thick cylinder and Shrink fit*
	SLO-2					

Learning Resources	1. *Ferdinand P. Beer, E. Russell Johnston Jr., John T. DeWolf, David F. Mazurek, Mechanics of Materials, 7th ed., McGraw Hill, 2014* 2. *William A. Nash, Theory and Problems of Strength of Materials, Schaum's Outline Series, 3rd ed., McGraw Hill, 2007*	3. *Egor P. Popov, Engineering Mechanics of Solid, 2nd ed., Prentice Hall of India Pvt. Ltd., 2009* 4. *James M. Gere, Mechanics of Materials, 8th ed., Brooks/Cole, USA, 2013* 5. *Shigley. J. E., Applied Mechanics of Materials, International Student edition, McGraw Hill, 2000*

Learning Assessment

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

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

Course Designers

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2. Dr. A. Velayutham, DRDO, Avadi, velayudham.a@cvrde.drdo.in	*2.Dr. K. Jayabal, IIITDM, Kancheepuram, jayabal@iiitdm.ac.in*	*2.Mr. D. Raja, SRMIST*

Course Code	18MEC107T	Course Name	APPLIED THERMAL ENGINEERING	Course Category	C	Professional Core	L	T	P	C
							3	1	0	4

Pre-requisite Courses	18MEC101T	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechanical Engineering	Data Book / Codes/Standards	Refrigeration Tables &Psychrometric chart		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Analyze the sequence of operation of energy cycles			
CLR-2 :	Identify the fundamentals of Fuels and calculation of enthalpies			
CLR-3 :	Analyze the performance testing of IC Engines			
CLR-4 :	Apply the construction, principle of working and analysis of compressors			
CLR-5 :	Analyze the working principle of refrigeration systems			
CLR-6 :	Utilize the fundamentals and psychrometric processes			

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 basic operations required for energy release and method to calculate the efficiency	2	85	80	H	H	M	M	M	L	L	L	M	M	M	M	M	M	M	
CLO-2 :	Comprehend the Fuel properties and its applications	2	85	80	H	H	M	M	M	L	L	L	M	M	M	M	M	M	M	
CLO-3 :	Analyze the performance of IC Engines	3	85	80	H	H	M	M	M	L	L	L	M	M	M	M	M	M	M	
CLO-4 :	Identify the construction, operation of compressors, their performance evaluation	3	85	80	H	H	M	M	M	L	L	L	M	M	M	M	M	M	M	
CLO-5 :	Comprehend the types of refrigeration systems and evaluate its performance	2	85	80	H	H	M	M	M	L	L	L	M	M	M	M	M	M	M	
CLO-6 :	Analyze the fundamental processes of air conditioning systems and do fundamental calculations	2	85	80	H	M	M	M	M	L	L	L	M	M	M	M	M	M	M	

Duration (hour)		12	12	12	12	12
S-1	SLO-1	Introduction to air standard cycles	Introduction to fuels, Solid fuels	Classification of IC engines	Classification of Air Compressors	Vapor compression refrigeration system and its working principle
	SLO-2	Air standard efficiency, Assumptions	Liquid fuels	Basic operations	Construction and working of reciprocating compressor	Refrigerants and properties
S-2	SLO-1	Otto cycle: Air standard efficiency	Gaseous fuels, Fuel properties	Actual p-v diagram of four stroke SI engines	Compression with clearance volume	Eco-friendly refrigerants
	SLO-2	Mean effective pressure	Stoichiometric air fuel ratio	Actual p-v diagram of four strokeCI engines	Compression without clearance	Analysis of vapor compression refrigeration cycle
S-3	SLO-1	Power developed	Theoretical air and excess air.	Comparison of four stroke and two IC engines	Equation for work-Single acting reciprocating compressor	P-h Chart
	SLO-2	Tutorials on Otto cycle	Air fuel ratio from analysis of products	Comparison of CI and SI Engines	Volumetric efficiency of compressor	Sub-cooling and superheating phenomena in VCR cycle
S-4	SLO-1	Tutorials on Otto cycle	Conversion between volumetric analysis to weight analysis	Engine Performance parameters	Tutorial problems on single stage compressor with clearance	Tutorial: Numerical problems on VC refrigeration system
	SLO-2	Diesel cycle: Air standard efficiency	Analysis of exhaust and flue gas	Measurements of fuel consumption	Tutorial problems on single stage compressor without clearance	Tutorial: Numerical problems on VC refrigeration system
S-5	SLO-1	Mean effective pressure	Internal energy and enthalpy of formation	Measurements of air consumption	Free air delivered	Simple vapor absorption refrigeration system
	SLO-2	Power developed	Determination of calorific values of the fuel-Solid fuel and liquid fuel.	Measurement of brake power	Free air delivered	Simple vapor absorption refrigeration system
S-6	SLO-1	Dual cycle: Air standard efficiency	Determination of calorific values of the fuel-Gaseous fuel	Measurement of in-cylinder pressure	Multistage compression	Properties of atmospheric air and Psychrometric chart
	SLO-2	Mean Effective pressure	Tutorials on determination of calorific value	Tutorials on IC Engine performance	Multistage compression	Properties of atmospheric air and Psychrometric chart

S-7	SLO-1	*Power developed*	*Tutorials on determination of calorific value*	*Tutorials on IC Engine Performance*	*Problems on multistage compression*	*Psychrometric processes. sensible heating and cooling*
	SLO-2	*Tutorials on Diesel cycle*	*Tutorials on determination of calorific value*	*Tutorials on IC Engine Performance*	*Problems on volumetric efficiency*	*Psychrometric processes. sensible heating and cooling*
S-8	SLO-1	*Tutorials on Diesel cycle*	*Tutorial: Numerical problems on First law analysis*	*Tutorial: Numerical problems on engine performance parameters*	*Tutorials on multi stage compression, FAD*	*Cooling and dehumidification*
	SLO-2	*Tutorials on Dual cycle*	*Tutorial: Numerical problems on First law analysis*	*Tutorial: Numerical problems on engine performance parameters*	*Tutorials on multi stage compression, FAD*	*Heating and humidification*
S-9	SLO-1	*Problems on Mean effective pressure*	*Heat calculations using enthalpy tables*	*Heat balance sheet*	*Rotary compressors*	*Tutorial: Numerical problems on psychrometric processes*
	SLO-2	*Comparison of Otto, Diesel and Dual cycles*	*Problem Solving in Heat calculations*	*Heat balance sheet*	*Vane compressor*	*Summer air conditioning system*
S-10	SLO-1	*Brayton cycle*	*Adiabatic flame temperature*	*Problems on Heat balance sheet*	*Roots blower*	*Winter air conditioning system*
	SLO-2	*Brayton cycle efficiency*	*Adiabatic flame temperature*	*Problems on Heat balance sheet*	*Different compressors and features*	*Year-round air conditioning systems*
S-11	SLO-1	*Concept of Reheat in Brayton cycle*	*Chemical Equilibrium*	*Problems on Heat balance sheet*	*Reciprocating compressors and rotary compressors - comparison*	*Heat load and simple calculations*
	SLO-2	*Concept of Regeneration in Brayton cycle*	*Chemical equilibrium calculations*	*Problems on Heat balance sheet*	*Reciprocating compressors and rotary compressors - comparison*	*Heat load and simple calculations*
S-12	SLO-1	*Tutorials on power developed*	*Tutorial Problems on Adiabatic flame temperature for various fuels*	*Engine performance curves: Constant speed engines*	*Tutorial: Numerical problems on multi stage compression*	*Tutorial: Numerical problems on psychrometric processes*
	SLO-2	*Tutorials on power developed*	*Tutorial Problems on Adiabatic flame temperature for various fuels*	*Engine performance curves: Variable speed engines*	*Tutorial: Numerical problems on multi stage compression*	*Tutorial: Numerical problems on psychrometric processes*

Learning Resources	*1. Mahesh Rathore , Thermal Engineering, Tata McGraw Hill, 2012* *2. Eastop T. D., Mcconkey. A, Applied Thermodynamics for Engineering Technologists, 5th ed., Pearson Edition, 2009* *3. Kenneth A Kroos, Merle C. Potter, Thermodynamics for Engineers, Cengage learning, 2016*	*4. Rajput.R. K, Thermal Engineering, 10th ed., Laxmi Publications, 2015* *5. Yunus A Cengel, Michael A Boles, Thermodynamics: An Engineering Approach,8th ed., Tata McGraw Hill, 2015*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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	*1. Dr. R Velraj, IES, CEG, Anna University, Chennai, velrajr@annauniv.edu*	*1. Mr. G. Manikandaraja, SRMIST*
2. Dr.A.Velayutham, DRDO, Avadi, velayudham.a@cvrde.drdo.in	*2. Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	*2. Dr. G. Kasiraman,SRMIST*

Course Code	18MEC108T	Course Name	MATERIALS TECHNOLOGY	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	18MEC111L	Progressive Courses	Nil
Course Offering Department	Mechanical Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Acquire knowledge about solidification of metals, phase diagrams and salient features of iron-carbon system			
CLR-2 :	Apply mechanism of plastic deformation, strengthening mechanisms, heat treatment and surface hardening processes			
CLR-3 :	Utilize the mechanical behavior of materials and learn about failure analysis			
CLR-4 :	Identify about structure, properties and applications of ferrous and non-ferrous materials			
CLR-5 :	Acquire knowledge about properties and applications of advanced engineering materials			
CLR-6 :	Utilize knowledge about mechanical behavior, phase diagrams, structure, properties of materials and their applications			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 :	Interpret phase diagrams and correlate structure property relationships	2	90	85	H	-	-	-	M	-	-	-	-	-	-	-	-	-	
CLO-2 :	Identify strengthening mechanism, effect of heat treatment and surface hardening on the properties of materials	3	90	85	H	-	-	-	M	-	-	-	-	-	-	-	-	-	-
CLO-3 :	Analyze failure of engineering materials	2	90	85	H	H	-	M	M	-	-	-	-	-	-	-	-	M	-
CLO-4 :	Select ferrous and non-ferrous alloys for various engineering applications	3	90	85	H	-	-	-	-	-	L	-	-	-	-	L	-	-	-
CLO-5 :	Apply advanced materials for specific applications based on their properties	2	90	85	H	-	-	-	-	-	M	M	-	-	-	-	-	-	L
CLO-6 :	Interpret phase diagrams, analyze mechanical behavior of materials, select materials for various engineering applications	3	90	85	H	H	-	M	M		M	M	-	-	-	L	-	M	L

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Crystal structures	Deformation by slip	Introduction to fracture	Properties of plain carbon steel	Introduction to Smart materials
	SLO-2	Imperfection in solids: Point, line	Slip systems, critically resolved shear stress	Types of fracture in metals	Properties of tool steel and stainless steel	Types of Smart materials
S-2	SLO-1	interfacial and volume defects Solidification	Shear strength of perfect and real crystals,	Stress-strain behavior of metals	Dual phase steels: properties	Shape memory alloys
	SLO-2	Nucleation and Growth	Concept of work hardening, Stages of work hardening	ceramics and polymers; True stress – true strain	Dual phase steels: processing, composition and applications	Properties of Nickel based and other superalloys
S-3	SLO-1	Dendritic growth	Solid solution strengthening	Hardness: Rockwell, Brinell, Vickers hardness	Brief introduction on High Strength Low Alloy (HSLA) steel	Classes of polymers
	SLO-2	Segregation and Homogenization	Grain boundary strengthening, Hall-Petch relation	Impact test: Charpy and Izod	effects of microalloying elements	Properties and applications of PE, PP, PS, PVC, Teflon
S-4	SLO-1	Introduction to Solid solutions	Dispersion strengthening: Precipitation	Griffith's theory of brittle fracture	Transformation induced plasticity (TRIP) steel, its properties and applications	Classes of ceramics
	SLO-2	Types and factors governing substitutional solubility based on Hume Rothery's rules	Particulates and Fibers	Griffith equation	Twinning induced plasticity (TWIP) steel, its properties and applications	Properties and applications of Al2O3, ZrO2, SiC, Si3N4, AlN
S-5	SLO-1	Introduction to Phase diagrams	Non-equilibrium phases	Stress intensity factor	Properties of cast irons: grey, white,	Types and classification of composite materials
	SLO-2	Phase rules and its application	Martensite, Bainite	Fracture toughness, Ductile to brittle transition	Properties of cast irons: malleable and spheroidal cast irons	Reinforcement and matrix material, Rule of Mixture
S-6	SLO-1	Interpretation of phase diagrams	Introduction to TTT	Introduction to Fatigue, S-N curve	Copper and copper alloys with their applications	Properties of MMC, CMC and PMC
	SLO-2	Interpretation of phase diagrams	CCT diagrams, and their importance	Low and high cycle fatigue test	Copper, Brass, Bronze, Cupronickel, Muntz metal, Gun metal	Applications of MMC, CMC and PMC

S-7	SLO-1	*Classification of phase diagram*	*Heat treatment processes: Annealing, Normalizing,*	*Stages of fatigue*	*Classification and properties of Aluminium alloys*	*Nanocrystalline materials, Classification based on dimension with examples,*
	SLO-2	*Classification of phase diagram*	*Tempering, Quenching*	*High temperature fracture, Creep curve*	*Age hardening, Different alloy series*	*CNT, graphene and their applications*
S-8	SLO-1	*Iron Iron-carbide phase diagram*	*Case hardening: carburizing,*	*Failure analysis: sources of failure*	*Magnesium alloys – advantages and problems*	*Biomaterials - applications, Types - metals, ceramics*
	SLO-2	*Iron Iron-carbide phase diagram*	*nitriding, cyaniding, carbo-nitriding*	*Procedure of failure analysis*	*Magnesium alloys – Types and designations*	*polymers and composites, Biocompatibility*
S-9	SLO-1	*Microstructural aspects and invariant reactions in Fe-C diagram*	*Flame and induction hardening*	*Introduction to Non-Destructive Testing (NDT)*	*Titanium alloys - α, β and α+β alloys*	*Introduction to structure and characterization of materials*
	SLO-2	*Microstructural aspects and invariant reactions in Fe-C diagram*	*Effect of hardening processes on hardness and microstructure*	*Liquid penetrant testing, Magnetic particle testing*	*Types of alloying additions, Properties and applications*	*XRD, SEM and TEM*

Learning Resources

1. *Flake.C Campbell, Elements of Metallurgy and Engineering Alloys, ASM International, 2008*
2. *Dieter.G.E, Mechanical Metallurgy, McGraw Hill, Singapore, 2001*
3. *Thomas H. Courtney, Mechanical Behaviour of Engineering materials, McGraw Hill, Singapore, 2000*
4. *Flinn.R.A , Trojan.P.K, Engineering Materials and their applications, Jaico, Bombay, 1995*
5. *Budinski.K.G, Budinski.M.K, Engineering Materials Properties and selection, Prentice Hall of India, 2004*
6. *ASM Metals Hand book, Failure analysis and prevention, Vol: 10, 14th ed., New York, 2002*
7. *Reza Abbaschian, Lara Abbaschian& Robert E. Reed-Hill, Principles of Physical Metallurgy, Cengage Learning, 2010*
8. *Michelle Addington and Daniel Schodek, "Smart Materials and New Technologies", Elsevier print, 2005*
9. *George S. Brady, Henry R. Clauser, JhonA.Vaccari, Materials Science Hand Book, McGraw-Hill, 2002*
10. *Sidney H Avnar, Introduction to physical metallurgy, 2nd ed., Tata McGraw-Hill, 1997*
11. *William D. Callister, David G. Rethwisch, Materials Science and Engineering: An Introduction,8th ed., Wiley publication, 2009*
12. *Donald R. Askeland, Wendelin J. Wright, Science and Engineering of Materials, 7th ed., Cengage Learning, 2011*
13. *Donald R. Askeland, Wendelin J. Wright, Essentials of Materials Science & Engineering, 3rd ed., Cengage, 2013*
14. *Raghavan V. Physical Metallurgy: Principles and Practice, Prentice Hall of India, 2012*
15. *Polmear I. Light Alloys: From Traditional Alloys to Nanocrystals, Butterworth-Heinemann, UK, 2005*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*30 %*	-	*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. P. Hariharan, Anna University,* hari@annauniv.edu, *hariharan2311@gmail.com*	*Dr. ShubhabrataDatta, SRMIST*
2. Dr. A. Velayutham, DRDO, Avadi, velayudham.a@cvrde.drdo.in	*2. Dr. N. Arunachalam, IIT Madras, chalam@iitm.ac.in*	*Mr. D. Selwyn Jebadurai, SRMIST*

Course Code	18MEC109L	Course Name	STRENGTH OF MATERIALS LABORATORY	Course Category	C	Professional Core	L	T	P	C
							0	0	2	1

Pre-requisite Courses	Nil	Co-requisite Courses	18MEC206T	Progressive Courses	Nil
Course Offering Department	Mechanical Engineering			Data Book / Codes/Standards	Nil

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Identify the procedures for conducting various destructive tests
CLR-2 :	Identify the concept of hardness and influence of heat treatment
CLR-3 :	Utilize mechanical properties of various materials under different loading
CLR-4 :	Utilize behavior of materials under cyclic loading
CLR-5 :	Identify the aspects of testing the strength of various materials under different loading conditions
CLR-6 :	Utilize destructive tests to determine strength of materials under externally applied loads

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 procedures for conducting various destructive testing methods like impact, compression test	3	80	85	H	H	M	M	H	-	-	-	H	-	-	-	-	-	-
CLO-2 :	Identify to measure hardness of materials and to interpret the same after heat treatment	3	80	85	H	H	M	M	M	-	-	-	H	-	-	-	-	-	-
CLO-3 :	Determine the Young's modulus using deflection test on beams and tensile test on rods & springs	3	80	85	H	H	M	M	H	-	-	-	H	-	-	-	-	-	-
CLO-4 :	Compare the fatigue behavior of a notched and un-notched specimen	3	80	85	H	H	M	M	M	-	-	-	H	-	-	-	-	-	-
CLO-5 :	Identify the aspects of testing the strength of various materials under different loading conditions	3	80	85	H	H	M	M	M	-	-	-	H	-	-	-	-	-	-
CLO-6 :	Conduct destructive tests to determine strength of materials under externally applied loads	3	80	85	H	H	M	M	M	-	-	-	H	-	-	-	-	-	-

Duration (hour)		6	6	6	6	6
S-1	SLO-1	Tensile test on Mild steel rod	Test on open coil springs	Torsion test on Graded steels	Double shear test on metallic materials	Bend test of metallic rods
	SLO-2					
S-2	SLO-1	Tensile test on Mild steel rod	Test on closed coil Helical springs	Torsion test on Graded steels	Double shear test on metallic materials	Bend test of metallic rods
	SLO-2					
S-3	SLO-1	Compression test of Concrete cubes	Izod impact test	Deflection test on beams of different materials	Rockwell & Brinell hardness test of metallic materials	Fatigue testing of materials under notched conditions
	SLO-2					
S-4	SLO-1	Compression test of Cylinders	charpy impact test	Deflection test on beams of different materials	Rockwell & Brinell hardness test of metallic materials	Fatigue testing of materials under un-notched conditions
	SLO-2					
S-5	SLO-1	Comparison of mechanical properties of Unhardened specimen	Strain measurement on rods using rosette strain gauge	Measurement of pressure on thin walled cylinders using strain gauge.	Buckling analysis of struts	Study on photo elasticity
	SLO-2					
S-6	SLO-1	Comparison of mechanical properties of Quenched and tempered specimen	Strain measurement on beams using rosette strain gauge	Measurement of pressure on thin walled cylinders using strain gauge.	Buckling analysis of struts	Study on photo elasticity
	SLO-2					

Learning Resources	1. Ferdinand Beer, E. Russell Johnston, Jr., John DeWolf, David Mazurek, Mechanics of Materials, 7th ed., McGraw - Hill, 2013	2. Kazimi S. M. A, Solid Mechanics, 2nd ed.,Tata McGraw Hill, 2001 3. Laboratory Manual

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*
	Understand										
Level 2	Apply	-	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*
	Analyze										
Level 3	Evaluate	-	*30 %*	-	*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. Mr. A. Vinoth, SRMIST*

Course Code	18MEC110L	Course Name	HEAT POWER LABORATORY	Course Category	C	Professional Core	L	T	P	C
							0	0	2	1

Pre-requisite Courses	Nil	Co-requisite Courses	18MEC107T	Progressive Courses	
Course Offering Department	Mechanical Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Analyze components and functions of IC Engines			
CLR-2 :	Utilize the properties of lubricants and fuels			
CLR-3 :	Analyze performance and heat balance test on IC engines			
CLR-4 :	Utilize Morse, retardation and emissions test			
CLR-5 :	Analyze performance test on steam power plant and air compressor			
CLR-6 :	Utilize operations and performance of Internal combustion engines, air compressors and steam power plant			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 components and functions of IC Engines	2	95	85	H	M	-	M	-	-	-	-	H	-	-	-	H	-	-
CLO-2 :	Analyze the properties of lubricants and fuels	2	95	85	H	H	-	L	-	-	-	-	H	-	-	-	-	L	-
CLO-3 :	Conduct performance and heat balance test on IC engines	2	95	85	H	H	M	L	M	-	-	-	H	-	-	-	-	M	-
CLO-4 :	Conduct Morse, retardation and emissions test	3	95	85	H	H	-	-	-	-	-	-	H	-	-	-	-	-	M
CLO-5 :	Analyze performance test on steam power plant and air compressor	3	95	85	H	H	-	-	-	-	-	-	H	-	-	-	-	H	H
CLO-6 :	Analyze operations and performance of Internal combustion engines, air compressors and steam power plant	3	95	85	H	H	M	L	-	-	-	-	H	-	-	-	H	-	-

Duration (hour)		6	6	6	6	6
S 1-2	SLO-1	Components of Internal combustion engine	Determine viscosity using Redwood viscometer	Performance test on petrol engine with electrical dynamometer	Heat balance test on four stroke diesel engine with calorimeter	Heat balance test on boiler
	SLO-2					
S 3-4	SLO-1	Valve timing diagram of IC Engines	Determine viscosity using Saybolt viscometer	Performance test on single cylinder high speed diesel engine with Rope brakedynamometer/Morse Test	Heat balance test on four stroke diesel engine without calorimeter	Performance test on steam turbine
	SLO-2					
S 5-6	SLO-1	Port timing diagram of IC Engines	Determine flash and fire point/cloud and pour point	Performance test on single cylinder high speed diesel engine withEddy current/hydraulic dynamometer	Retardation test on slow speed diesel engine/engine emission measurements	Performance test on two stage reciprocating air compressor
	SLO-2					

Learning Resources	1. Ganesan. V, Internal Combustion Engines, Tata McGraw-Hill, New Delhi, 2015	2. Mathur.M. L, Sharma. R. P, A course in Internal Combustion Engines, DhanpatRai & Sons, 2010 3. Laboratory Manual

Learning Assessment

	Bloom's Level of Thinking	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	1. Dr. R Velraj, IES,CEG, Anna University, Chennai, velrajr@annauniv.edu	1.Dr. G. Balaji, SRMIST
2. Dr. A. Velayutham, DRDO, Avadi, velayudham.a@cvrde.drdo.in	2. Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in	2.Dr. D. Sivakrishna Reddy, SRMIST

Course Code	18MEC111L	Course Name	MATERIALS TECHNOLOGY LABORATORY	Course Category	C	Professional Core	L	T	P	C
							0	0	2	1

Pre-requisite Courses	Nil	Co-requisite Courses	18MEC108T	Progressive Courses	Nil
Course Offering Department	Mechanical Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Utilize the concepts and need of specimen preparation and procedures to be followed for microscopic observation
CLR-2 :	Identify and utilize the microstructure of various metals, alloys and its metallurgical properties
CLR-3 :	Utilize heat treatment process for various applications
CLR-4 :	Evaluate heat treatment impact on hardness and micro structural changes
CLR-5 :	Analyze the wear behavior and understand stress acting on a tensile specimen
CLR-6 :	Utilize the knowledge for identifying metals, alloys based on microstructure and analyze the effect of heat treatment

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 concepts of specimen preparation for microscopic observation	1	95	90	H	-	-	-	H	-	-	-	H	-	-	-	L	-	-
CLO-2 :	Identify microstructure of various metals, alloys and micro structural changes for various heat treatment processes	1	95	90	H	-	-	M	H	-	-	-	M	-	-	-	L	-	-
CLO-3 :	Evaluate hardness and analyze the effect of heat treatment processes	2	95	90	H	-	-	H	H	-	-	-	M	-	-	-	H	-	H
CLO-4 :	Analyze the effects of heat treatments and properties of GC Iron and SG Iron	3	95	90	H	-	-	H	M	-	-	-	H	-	-	-	H	-	H
CLO-5 :	Analyze wear behavior and understand stress acting on a tensile specimen	2	95	85	H	H	-	H	H	-	-	-	H	-	-	-	H	-	H
CLO-6 :	Identify metals, alloys based on microstructure, analyze effect of heat treatment on hardness and microstructural changes	3	95	90	H	-	-	H	H	-	-	-	M	-	-	-	H	-	H

Duration (hour)		6	6	6	6	6
S 1-2	SLO-1	Study the Mounting Process	Identify Alloy - Steel based alloys	Identify various heat treatment for MCS	Jomny End quenched Steel	Coating thickness Evaluation
	SLO-2	Preparing the sample for identification under microscope				
S 3-4	SLO-1	Identify Metal - Plain Carbon steel	Identify Alloy - Copper based alloys	Various heat treated steels like Quenched, Normalised, annealed, Tempered	Micro Vickers Tester	Analyze various stress using tensometer
	SLO-2					
S 5-6	SLO-1	Identify Metal - Cast iron	Identify Alloy -Light Metal alloys	Case hardened steel- Induction Hardened and Laser Hardened	properties of GC Iron and SG Iron	Wear analysis using Pin-on-disc
	SLO-2					

Learning Resources	
1.	Sidney H Avnar, Introduction to physical metallurgy, 2nd ed., Tata McGraw-Hill, 1997
2.	Donald R. Askeland, Wendelin J. Wright, Science and Engineering of Materials, 7th ed., Cengage Learning, 2011
3.	ASTM standards
4.	Laboratory Manual

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	*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. P. Hariharan, Anna University,* hari@annauniv.edu, *hariharan2311@gmail.com*	*1. Mrs. R. Ambigai, SRMIST*
2. Dr. A. Velayutham, DRDO, Avadi, velayudham.a@cvrde.drdo.in	*2. Dr. N. Arunachalam, IIT Madras, chalam@iitm.ac.in*	*2. Dr. U. Mohammed Iqbal, SRMIST*

ACADEMIC CURRICULA

Professional Core Courses

MECHATRONICS ENGINEERING

Regulations - 2018

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

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

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

Kattankulathur, Kancheepuram, Tamil Nadu, India

Course Code	18MHC101J	Course Name	MECHANICS OF SOLIDS AND FLUIDS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Understand the behavior of materials under load
CLR-2 :	Identify types of beam and understand their deflection under different types of load
CLR-3 :	Understand the behavior of materials under torque
CLR-4 :	Analyze the buckling load for columns with different support conditions.
CLR-5 :	Analyze the physical behavior of fluids using the concepts of continuity equation and Bernoulli's theorem.
CLR-6 :	Explain the basic idea of dimensional analysis

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 :	Estimate the different types of stress induced in material	3	90	85	H	H	M	-	L	-	-	-	H	-	-	-	H	-	H
CLO-2 :	Analyze the shear force and bending moment in beam	3	85	80	H	H	M	-	L	-	-	-	H	-	-	-	H	-	H
CLO-3 :	Calculate torque induced in shaft	3	90	85	H	H	M	-	L	-	-	-	H	-	-	-	H	-	H
CLO-4 :	Analyze the buclking of column.	3	85	80	H	H	M	-	L	-	-	-	H	-	-	-	H	-	H
CLO-5 :	Dertermine the coefficient of discharge of different devices	3	85	80	H	H	M	-	L	-	-	-	H	-	-	-	H	-	H
CLO-6 :	Estimate losses in pipes	3	85	80	H	H	M	-	L	-	-	-	H	-	-	-	H	-	H

		Stress, Strain and Deformation of Solids	Transverse Loading on Beams, Shear Force and Bending Moment	Torsion and Columns	Fluid Flow Concepts and Dynamics of Fluids	Dimensional Analysis and Flow through Pipes
Duration (hour)		15	15	15	15	15
S-1	SLO-1	Concept of stress-strain and its types, Hooke's law, modulus of elasticity	Types of beams and loadings, shear force and bending moments	Theory of torsion	Introduction to Fluids Mechanics	Introduction of Dimensions and units
	SLO-2	Factor of safety, Poisson's ratio, elastic constants and their relationship	Sign convention for shear force and bending moments	Derive torsional equation	Properties of fluid	Concepts of dimensional homogeneity, Rayleigh method
S-2	SLO-1	Analysis of bars of uniform cross sections subjected to different loads	Analyze shear force, bending moment for cantilever beam with point load at free end	Analyze torque transmitted by a solid shaft	Application of fluid	Problems in Rayleigh method
	SLO-2	Analysis of bars varying cross sections subjected to different loads	Analyze shear force, bending moment for cantilever beam with different loads at different points	Problems in Analysis of torque transmitted by a solid shaft	Basics numerical problem in fluid properties	Application of Rayleigh method
S-3	SLO-1	Problems in Analysis of bars of uniform cross sections subjected to different loads.	Problems in Analysis of shear force and bending moment for cantilever beam with Uniformly Distributed Load	Analyze torque transmitted by a hollow shaft	Derivation of Continuity Equation	Introduction of Buckingham's Π theorem
	SLO-2	Problems in Analysis of bars of varying cross sections subjected to different loads		Problems in Analysis of torque transmitted by a hollow shaft	Problems in velocity and discharge of fluids in pipe using continuity equation	Properties of Buckingham's Π theorem
S 4-5	SLO-1	Lab 1: Tensile test on mild steel	Lab 4: Charpy and Izod impact test on steel specimen	Lab 7: Torsional test on mild steel	Lab 10: Determine coefficient of discharge of Orificemeter	Lab 13: Verify Bernoulli's theorem
	SLO-2					
S-6	SLO-1	Principle of superposition	Analyze shear force and bending moment for simply supported beam with point loads	Analysis of strength of varying cross sections of shafts	Equations of motion, derivation of Euler's equation and Bernoulli's equation	Numerical problems in Buckingham's Π theorem
	SLO-2	Problems in Principle of Superposition	Analysis of shear force, bending moment for simply supported beam with UDL	Analysis of strength of varying cross sections of shafts	Derive Euler's equation and Bernoulli's equation	Advantage and disadvantage of Rayleigh method and Buckingham's Π theorem
S-7	SLO-1	Analyze uniform and varying cross section of composite bar	Problems in cantilever beams	Problems in shafts with varying cross section	Problems in Euler's equation and Bernoulli's equation	Introduction of Losses in pipes
	SLO-2	Problems in composite bar with uniform and varying cross section	Problems in simply supported beams	Problems in shafts with varying cross section	Assumptions and Disadvantages of Bernoulli's equation	Types of losses, analysis of Minor losses in pipes

S-8	SLO-1	*Analyze stress in composite bars due to temperature difference.*	*Analyze shear force, bending moment for overhanging beam with point loads and UDL*	*Types of columns, applications*	*Application of Bernoulli's equation*	*Problems in Minor losses*
	SLO-2	*Problems in stress in composite bars due to temperature difference*	*Analyze shear force, bending moment for overhanging beam with point loads and UDL*	*Expression for buckling load of columns with different support conditions*	*Introduction to Venturimeter*	*Problems in Minor losses*
S 9-10	SLO-1	*Lab 2: Deflection test on different beams*	*Lab 5: Double shear and (or) Compression test*	*Lab 8: Fatigue test*	*Lab 11: Determine coefficient of discharge of Venturimeter*	*Lab 14: Determine Minor losses: Expansion and contraction losses in pipes*
	SLO-2					
S-11	SLO-1	*Principal plane and Principal stresses*	*Analyze maximum bending moment and point of contraflexure in overhanging beam*	*Determine buckling load for columns with different support conditions using Euler's formula*	*Derivation and assumption of Venturimeter*	*Introduction to Major losses in pipes*
	SLO-2	*Analysis of direct stresses in one plane and two mutually perpendicular planes*	*Analysis of maximum bending moment and point of contraflexure in overhanging beam*	*Determine buckling load for columns with different support conditions using Euler's formula*	*Problems in Venturimeter*	*Problems in Darcy Weisbach and Chezy formula*
S-12	SLO-1	*Analyze direct stresses in one plane and two mutually perpendicular planes using Mohr's circle*	*Theory and assumption of simple bending in beam*	*Problem in buckling*	*Introduction to Orifice meter*	*Analyze discharge, velocity of fluids flows through pipes in series*
	SLO-2		*Derivation of simple bending in a beam*	*Determine buckling load for columns with different support conditions using Euler's formula*	*Derivation and assumption of Orifice meter*	*Analyze discharge, velocity of fluids flows through pipes in parallel*
S-13	SLO-1	*Problems in Analysis of direct stresses in one plane and two mutually perpendicular planes*	*Numerical Problems in theory of simple bending in beam*	*Determine buckling load for columns with different support conditions using Euler's formula*	*Numerical Problems in Orificemeter*	*Construction and working principle of centrifugal pump*
	SLO-2		*Analysis of bending stress in symmetrical and unsymmetrical beam section*	*Problems in columns using Euler's formula*	*Application of Orifice meter*	*Construction and working principle of reciprocating pump*
S 14-15	SLO-1	*Lab 3: Deflection test on different beams*	*Lab 6: Charpy and Izod impact test on steel specimen*	Lab 9: *Fatigue test*	*Lab 12: Determine Major losses in pipe flow*	*Lab 15: Determine Minor losses: Expansion and contraction losses in pipes*
	SLO-2					

Learning Resources	1. *Bansal. R. K, Strength of Materials, 6th ed., Lakshmi publications Pvt. Ltd., 2018* 2. *Ramamurtham S and Narayanan R, Strength of Materials, 18th ed., DhanpatRai Pvt. Ltd., 2018* 3. *Bansal. R. K, Fluid Mechanics and Hydraulic Machines, 10th ed., Laxmi publications (P) Ltd., 2018*	4. *Kumar. K. L, Engineering Fluid Mechanics, 8th ed., S. Chand and co limited, 2012* 5. *Timoshenko. S. P., Gere .M. J, Mechanics of Materials, 5th ed., Stanley Thornes (PUB) Ltd, 1999.* 6. *Strength of Material Laboratory Manual, SRMIST* 7. *Fluid Mechanics Laboratory Manual, SRMIST*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
r. Level 1	Remember	*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.R.Dhinesh Babu, Senior Engineer, Technofit SDN BHD.,dinesh@technofit.com	*2. Dr.B.Mohan, Professor, Anna University, mohan@mitindia.edu*	*2. Mr. G. Balakumaran, SRMIST*

Course Code	18MHC102T	Course Name	ELECTRICAL MACHINES AND ACTUATORS	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses	18EES101J	Co-requisite Courses	18MHC104L	Progressive Courses	Nil
Course Offering Department	Mechatronics Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Understand the construction and principle of operation of DC machines			
CLR-2 :	Understand the construction and principle of operation of AC machines			
CLR-3 :	Understand the construction and principle of operation of Special machines			
CLR-4 :	Identify different Control circuits for DC and AC motors			
CLR-5 :	Analyse the DC and AC machines for suitable applications			
CLR-6 :	Apply the Control circuits for different applications			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	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 :	Operate different types of DC machines	3	75	70	H	H	-	-	-	L	-	-	-	-	-	M	-	-	-
CLO-2 :	Operate different types of AC machines	3	75	70	H	H	-	-	-	L	-	-	-	-	-	M	-	-	-
CLO-3 :	Operate different types of Special machines	3	75	70	H	M	-	-	-	L	-	-	-	-	-	M	-	-	-
CLO-4 :	Analyze the control circuits for suitable actuation	3	75	70	H	-	M	M	M	L	-	-	-	-	-	M	-	-	-
CLO-5 :	Apply the different machines for suitable Applicatios	3	75	70	H	-	M	M	M	L	-	-	H	-	-	M	-	-	-
CLO-6 :	Operate, analyze and apply different machines and control circuits for suitable applications	3	75	70	H	-	M	M	M	L	-	-	H	-	-	M	-	-	-

		DC Machines	Trandformers and Induction Motors	Synchronous and Special Machines	Thyrister for Controller for Actuators	Applications of Actuators
Duration (hour)		9	9	9	9	9
S-1	SLO-1	DC machines: Introduction	Transformer: Construction	Synchronous motor	Introduction to Relays	Applications of actuators
	SLO-2	Construction	Principle, Types of Transformers	Construction	Fuses and Circuit Breakers	Different types of drives
S-2	SLO-1	Principle of operation	Emf equation	Synchronous motor	Introduction to Thyristor	Electric vehicles
	SLO-2	Types of DC machines based on construction	Voltage regulation	Principle of operation	Thyristor Rectifier	DC drive with chopper control for electric vehicle
S-3	SLO-1	Shunt Motor,	Simple problems in Transformers	Methods of starting Synchronous motor	Thyristor Choppers	Introduction to traction
	SLO-2	Series Motor, Compound motor	Introduction to 3-phase system	Difference between Induction and Synchronous motors	Thyristor Choppers	chopper controlled traction drive
S-4	SLO-1	Back Emf, Voltage equations	Three phase induction motor construction	Applications of Synchronous motors	Thyristor Inverters	Robotic gripper
	SLO-2	Torque equation, Simple Problems	principle of operation	Introduction to special machines	Applications of converters	Applications of robotic grippers
S-5	SLO-1	Characteristics of D.C Shunt motor, Series motor	Production of RMF	PMDC motors: Construction	Thyristor controller starters	Introduction to mems
	SLO-2	Speed Control Methods	Production of RMF	principle of operation	Electronic speed control methods for DC motors	Applications of mems actuators
S-6	SLO-1	Necessity of a starter	Torque-slip characteristics	Stepper motors: construction,	Thyristor speed control of DC Shunt Motor	Introduction to solenoids

	SLO-2	*Types of Starters*	*Torque equation*	*principle of operation of VR, PM Stepper Motors*	*Thyristor speed control of DC Series Motor*	*Solenoid operated fuel injection systems*
S-7	SLO-1	*3 point Starters*	*Linear Induction Motors: Construction*	*Hybrid type Stepper Motors: Construction*	*Speed control of single phase Induction motor using Inverter*	*Stepper motor throttle actuators*
	SLO-2	*3 point Starters*	*Principle of operation*	*Principle of operation*	*Speed control of single phase Induction motor using Inverter*	*Stepper motor throttle actuators*
S-8	SLO-1	*4 point Starters*	*Difference between Three phase and Single Phase induction Motors*	*BLDC motors: Construction*	*Electronic Speed control of Synchronous Motor*	*Actuators for capsule filling machines*
	SLO-2	*4 point Starters*	*Difference between Three phase and Single Phase induction Motors*	*Principle of operation*	*Driver circuit for Stepper motors*	*Actuators for capsule filling machines*
S-9	SLO-1	*Braking methods- Dynamic and plugging*	*Introduction to Single Phase induction Motors*	*Servo Motors: Types, Construction*	*Unipolar drive for Variable reluctance*	*Actuators for Labelling Machines*
	SLO-2	*Regenerative braking*	*Principle and operation of single phase induction motor*	*Principle of operation*	*Bipolar drive for Permanent Magnet and Hybrid motors*	*Actuators for Labelling Machines*

Learning Resources	*1. B. L Theraja, A. K. Theraja, A text book of electrical technology,Volume II, S.Chand Publications, 2008* *2. S. K. Bhattacharya,S.Chatterjee,industrial Electronics and control, TTTI, Chandigarh*	*3. Gopal K.Dubey, Fundamentals of Electrical drives,Narosa publications 2014*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*30 %*	-	*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. S. Janardhanam, CAPGEMINI.	*2. Dr. K. Sujatha, Dr. MGR Educational and Research Institute, drksujatha23@gmail.com*	*2. Dr. T. Muthuramalingam, SRMIST*

Course Code	18MHC103T	Course Name	SOLID STATE DEVICES AND CIRCUITS	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses	18EES101J	Co-requisite Courses	18MHC104L	Progressive Courses	18MHC108L
Course Offering Department	Mechatronics Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Utilize the characteristics of semiconductor devices
CLR-2 :	Identify the different amplifier using 'h parameter and equivalent circuit'
CLR-3 :	Build the various concepts of feedback and oscillators and multi vibrators
CLR-4 :	Utilize the various rectifier and regulator circuits
CLR-5 :	Identify the different power supply circuits
CLR-6 :	Gain knowledge on operational amplifiers and its basic applications

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLO-1 :	Describe band theory of solids with special reference to semi-conductors.	2	75	70
CLO-2 :	Design Amplifier using 'h' Parameters and Equivalent Circuits	3	75	70
CLO-3 :	Illustrate the various concepts of feedback and oscillators and multi vibrators	3	75	70
CLO-4 :	Design various Rectifier and Regulator circuits	3	75	70
CLO-5 :	Evaluate the performance of Power Supply Circuits.	3	75	70
CLO-6 :	Gain knowledge on operational amplifiers and its basic applications	3	75	70

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	
H	M	M	H	M	L	M	L	M	M	-	H	H	H	H	
H	M	M	H	M	L	M	-	M	M	L	H	H	H	H	
H	M	M	M	L	L	M	L	M	M	L	H	-	-	-	
H	M	M	-	L	L	M	L	-	M	L	H	H	H	H	
H	M	M	H	L	-	M	L	M	M	L	H	-	-	-	
H	M	-	H	M	L	M	L	M	M	L	H	H	H	H	

		Special Semiconductor Devices	Amplifier	Feedback Circuits	Switching Circuits and Power Supplies	Operational Amplifiers
Duration (hour)		9	9	9	9	9
S-1	SLO-1	Semiconductor devices: Introduction	Introduction to amplifiers. Transistor as an amplifier, FET as an amplifier	Basic concepts of feedback	Basic about Switching action of transistor	Introduction to Operational amplifier
	SLO-2	Classification of semiconductor devices	Types of Biasing	Types-Positive and negative feedback	Concept of Switching action of transistor	Ideal characteristics of op-amp
S-2	SLO-1	Characteristics of Zener diode	Self- biasing of transistor	Principle of feedback in amplifiers	Introduction of astable multivibrator	Internal block diagram of op-amp
	SLO-2	Application of Zener diode	Fixed biasing, Voltage divider biasing	Principle of feedback in oscillators	Working principle of astable multivibrator	Slew rate of op-amp
S-3	SLO-1	Working principle, characteristics Schottky, diode PIN and Shockley diode	Small signal model of BJT	Voltage series network	Introduction of monostable multivibrator	Introduction about DC characteristics of op- amp
	SLO-2	Applications of Schottky, diode PIN and Shockley diode	Two port network of BJT	Voltage shunt network	Working of monostable multivibrator	Concept of DC characteristics op- amp
S-4	SLO-1	Working principle, characteristics Tunnel diode	Hybrid parameter for BJT	Current series network	Introduction of bistable multivibrator	Introduction about AC characteristics of op-amp
	SLO-2	Applications of Tunnel diode and varactor diode	h- parameter model for CE, CB and CC configuration	Current shunt network	Working of bistable multivibrator	Concept of AC characteristics op- amp
S-5	SLO-1	Working principle, characteristics Tunnel diode and varactor diode	h- parameter model for CE configuration and analysis for CE configuration	LC oscillator: Hartley oscillator - working principle	Circuit diagram of Schmitt trigger	Introduction of differential amplifier
	SLO-2	Applications of Tunnel diode and varactor diode	Analysis for CE configuration	Hartley oscillator -derivation for the frequency of oscillation	Working of Schmitt trigger	Types of differential amplifier
S-6	SLO-1	Working principle, characteristics of thyristor: UJT	Power amplifiers: Class A working principle	Colpitt's oscillator - working principle	Introduction to Rectifiers and its types	Inverting buffer amplifier

	SLO-2	*Applications of Thyristor: UJT*	*Class A derivation for the efficiency*	*Colpitt's oscillator - derivation for the frequency of oscillation*	*Regulators and its types*	*Non-inverting buffer amplifier*
S-7	SLO-1	*Working principle, characteristics of thyristor: SCR*	*Class B working principle*	*Clap oscillator - working principle*	*Circuit diagram and working of Series regulator*	*Basic applications: Inverting Summing amplifier*
	SLO-2	*Applications of thyristor: SCR*	*Class B derivation for the efficiency*	*Clap oscillator - derivation for the frequency of oscillation*	*Circuit diagram and working of Shunt regulator*	*Non-Inverting Summing amplifier*
S-8	SLO-1	*Working principle, characteristics of DIAC*	*Class AB, Class C working principle*	*RC oscillator: RC Phase shift oscillator - working*	*Block diagram of SMPS*	*Subtractor*
	SLO-2	*Applications of DIAC*	*Class AB, Class C derivation for the efficiency*	*RC Phase shift oscillator - derivation for the frequency of oscillation*	*Working principle of SMPS*	*V-I and I-V converter*
S-9	SLO-1	*Working principle, characteristics of TRIAC*	*Tuned amplifiers*	*Wien bridge oscillator - working*	*Block diagram of UPS*	*Introduction and basic concept of Comparator*
	SLO-2	*Applications of TRIAC*	*Types of Tuned amplifiers*	*Wien bridge oscillator - derivation for the frequency of oscillation*	*Working principle of UPS*	*Application of Comparator*

Learning Resources	*1. David A Bell, Electronic devices and circuits, Oxford Publication., 2008* *2. Robert Boylestad and Louis Nashelsky, Electronic devices and circuit theory, 7th ed., Prentice Hall., 2005* *3. Roy Choudhury, Shail B. Jain, Linear integrated circuits, New Age International publishers, 2010*	*4. J. B. Gupta, Electronic devices and Circuits, Sanjay Kumar Kattaria Publication, 2010* *5. Milman., Halkias. C, Electronic devices and circuits, Tata McGraw Hill publications, 2001*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*30 %*	-	*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.AnandaKumar, Deputy Chief Engineer, Control and Instrumentation, TPS-2, NLC India Limited, sith.anandkumar@gmail.com	*1. Dr. B. Chittibabu, IIITDM, Kanchipuram, bcbabu@iiitdm.ac.in*	*1. Mrs. V. Krithika, SRMIST*
2.Mrs.T.Priya, Kavin Engineering and Services Private Limited, priya@kavinengg.com	*2. Dr. P. Karthikeyan, MIT campus, Anna university, pkarthikeyan@annauniv.edu*	*2. Mr. K. Sridharan, SRMIST*

Course Code	18MHC104L	Course Name	ELECTRICAL AND ELECTRONICS LABORATORY	Course Category	C	Professional Core	L	T	P	C
							0	0	4	2

Pre-requisite Courses	18EES101J	Co-requisite Courses	18MHC102T	Progressive Courses	Nil
Course Offering Department	Mechatronics Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Design the circuits using discrete components.
CLR-2 :	Understand the basic concepts of integrated circuits and design circuits
CLR-3 :	Understand the basic concepts and operation of DC machines
CLR-4 :	Understand the basic concepts and operation of AC machines
CLR-5 :	Improve their ability in selecting components for particular application
CLR-6 :	Utilize characteristics of semiconductor devices, amplifiers, multivibrator and operational amplifiers and electrical drives

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1 Level of Thinking (Bloom)	Learning 2 Expected Proficiency (%)	Learning 3 Expected Attainment (%)	PLO 1 Engineering Knowledge	PLO 2 Problem Analysis	PLO 3 Design & Development	PLO 4 Analysis, Design, Research	PLO 5 Modern Tool Usage	PLO 6 Society & Culture	PLO 7 Environment & Sustainability	PLO 8 Ethics	PLO 9 Individual & Team Work	PLO 10 Communication	PLO 11 Project Mgt. & Finance	PLO 12 Life Long Learning	PLO 13 PSO - 1	PLO 14 PSO - 2	PLO 15 PSO - 3
CLO-1 :	Implement the functionality of the circuits using discrete components	2	85	80	H	-	-	-	H	-	H	-	H	H	-	-	-	-	-
CLO-2 :	Develop knowledge on basic concepts of integrated circuits and design circuits	3	85	80	H	-	-	H	H	-	H	-	H	H	-	-	-	-	-
CLO-3 :	Apply the knowledge on basic concepts in operating DC and AC machines	3	85	80	H	-	-	-	H	-	H	-	H	H	-	-	-	-	-
CLO-4 :	Analyse the Performance Characteristics of DC and AC and Special machines	2	85	85	H	-	-	H	H	-	-	-	H	H	-	-	-	-	-
CLO-5 :	Apply the knowledge in selecting components for particular application	2	85	85	H	-	-	-	-	-	H	-	H	H	-	-	-	-	-
CLO-6 :	Apply characteristics of semiconductor devices, amplifiers, multivibrator and operational amplifiers and electrical drives	3	85	80	H	-	-	-	-	-	-	-	H	H	-	-	-	-	-

Duration (hour)		12	12	12	12	12
S 1-4	SLO-1	Characteristics of PN and Zener diode	Rectifiers without filter: Half wave, full wave and bridge	Load Test on DC Shunt Motor	Load Test on Single Phase Transformer	Speed Control of Stepper Motor
	SLO-2					
S 5-8	SLO-1	Characteristics of transistor: BJT, UJT	Rectifiers with filter: Half wave, full wave and bridge	Load Test on DC Series Motor	Load Test on Single Phase Induction Motor	Characteristics of servo Motor
	SLO-2					
S 9-12	SLO-1	Design of oscillator and multivibrator circuits	Op Amp: Non-inverting, inverting and buffer amplifier	Speed Control of DC Shunt Motor	Load Test on Three Phase Induction Motor	Interpretation of technical data sheet
	SLO-2					

Learning Resources	1. Electronics laboratory manual	2. Electrical laboratory manual

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	*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. N. Gunavardhini, TANGEDCO, Salem, gunatneb1990@gmail.com	*1. Dr.S. S Dash, Government College of Engineering Kednhhar, Orisha, munu_dash_2k@yahoo.com*	*1. Dr. M. Santhosh Rani, SRMIST*
2. Dr. S. Janardhanam, CAPGEMINI	*2. Dr. K. Sujatha, Dr. MGR Educational and Research Institute, drksujatha23@gmail.com*	*2. Dr. T. Muthuramalingam, SRMIST*

Course Code	18MHC105J	Course Name	FLUID POWER SYSTEM AND AUTOMATION	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Utilize fundamental knowledge on fluid power, working of pneumatic and electro-pneumatic system components			
CLR-2 :	Utilize working principles of pneumatic and electro-pneumatic components; design and develop fluid power circuits			
CLR-3 :	Design, develop fluid power circuits for various applications, utilize working of hydraulic systems components			
CLR-4 :	Utilize working principle of various hydraulics application circuits.			
CLR-5 :	Utilize programmable logic controllers and PLC programming for fluid power system control.			
CLR-6 :	Utilize fluid power system components and design and control fluid power circuits for automation applications			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 :	Recognize the use of fluid power systems, and identify various pneumatic and electro-pneumatic components	2	80	75	H	L	L	L	M	L	-	-	-	-	-	L	L	M	L
CLO-2 :	Identify various pneumatic and electro-pneumatic components and design fluid power circuit for a given application	3	80	75	H	H	H	H	M	L	-	-	M	-	M	M	M	M	M
CLO-3 :	Design fluid power circuit for a given application and understand the working of various hydraulic components.	3	75	70	H	H	H	H	M	L	L	-	M	-	M	M	M	M	M
CLO-4 :	Apply hydraulic components, diagnose faults and precautions to be followed in fluid power systems.	3	75	70	H	M	M	M	M	L	L	-	-	-	M	L	L	M	M
CLO-5 :	Establish programming control using PLC for fluid power systems.	3	75	70	H	H	M	M	M	L	-	-	M	-	M	M	M	M	H
CLO-6 :	Design, develop and control fluid power systems for various applications.	3	75	70	H	H	M	M	M	L	L	-	M	-	M	M	M	M	M

		Introduction to Pneumatics and Electro-pneumatics	Pneumatics and Electro-Pneumatics Components, Design of Circuits	Design of Circuits Intoductions to Hydraulics	Hydraulics and Electrohydraulic components and circuits	Programmable Logic Controllers
Duration (hour)		15	15	15	15	15
S-1	SLO-1	Introduction to Fluid Power System, Physics of Fluid Power System	Flow Control Valves and their functions	Cascading Electro-Pneumatic Circuit - Two Groups in Two Cylinder Sequential Control	Synchronization Circuits	Introduction to Programmable Logic Controllers (PLC)
	SLO-2	Advantages, Applications, Comparison of Pneumatic and Hydraulic Systems	Simple and Pressure Compensated Flow Control Valve	Cascading Electro-Pneumatic Circuit - Two Groups, Three-Cylinder Sequential-Control	Conditions for Synchronization	Advantages and Applications of PLC
S-2	SLO-1	Introduction to Pneumatic Components, Rotary Compressor - Construction and Principle of Operation	Non – Return Valves: Check Valve, Pilot Operated Check Valve	Cascading Pneumatic Circuit: Three Groups, Three-Cylinder Sequential Control	Hydraulic Accessories- Filters, Seals	Parts of PLC
	SLO-2	Reciprocating Compressors -Construction and Principle of Operation	Speed Control Circuits	Cascading Pneumatic Circuit: Three Groups, Three-Cylinder Sequential Control	Simple Pressure Relief Valve and Compound Pressure Relief Valve	Operation of PLC, Architecture of PLC
S-3	SLO-1	Air Treatment, Air Dryer	Logical Valves – Dual Pressure Valve, Shuttle Valve	Cascading Electro-Pneumatic Circuit - Three Groups, Three Cylinder Sequential Control	Sequence valve with application circuit	Introduction to PLC Programming Techniques
	SLO-2	FRL – Filter, Regulator and Lubricator	Pnuematic circuits using logical valves	Cascading Electro-Pneumatic Circuit - Three Groups, Three Cylinder Sequential Control	Pressure reducing valve with applicaton circuit	Introduction to ladder logic programming
S 4-5	SLO-1	Lab 1: Introduction to Symbolic Representation of Pneumatic Components	Lab 4: Speed Control Circuits	Lab 7: Pneumatic, Electro-pneumatic Implementation of Two Cylinder Cascading Circuit	Lab 10: Timer and Counter Based Electro-Pneumatic Control Circuits	Lab 13: Introduction to PLC and Ladder Logic Programming Software
	SLO-2					
S-6	SLO-1	Pneumatic Actuators, Linear, Rotary and Semi Rotary Type	Quick Exhaust Valve, Time Delay Valve	Timer Based Control of Pneumatic Cylinder	Pressure unloading and counter balance valve	Ladder Logic Program -Implementation of Logic Gates
	SLO-2	Cushioning in Cylinders	Pneumatic Circuits using Quick Exhaust Valve, Time Delay Valve	Counter Based Control of Pneumatic Cylinder	Pressure unloading and counter balance application circuit	Ladder Logic Program -Implementation of Start/Stop Operation and Latching

S-7	SLO-1	*Special Cylinders*	*Introduction to Sequential Control*	*Discussion on Different Pneumatic and Electro-pneumatic Circuit Implementation*	*Accumulators – Working Principle and Types*	*Ladder Logic Program – Continuous Reciprocation Circuits*
	SLO-2	*2/2, 3/2, 5/2, 5/3 Direction Control Valves- Construction and Principle of Operation*	*Pneumatic Circuit - Two and Three Cylinder Sequential Control*	*Selection of Pneumatic Components*	*Application Circuits of Accumulator*	*Ladder Logic Program – Sequential Circuit Implementation*
S-8	SLO-1	*Direct and Indirect Control of Single Acting Cylinder*	*Electro-pneumatic Circuit - Two Cylinder Sequential Control*	*Introduction to Hydraulic Components*	*Proportional Valve – Working Principle and Control*	*Ladder Logic Program – Sequential Circuit Implementation*
	SLO-2	*Direct and Indirect Control of Double Acting Cylinder*	*Electro-pneumatic Circuit - Two Cylinder Sequential Control*	*Fluids for Hydraulic Systems*	*Force and Torque Proportional Control*	*Ladder Logic Program – Pneumatic Application*
S 9-10	SLO-1	*Lab 2: Direct and Indirect Control of Single acting and Double acting Cylinder*	*Lab 5: Pneumatic Implementation of Two Cylinder Sequential Control Circuit*	*Lab 8: Pneumatic Implementation of Three Cylinder Cascading Circuit*	*Lab 11: Hydraulic Synchronization Circuits*	*Lab 14: Developing PLC Program for Sequential Control of Pneumatic Cylinder*
	SLO-2					
S-11	SLO-1	*Introduction to Electro-pneumatics*	*Electro-pneumatic Circuit - Three Cylinder Sequential Control*	*Gear Pumps*	*Servo Valve – Working Principle and Types*	*Interlocks in PLC*
	SLO-2	*Electro-pneumatic Components – Electrical Switches and Solenoid*	*Electro-pneumatic Circuit - Three Cylinder Sequential Control*	*Vane Pumps*	*Flapper Type, Jet Pipe, Electro Hydraulic Servo Valves*	*Ladder Logic Program – Interlocking*
S-12	SLO-1	*Construction and Working Principle of Relays*	*Circuits with Overlapping Signals*	*Piston Pumps*	*Design, Selection of Components of Hydraulic Press, Hydraulic Machine Tools*	*Timers in PLC*
	SLO-2	*Timers and Counters*	*Steps to Solve Signal Overlapping Problem using Cascading Technique*	*Pump Performance, Characteristics and Selection*	*Design and Selection of Components of Articulated Mechanisms*	*Counters in PLC*
S-13	SLO-1	*Continuous Reciprocation of Single acting and Double Acting Cylinder – Pneumatic Implementation*	*Cascading Pneumatic Circuit - Two Groups in Two Cylinder Sequential Control*	*Direction Control Valves 3/2, 4/2*	*Fault Diagnostics in Fluid Power Circuits*	*Ladder Logic Program – Implementation of Timer and Counter Based Applications*
	SLO-2	*Continuous Reciprocation of Single acting and Double Acting Cylinder – Electro Pneumatic Implementation*	*Cascading Pneumatic Circuit - Two Groups in Three Cylinder Sequential Control*	*4/3 DCV – Different Center Positions*	*Safety and Emergency Mandrels in Hydraulic and Pneumatic Systems*	*Summary of the Course discussion*
S 14-15	SLO-1	*Lab 3: Continuous Reciprocation of Single acting and Double acting Cylinder*	*Lab 6: Electro-pneumatic Implementation of Two Cylinder Sequential Control Circuit*	*Lab 9: Electro-pneumatic Implementation of Three Cylinder Cascading Circuit*	*Lab 12: Developing Automation Solution for Industrial Application using Sensors*	*Lab 15: Model Practical Examination*
	SLO-2					

Learning Resources	1. *Anthony Esposito, Fluid Power with applications, 7th ed., Prentice Hall, 2014* 2. *FESTO, Fundamentals of Pneumatics, Vol I, II, III.* 3. *Majumdar .S.R., Oil Hydraulics: Principle and Maintenance, Tata McGraw Hill Education, 2012*	4. *Andrew Parr, Hydraulics and pneumatics, Jaico Publishing House, 2006* 5. *Frank D. Petrezulla, Programmable Logic Controller, 4th ed., McGraw Hill Education, 2011* 6. *Laboratory manual for Fluid Power System and Automation, SRMIST.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (20%)		CLA – 2 (30%)		CLA – 3 (30%)		CLA – 4 (20%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
r. Level 1	Remember	*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. Harish Nachnani, National Sales Manager, Festo India(P) Ltd, harish.nachnani@festo.com	*1. Dr. P. Karthikeyan, MIT campus, Anna university, pkarthikeyan@annauniv.edu*	*1. Mr. Sanjay Kumar Kar, SRMIST*
2. Mr.Girish Joshi, Senior Manager, BoschRexroth ltd, joshi.gs@boschrexroth.co.in	*2. Dr.B.Mohan, Professor, Anna University, mohanb@mitindia.edu*	*2. Ms. G. Madhumitha SRMIST*

Course Code	18MHC106T	Course Name	KINEMATICS AND DYNAMICS OF RIGID BODIES AND MECHANISMS	Course Category	C	Professional Core	L	T	P	C
							3	1	0	4

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Utilize the concept of machines, mechanisms and flywheel
CLR-2 :	Utilize knowledge on the performance of cams, gyroscope
CLR-3 :	Impart knowledge on the performance of gears and gear trains
CLR-4 :	Explore the undesirable effects of unbalanced force in engines and its remedies
CLR-5 :	Utilize knowledge in vibratory systems
CLR-6 :	Utilize various laws governing rigid body motions, vibration characteristics and balancing of mechanical machines

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 concept of machines, mechanisms and flywheel.	1	85	80	H	L	-	H	M	-	L	L	M	-	-	-	M	-	-
CLO-2 :	Analyze the performance of cams, gyroscope	2	85	80	H	H	-	H	M	-	L	L	M	-	-	-	-	-	-
CLO-3 :	Analyze the performance of gears and gear trains.	2	85	80	H	H	-	H	M	-	L	L	M	-	-	-	-	-	-
CLO-4 :	Utilize the knowledge of undesirable effects of unbalanced force in engines	2	85	80	H	H	-	H	M	-	L	L	M	-	-	-	-	-	-
CLO-5 :	Interpret and solve problems in vibratory systems and analyze the effects	2	85	80	H	H	-	H	M	-	L	L	M	-	-	-	-	-	-
CLO-6 :	Implement various laws governing rigid body motions, vibration characteristics and balancing of mechanical machines	2	85	80	H	H	-	H	M	-	L	L	M	-	-	-	-	-	-

		Basic Elements of Mechanisms	Cams and Gyroscope	Gears and Gear trains	Balancing of masses	Vibrations
Duration (hour)		12	12	12	12	12
S-1	SLO-1	Introduction to kinematic links, pairs, chain, machine and structure	Classifications of cam and follower	Fundamentals of toothed gearing	Introduction to balancing of masses	Introduction to Vibration
	SLO-2	Degrees of freedom(DOF)	Classifications of cam and follower	Types of gear	static and dynamic mass balancing	Types of vibration
S-2	SLO-1	Grashoff's law, Kutzback's criterion for planar mechanism	Construction of cam profile when the follower moves with uniform velocity and simple harmonic motion	Gear nomenclature	Balancing of several masses rotating in single plane.	Longitudinal, transverse vibration
	SLO-2	Kinematic inversions of four bar mechanism and slider crank mechanism and its kinematic inversions				
S-3	SLO-1	Modelling Simulation of Crank and slotter lever mechanism	Construction of cam profile when the follower moves with uniform acceleration and retardation	Law of gearing, forms of teeth	Balancing of several masses rotating in single plane.	Dunkerley's method.
	SLO-2	Modelling Simulation of Whitworth quick return mechanism		Length of path of contact		Critical speed of shafts
S-4	SLO-1	Practice 1: Problems on DOF of Planar mechanisms, crank and slotted lever mechanism	Practice 4: Problems on construction of cam profile when the follower moves with uniform velocity and simple harmonic motion	Practice 7: Problems on Length of path of contact	Practice 10: Problems on Balancing of several masses rotating in single plane.	Practice 13: Problems on Longitudinal, transverse vibrations
	SLO-2					
S-5	SLO-1	Turning moment diagram of a single cylinder engine	Construction of cam profile when the follower moves in cycloidal motion	Length of arc of contact	Balancing of several masses rotating in different planes.	Viscous damping
	SLO-2			Contact ratio, interference		damping factor
S-6	SLO-1	Turning moment diagram of a multi	Gyroscope: Forces and couples	Gear trains.	Balancing of reciprocating masses.	Torsional vibrations.

	SLO-2	*cylinder engine*		*Types of gear trains- simple gear train*		
S-7	SLO-1	*Fluctuation of energy, coefficient of fluctuation of energy*	*Effect of gyroscopic couple in aeroplanes*	*Compound gear train.*	*Balancing of single cylinder engine.*	*Single and two rotor systems*
	SLO-2			*Reverted gear train.*		
S-8	SLO-1	*Practice 2: Problems turning moment diagram for single cylinder and multi cylinder*	*Practice 5: Problems on construction of cam profile profile when the follower moves in cycloidal motion*	*Practice 8: Problems on simple, compound and reverted gear trains*	*Practice 11: Problems on Balancing of single cylinder engine*	*Practice 14: Problems on Dunkerley method and critical speed of shaft*
	SLO-2					
S-9	SLO-1	*Coefficient of Fluctuation of speed*	*Stability of a four wheel drive moving in a curved path*	*epicyclic gear train* .	*Balancing of multi cylinder inline engine.*	*Three rotor systems.*
	SLO-2					
S-10	SLO-1	*Energy stored in flywheel*	*Gyroscope: stability of two-wheel*	*Tabular method – epicyclic and reverted gear train*	*Hammer blow*	*Torsional vibrations on geared systems*
	SLO-2				*swaying couple*	
S-11	SLO-1	*Dimensions of flywheel rim.*	*Effect of gyroscopic couple in ships*	*Compound epicyclic gear train.*	*Tractive force.*	*Vibration analysis of geared systems.*
	SLO-2					
S-12	SLO-1	*Practice 3: Problems on energy stored in flywheel and flywheel rim dimensions*	*Practice 6: Problems on effect of gyroscopic couple on aeroplanes and four wheeler and two wheeler*	*Practice 9: Problems on Compound epicyclic gear train.*	*Practice 12: Problems on Balancing of multi cylinder inline engine.*	*Practice 15: Problems on two rotor system and three rotor system*
	SLO-2					

Learning Resources	1. *Ratan.S.S, Theory of Machines, 4th ed., Tata McGraw Hill, 2014* 2. *R.L. Norton, Kinematics and Dynamics of Machinery, 1st ed., Tata McGraw Hill, 2010* 3. *Sadhu singh Theory of machines, 3rd ed., Pearson, 2011* 4. *Gordon R. Pennock & Shigley J.E John J Uicker, 4th ed., Theory of machines and mechanisms, Oxford university press, 2014* 5. *R.K. Bansal, J.S. Brar, Theory of Machines, 5th ed., Lakshmi publications, 2016*	6. *Singiresu S.Rao, Mechanical Vibrations, Nem Chand and Bros, 1998* 7. *Thomas Beven, Theory of Machines, 3rd ed., CBS Publishers and Distributors, 2013* 8. *Sing.V.P, Mechanical Vibrations, Dhanpat Rai and Co., 1998* 9. *Rao.J.S., Dukkipati.R.V, Mechanism and Machine Theory, Wiley Eastern Ltd., 2006* 10. *John Hannah, Stephens.R.C, Mechanics of Machines, Viva Low Price student edition, 1999* 11. *Ghosh .A., Mallick.A.K, Theory of Mechanisms and Machines, Affiliated East - West Pvt. Ltd., 2006*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*30 %*	-	*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. K.Balaguru, Hindhustan Aeronautics Ltd, gurubalao7@gmail.com	*1. Dr.S. S Dash, Govt. College of Engineering Kednhhar, Orisha, munu_dash_2k@yahoo.com*	*1. Mr. J. Thiyagarajan, SRMIST*
2. Mr. M. Arun kumar Rolls-Royce India (P) Ltd., arumkumar.manickam@rolls_royce.com	*2. Dr. K. Sujatha, Dr. MGR Educational and Research Institute, drksujatha23@gmail.com*	*2.*

Course Code	18MHC107T	Course Name	SYSTEM DYNAMICS	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Classify and manipulate the signals with systems
CLR-2 :	Understand the significance of Laplace transform in modeling and solving the LTI systems
CLR-3 :	Model all possible systems and derive their transfer functions
CLR-4 :	Determine the time domain characteristics of system and stability analysis using root locus
CLR-5 :	Obtain the frequency response and determine stability margins for linear systems
CLR-6 :	Impart the knowledge on modeling of systems with analysis and design

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	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 and identify the different types of signals and systems	2	80	75	H	H	M	L	M	L	M	M	L	L	M	H	M	L	M
CLO-2 :	Importance of Laplace transform in system analysis and design	2	75	75	H	H	M	H	M	L	M	M	L	L	M	H	M	L	M
CLO-3 :	Find the transfer function of possible systems using different methods	2	75	75	H	H	H	H	M	L	L	M	L	L	M	H	M	L	M
CLO-4 :	Design a system with required specifications	3	70	70	H	H	H	H	M	L	M	M	M	L	M	H	H	L	M
CLO-5 :	Analyze a system in frequency domain and determine the margins for stability of system	3	70	70	H	H	H	H	M	L	M	M	M	L	M	H	H	L	M
CLO-6 :	Identify, analyze and design of a system for the required specifications	3	75	70	H	H	H	H	M	L	M	M	M	L	M	H	H	L	M

		Introduction to Signals and Systems	Linear Time - Invariant Systems	Modeling in S-Domain	Time Domain Analysis and Root Locus	Frequency Response Analysis
Duration (hour)		9	9	9	9	9
S-1	SLO-1	Introduction to Signals	Introduction to LTI systems	Transfer functions of simple mechanical systems	First order System and its specifications	Introduction to frequency response
	SLO-2	Representation of signals in continuous and discrete time	Impulse response of LTI systems	Transfer functions of simple mechanical systems	Step, ramp and impulse response analysis of first order systems	Frequency domain specifications
S-2	SLO-1	Elementary/basic Signals	Derivation of Convolution integral formula	Transfer functions of simple electrical networks	Second order system and its specifications	Correlation between time domain and frequency domain specifications
	SLO-2	Relationship among the elementary signals	Properties of convolution integral	Transfer functions of simple electrical networks	Impulse response of second order systems	Construction of Bode plot
S-3	SLO-1	Properties of signals	Properties of LTI system	Analogous systems Mechanical and electrical	Step response of second order systems	Construction of Bode plot
	SLO-2	Properties of signals	Properties of LTI system	Mechanical and Electrical analogous system	Step response of second order systems	Determination of gain and phase margins
S-4	SLO-1	Signal power and energy	Differential equation representation of systems	Transfer function of electromechanical systems	Transient response specifications of under damped systems	Problems on drawing Bode plot and determining the margins for stability
	SLO-2	Problems on properties of signal	Responses of the system in time domain	Transfer function of electromechanical systems	Time domain specifications of the under damped systems	Problems on drawing Bode plot and determining the margins for stability
S-5	SLO-1	Operations on signals	Solving differential equation in time domain	Block diagram representation of system	Steady state error for closed loop system	Determination of transfer functions from Bode Plot
	SLO-2	Manipulations on the dependent and independent variables	Solving differential equation in time domain	Block diagram reduction technique rules	Steady state error for different types and inputs of a system with generalized error coefficients	Determination of transfer functions from Bode Plot
S-6	SLO-1	Representation of Systems	Introduction to Laplace transformation and region of convergence	Problems on Block diagram reduction	Stability of the system with respect to the position of poles in s plane	Introduction and properties of Polar Plots

	SLO-2	*Continuous and discrete time systems*	*Laplace transform of standard functions*	*Problems on Block diagram reduction*	*Stability analysis using Routh-Hurwitz criterion*	*Gain and phase margins in Polar plot*
S-7	SLO-1	*Classification and properties of system*	*Properties of Laplace transform*	*Introduction to Signal flow graphs*	*Problems on stability checking using Routh-Hurwitz criterion*	*Problems on drawing Polar plots and determining the margins*
	SLO-2	*Classification and properties of system*	*Properties of Laplace transform*	*Relationship between block diagram and signal flow graph*	*Problems on stability checking using Routh-Hurwitz criterion*	*Problems on drawing Polar plots and determining the margins*
S-8	SLO-1	*Problems on properties of system*	*Transfer function approach for dynamic system using Laplace transform*	*Determination of transfer function using*	*Introduction of Root locus and its properties*	*Nyquist stability criterion*
	SLO-2	*Problems on properties of system*	*Poles and zeros of system in 's' plane*	*Determination of transfer function using*	*Construction of Roots locus*	*Assesment of relative stability*
S-9	SLO-1	*Properties of system which contains differential equations*	*Solving differential equation using Laplace transform*	*Problems on determining the transfer function using Mason's Gain formula*	*Problems on the construction of Root locus*	*Problems on Nyquist stability criterion*
	SLO-2	*Properties of system which contains differential equations*	*Solving differential equation using Laplace transform*	*Problems on determining the transfer function using Mason's Gain formula*	*Problems on the construction of Root locus*	*Problems on Nyquist stability criterion*

Learning Resources	1. *K Ogata, System Dynamics, 3rd ed., Prentice Hall, 1998* 2. *B P Lathi, Principles of Linear Systems and Signals, 2nd ed., Oxford University Press, 2009* 3. *Alan V Oppenheim., Alan S Willsky, Ian T. Young., Signals and Systems, Prentice Hall, 1983*	4. *J Nagrath, M Gopal, Control Systems Engineering, 5th ed., New Age International, 2007* 5. *Norman S Nise, Control Systems Engineering, 7th ed., Wiley, 2015*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*30 %*	-	*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. K. Karthikeyan, R&D Specialist, ABB India Ltd, Bangalore, India, sayalkarthik@yahoo.co.in	*1. Dr. Dr. B. Chittibabu, IIITDM, Kanchipuram, bcbabu@iiitdm.ac.in*	*1.Dr. M. Mohamed Rabik, SRMIST*
2. Dr. Vishal P Barde, Senior Lead Engineer, Mahindra & Mahindra, Chennai, vishalbarde@gmail.com	*2. Dr. P. Karthikeyan, MIT campus, Anna university, pkarthikeyan@annauniv.edu*	*2..Mr. S. Vasanth, SRMIST*

Course Code	18MHC108J	Course Name	DIGITAL SYSTEMS AND MICROPROCESSORS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Perceive the fundamental Knowledge of Digital devices			
CLR-2 :	Know the working principle of digital circuit for performing its function			
CLR-3 :	Know the working nature of the sequential Devices			
CLR-4 :	Expose the architecture and instruction set of different microprocessors			
CLR-5 :	Deal with the Assembly Language program using typical instruction			
CLR-6 :	Gain knowledge about different peripheral interfacing Devices			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 and applications of various digital circuits	1	95	90	H	M	L	L	L	-	-	-	L	-	-	L	M	-	M
CLO-2 :	Design the combinational and sequential circuits	3	90	85	H	H	M	M	M	-	-	-	M	-	M	H	M	M	L
CLO-3 :	Enlighten the architecture of microprocessors	1	85	80	H	L	-	L	M	-	-	-	-	-	L	M	M	H	M
CLO-4 :	Develop the assembly language programs	3	80	75	H	H	M	M	M	-	-	-	M	-	L	M	M	H	M
CLO-5 :	Use the processors for various applications	2	80	75	H	L	L	L	H	-	-	-	M	-	H	M	H	H	H
CLO-6 :	Use microprocessor with different peripherals	1	90	85	H	L	L	L	M	-	-	-	H	-	H	M	M	H	M

		Combinational Circuit Design	Sequential circuit Design	8085 Microprocessor	8086 Microprocessor	Peripheral Interfacing
Duration (hour)		15	15	15	15	15
S-1	SLO-1	Introduction to logic gates, Digital logic circuits, Boolean laws and Expression	Introduction to Latches and Flip-Flop,	Introduction to microprocessors	Introduction, Pin Descriptions of 8086 microprocessor	Introduction to Data transfer Schemes
	SLO-2	Minterm, Maxterm, Sum of Products (SOP) and Product of Sums (POS)	Triggering of flip flops	Pin Descriptions of 8085 microprocessor	Modes of operation : Maximum and Minimum mode	Software interrupt
S-2	SLO-1	Boolean Laws and theorems	Truth Table, Characteristic Table, Excitation table and equations for flip flops	Architecture of 8085 microprocessor	Architecture of 8086 microprocessor	Pin Description of programmable interrupt controller-8259
	SLO-2	Minimization of Boolean expressions using Boolean Laws and theorems				Architecture of Programmable Interrupt Controller-8259
S-3	SLO-1	Minimization of Boolean expressions using K - map	Conversion of SR flip flop to any flip flop	Instruction set of 8085 microprocessor:Types	Instruction set of 8086 microprocessor	Pin Description of Programmable Peripheral Interface-8255
	SLO-2		Conversion of JK flip flop to any flip flop	Data Transfer Instruction Set	Data Transfer Instruction Set	Architecture of Programmable Peripheral Interface-8255
S 4-5	SLO-1	Lab 1: Verification of logic gates and implementation of Boolean expression	Lab 4: Implementation of Code converters	Lab 7: Implementation of Shift registers	Lab 10: Code conversion using 8085 microprocessor	Lab 13: Sorting of an array using 8086 microprocessor
	SLO-2					
S-6	SLO-1	Minimization of Boolean expressions using karnaugh map with don't care conditions	Conversion of D flip flop to any flip flop	Arithmetic Instruction set	Arithmetic Instruction set	Pin Description of programmable Communication Interface (USART)-8251
	SLO-2		Conversion of T flip flop to any flip flop	Logical Instruction Set	Logical Instruction Set	Architecture of programmable Communication Interface (USART)-8251
S-7	SLO-1	Design steps for combinational circuits.	Master –Slave Flip-flop	Branching Instruction Set	Branching/Program Control Instruction Set	Pin Description of Direct Memory Access-8257
	SLO-2	Design of adder and subtractor.	Steps to design Sequential Circuits			Architecture of Direct Memory Access-8257

S-8	SLO-1	*Design of Multiplexer*	*Design of synchronous counter*	*Control Instruction set*	*String Manipulation Instruction set*	*Pin Description of programmable Interval timer -8253*
	SLO-2	*Design of De-Multiplexer*			*Processor Control Instruction set*	*Architecture of programmable Interval timer -8253*
S 9-10	SLO-1 SLO-2	*Lab 2: Implementation of Adder Subtractor, Multiplexer, Demultiplexer*	*Lab 5: Implementation of Flip flops*	*Lab 8: Study of microprocessor*	*Lab 11: Multiplication and division using 8086 microprocessor*	*Lab 14: Generation of waveforms by interfacing with 8085 microporcessor*
S-11	SLO-1	*Design of Encoder*	*Design of asynchronous sequential circuits*	*Addressing modes of 8085 microprocessors: Direct and indirect addressing mode*	*Addressing modes of 8086 microprocessors: Register and Immediate data – Group I*	*Applications: stepper motor control using 8085 microprocessor*
	SLO-2	*Design of Decoder*		*Register addressing mode register indirect addressing mode and implied addressing mode*	*Addressing mode for memory data – Group II*	
S-12	SLO-1	*Logic Diagram of Parallel binary adder/Subtractor*	*Design of Asynchronous Up, Down counter*	*Timing Diagram of 8085 microprocessor*	*Addressing mode for I/O – Group III*	*A/D and D/ A conversion using 8086 microprocessor*
	SLO-2		*Design of Asynchronous Up/ Down counter*		*Interrupts of 8086 microprocessor*	
S-13	SLO-1	*Design of code converters*	*Concept and Types of Shift Registers(Serial In Serial Out, Serial In Parallel Out, Parallel In Serial Out and Parallel In Parallel Out shift registers*	*Simple Assembly language programs using the instructions of 8085 microprocessor*	*Timing Diagram of 8086 microprocessor*	*A/D and D/ A conversion using 8085 microprocessor*
	SLO-2	*Design of magnitude comparator*			*Assembler Directives and assembly language programs of 8086microprocessor*	
S 14-15	SLO-1 SLO-2	*Lab 3: Implementation of encoder and decoder*	*Lab 6: Design of synchronous counter*	*Lab 9: Arithmetic operations using 8085 microprocessor*	*Lab 12: Stepper motor Interfacing using 8085 Microprocessor*	*Lab 15: Model Practical Examination*

Learning Resources	1. *M. Morris Mano, Michael D Ciletti, Digital Design, 5th ed., Pearson, 2014* 2. *Charles H.Roth, Fundamentals of Logic Design, 6th ed., Thomson Learning, 2013* 3. *Ramesh S. Gaonkar, Microprocessor Architecture. Programming and Applications with the 8085, 5th ed., Penram International Publishing (India) Private Limited. 2005*	4. *Mohammed Rafiquzzaman, Microprocessors and Microcomputer based System Design, Universal Book Stall, New Delhi, 1990* 5. *Doughlas V.Hall, Microprocessors and Interfacing, Programming and Hardware, Tata McGraw Hill, 2012* 6. *Laboratory manual for Digital Systems and Microprocessors, SRMIST*

Learning Assessment

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

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. K. Karthikeyan, R&D Specialist, ABB India Ltd, Bangalore, India, sayalkarthik@yahoo.co.in	*1. Dr. Dr. B. Chittibabu, IIITDM, Kanchipuram, bcbabu@iiitdm.ac.in*	*1.Dr. M. Mohamed Rabik, SRMIST*
2. Dr. Vishal P Barde, Senior Lead Engineer, Mahindra & Mahindra, Chennai, vishalbarde@gmail.com	*2. Dr. P. Karthikeyan, MIT campus, Anna university, pkarthikeyan@annauniv.edu*	*2..Mr. S. Vasanth, SRMIST*

ACADEMIC CURRICULA

Professional Core Courses

NANOTECHNOLOGY

Regulations - 2018

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

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

Kattankulathur, Kancheepuram, Tamil Nadu, India

Course Code	18NTC101T	Course Name	NANOSCALE CHEMISTRY	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Understand the role of chemistry in nanoparticle synthesis
CLR-2 :	Improve their ability in understanding the thermodynamic behavior of nanomaterials
CLR-3 :	Acquire knowledge about size effects and reaction kinetics and phase properties at nanoscale
CLR-4 :	Enhance knowledge about Symmetry and lattice parameters
CLR-5 :	Enhance knowledge about the various nanosynthesis techniques
CLR-6 :	Utilize the knowledge of processing in nanochemistry

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1 Level of Thinking (Bloom)	Learning 2 Expected Proficiency (%)	Learning 3 Expected Attainment (%)
CLO-1 :	Identify the difference between bulk and nanoscale thermodynamics	2	80	75
CLO-2 :	Identify symmetry, point groups and its application in lattice determination	2	80	70
CLO-3 :	Describe phase diagram and transition in nanoscale	2	75	70
CLO-4 :	Analyze the physical chemistry of nanomaterials	2	80	75
CLO-5 :	Analyze the mechanism of different chemical synthesis routes	2	80	70
CLO-6 :	Analyze the chemistry based processes at nanoscale	2	80	70

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

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Fundamental Properties of nanomaterials	Symmetry of molecules	Crystalline phase transitions in nanocrystals	Supercritical fluids-introduction	Introduction on different synthesis route of nanoparticles
	SLO-2	Size effects on structure and morphology of free and supported nanoparticles	point groups of molecules	Phase transitions and grain size dependence	Processes involving supercritical fluids	Overview on precipitative methods
S-2	SLO-1	Size and confinement effects of nanomaterials	Symmetry of nanosystems	Phase diagram of Water and Carbondioxide	Phase diagram of a pure substance	Chemical precipitation and co-precipitation methods to synthesize nanomaterials
	SLO-2	Fraction of surface atoms	Point groups of nanoclusters	Different forms of phase transition	Pressure–density diagram for CO_2	Chemical reduction method to synthesize metallic nanocrystals
S-3	SLO-1	Specific surface energy and surface stress of nanomaterials	Miller indices and representation of directions	Classification of phase transitions	Physicochemical properties: solubility or dissolving power of different fluids	Metathesis to prepare nanoparticles
	SLO-2	Effect of size on the lattice parameter	Bragg's law of diffraction	Tools to detect phase transition	Variation of viscosity with respect to presure	Steps involved in Sol-gel synthesis
S-4	SLO-1	Classification of nano-structured materials	XRD analysis of bulk and nanomaterials	Wulff anf Wulff-Kirchoff plot for equilibrium geometry	Transport properties of supercritical fluids	Reaction mechanisms: Hydrolysis and polycondensation
	SLO-2	0D, 1D, 2D,3D structures	Identification of crystal planes in bulk and nanomaterials	Phase transition of Barium Titanate nanoparticles as example	Diffusion and Brownian motion	Introduction to micelles, reverse micelles and microemulsions
S-5	SLO-1	Introduction to thermodynamics of bulk materials	Scherer equation to calculate the grain or crystallite size	Influence of the surface or interface on nanocrystals	Thermal conductivity or heat transport phenomenon of supercritical fluids	Synthesis of nanomaterials using microemulsion route
	SLO-2	Gibb's equation	Specific features of nanoscale growth	Modification of transition barrier, geometric evolution of the lattice in nanocrystals	Purification and extraction of supercritical fluids	Prepare inorganic nanomaterials using hydrothermal and solvothermal routes
S-6	SLO-1	Derivation of free energies of nanostructures with different geometry	Size control of nanoparticles	Influence of the nanocrystal surface or interface on the lattice parameter	Synthesis of supercritical fluids	Preparation of arrays of oxide nanocrystals using thermolysisroute
	SLO-2	Surface energy and work function of nanostructures with different geometry	Triggering the phase transition in small particles fabrication	Crystallization of metallic glasses	Cryochemistry of metals-Introduction	Microwave heating assisted synthesis of nanomaterials
S-7	SLO-1	Thermodynamics of nanospheres	Application to solid nanoparticles	Grain growth and grain growth kinetics	Silver and other metals	Introduction to sonochemistry

	SLO-2	*Thermodynamics of nanorods*	*Controlling nucleation in nanomaterial synthesis*	*High pressure phase stabilization and DSC studies of nanomaterials*	*Stabilization of nanoparticles by polymers*	*Sonochemical synthesis of nanometals*
S-8	SLO-1	*Thermodynamics of nanoclusters*	*Controlling growth in nanomterial synthesis*	*TGA studies of nanomaterials*	*Stabilization of nanoparticles by mesogenes*	*Synthesis of nanosized hydroxides using sonochemical method*
	SLO-2	*Kinetic versus thermodynamic stability*	*Controlling aggregation of nanoparticles*	*Solid solutions*	*Reactions of rare-earth elements activity, selectivity and size effect*	*Core-shell synthesis of semiconductor nanocrystals*
S-9	SLO-1	*Understanding the thermodynamics at nanoscale*	*Stability of colloidal dispersions*	*Congruence in solid solutions*	*Reactions at superlow temperatures*	*Electrochemical synthesis of nanoparticles*
	SLO-2	*Factors affecting thermodynamics at nanoscale*	*Breaking matter into pieces*	*Phase change and applications of nanosystems*	*Reactions of silver particles of various sizes and shapes*	*Photochemical synthesis of nanoparticles*

Learning Resources	1. *Ben Rogers, Jesse Adams, SumithaPennathur,Nanotechnology – Understanding small systems, 3rd ed., CRC press, 2017*	2. *Nils O Peterson, Foundations for Nanoscience and Nanotechnology, CRC press, 2017*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*30 %*	-	*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. Nagesh Kini, Thermax, Pune, Maharastra, nagesh.kini@gmail.com	*2. Prof. G. Ranga Rao, Department of Chemistry, IITM Chennai, grrao@iitm.ac.in*	*2. Dr. S. HariniPriya, SRMIST*

Course Code	18NTC102T	Course Name	QUANTUM MECHANICS FOR NANOTECHNOLOGISTS	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Utilize the concept of old and new Quantum Mechanics			
CLR-2 :	Analyze the bound and scattering states			
CLR-3 :	Utilize quantum physics behind applications - Nanodimension			
CLR-4 :	Solve the many body problems using various assumptions			
CLR-5 :	Identify the implications of quantum theory and approximations at nanoscale			
CLR-6 :	Utilize the basis of quantum mechanics and get acquainted with its applications			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 the basics of Quantum Mechanics	2	80	75	M	M	H	M	M	M	M	H	H	H	M	H	H	H	M
CLO-2 :	Apply Quantum Mechanics in low-dimensional systems	2	80	70	H	M	H	H	M	M	M	H	M	H	M	H	M	M	M
CLO-3 :	Perform approximation methods to solve problems in nanoscale	2	75	70	M	M	H	M	H	H	H	H	H	H	H	M	H	H	H
CLO-4 :	Gain expertise in processes based on quantum phenomena	2	80	75	M	H	H	H	M	H	H	H	M	H	M	H	H	H	H
CLO-5 :	Solve problems using quantum mechanics	2	80	70	H	M	M	M	H	M	M	H	H	H	M	H	H	H	H
CLO-6 :	Analyze the basis of quantum mechanics and get acquainted with its applications	2	80	70	M	H	M	H	H	M	M	H	H	H	M	H	H	H	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Old quantum mechanics, wave particle duality	Classical interpretation of scattering state	Energy eigen functions and eigen values with precession coordinates	Principle of variational method	Two particle system's Schrödinger equation
	SLO-2	Heisenberg uncertainty principle	Quantum interpretation of scattering State	Infinite well potential in one dimensions	Proof of variational method and implementation	Derivation of two particle system's Schrödinger equation
S-2	SLO-1	Generalized Heisenberg uncertainty principle	Reflection of particles (wavefunction)	Numericals on infinite well potential in one and three dimensions	Energy eigen value in case of time independent perturbation theory for non-degenerate energy levels	Transformation to center of mass frame from laboratory frame
	SLO-2	Ehrenfest theorem	Transmission of Particles (wavefunction)	Quantum confinement effect in nanoscale	Energy eigen value in case of time independent perturbation theory for non-degenerate energy levels (quantitative approach)	Exchange operator
S-3	SLO-1	Linear vector space	Rectangular potential barrier ($E<V_0$): quantitative	Finite Well Potential, Delta potential	Eigen function in case of time independent perturbation theory for non-degenerate energy levels	Symmetrization of wave function
	SLO-2	Hilbert space	Rectangular potential barrier ($E>V_0$)	Eigen values, Schrödinger equation in spherical coordinates	Eigen function in case of time independent perturbation theory for non-degenerate energy levels(quantitative approach)	Antisymmetric wave function
S-4	SLO-1	Statistical interpretation, stationary states	Transmission probability plot as a function of energy ofparticle	Angular equation	Energy eigen value in case of Time independent perturbation theory for degenerate energy levels	Bosons and Fermions
	SLO-2	Orthogonal wave function	Numericals in rectangular potential barrier	Introduction on radial equation	Quantitative approach of energy eigen value in case of Time independent perturbation theory for degenerate energy levels	Exchange forces

S-5	SLO-1	*Normalization of wave function*	*Tunneling effect*	*Derivation of radial equation*	*Eigen function in case of time dependent perturbation theory for two-level systems*	*Solids, free electron gas*
	SLO-2	*Hermitian operator*	*Relation of tunneling with nanotechnology*	*Infinite spherical well*	*Quantitative approach of eigen Function in case of Time dependent perturbation theory for two-level systems*	*Band structure of solids*
S-6	SLO-1	*Properties of Hermitian operator*	*Alpha-particle emission*	*Numerical on infinite spherical well*	*Sinusoidal perturbations*	*Quantum scattering theory*
	SLO-2	*Commutation*	*Failure of Classical Mechanics to explain Alpha-particle emission*	*Ground state properties of hydrogen atom*	*Sinusoidal perturbations (quantitative approach)*	*Quantum scattering theory (quantitative approach)*
S-7	SLO-1	*Energy eigen value equation*	*Derivation on Alpha-particle emission*	*Angular momentum (L_x,L_y,L_z)*	*Incoherent perturbation*	*Differential and total cross sections*
	SLO-2	*Boundary condition of wavefunction*	*Numericals in particle emission*	*Angular momentum (L_x,L_y,L_z) in spherical coordinate*	*Role of incoherent perturbation*	*Differential and total cross sections (quantitative approach)*
S-8	SLO-1	*Schrödinger's time dependent wave equations*	*Resonant tunneling*	*Generalized angular momentum (J_x,J_y,J_z), Eigen values*	*Transition rate*	*Green's functions*
	SLO-2	*Schrödinger's time independent wave equations*	*Applications of resonant tunneling*	*Eigen values of momentum operator*	*Transition rate role is perturbation*	*Born approximation*
S-9	SLO-1	*Schrödinger's representation*	*Negative differential resistance*	*Spin ½, spin for two particle system*	*Adiabatic approximations (elementary concepts)*	*Applications in nanotechnology*
	SLO-2	*Heisenberg representation, interaction picture*	*Negative differential resistance in 2D materials*	*Role of spin in nanospintronics*	*Sudden approximations (elementary concepts)*	*Overall role and implication of quantum phenomena in nanotechnology*

Learning Resources	1. *G. Aruldhas, Quantum Mechanics, 2nd ed., PHI, 2013* 2. *David J. Griffiths, Introduction to Quantum Mechanics, 2nd ed., Pearson, 2009*	3. *Ajoy Ghatak, S. Lokanathan, Quantum Mechanics, 5th ed., Macmillan, 2009* 4. *Bransden B.H., JoachainC.J. Quantum Mechanics, 2nd ed., Pearson, 2007*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*30 %*	-	*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. Noriaki Terakubo, JGC CORPORATION, Japan, terakubo.noriaki@jgc.co.jp	*1. Dr. Uday Narayan Maiti, IITG Guwahati, udaymaiti@gmail.com*	*1. Dr. Ranjit Thapa, SRMIST*
2. Mr. R. Seshadri, TITAN Company Limited, seshadri@titan.co.in	*2. Dr. Noejung Park, Ulsan National Institute of Science and Technology, noejung@unist.ac.kr*	*2. Dr. Kiran Mangalampalli, SRMIST*

Course Code	18NTC103L	Course Name	NANOSCALE MATERIALS LABORATORY	Course Category	C	Professional Core	L	T	P	C
							0	0	2	1

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Analyze the chemical properties of nanostructured materials based on their size			
CLR-2 :	Utilize microscopes to view the morphology and spectrometers to find the absorbance of the nanomaterial			
CLR-3 :	Demonstrate various synthesis methods for nanomaterials preparation			
CLR-4 :	Utilize the characterization techniques and calculate the size and bandgap			
CLR-5 :	Analyze the optical and magnetic properties of the nanomaterials			
CLR-6 :	Compare the green synthesis and chemical reduction methods			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1 :	Perform various experimental methods for nanoparticles synthesis	2	80	75	M	M	H	H	M	M	M	H	H	H	M	H	H	H	M
CLO-2 :	Analyze the role of chemistry innanoparticle synthesis	2	80	70	M	H	H	H	M	M	M	H	M	H	M	H	M	M	M
CLO-3 :	Analyze and interpret data in determining the properties of materials	2	75	70	H	M	H	H	H	H	M	H	H	H	H	H	H	H	H
CLO-4 :	Describe the behavior of nanomaterials based on its chemistry	2	80	75	M	M	H	H	M	M	H	H	H	H	M	H	H	H	M
CLO-5 :	Identify the mechanism of different chemical synthesis routes	2	80	70	H	M	H	H	H	M	H	H	H	H	M	H	H	H	H
CLO-6 :	Perform various characterizations of nanomaterials	2	80	75	H	H	H	H	H	M	M	H	H	H	M	H	H	H	H

Duration (hour)		6	6	6	6	6
S 1-2	SLO-1	Introduction to the basics of laboratory	Synthesis of gold nanoparticles by chemical reduction Determination of absorption coefficient using UV-Vis spectrometer	Synthesis of photocatalytic solution using co-precipitation method	Cryochemical synthesis of metal nanoparticles anddetermination of particle size using UV-Vis spectrometer	Synthesis of iron oxide nanoparticles using precipitation method Scherrer formula to determine the crystallite size of nanoparticle using X-ray diffraction technique
	SLO-2					
S 3-4	SLO-1	Synthesis of zinc sulfide quantum dot using co-precipitation method Determination of optical bandgap using UV-Vis spectrometer	Synthesis of ferro fluids using chemical precipitation Determination of zeta potential of aqueous dispersion at different pH conditions	Synthesis of nanoparticles loaded polymer fibers using electrospinning technique	Preparation of nanoparticles using sonochemical method and elemental identification using XRF analysis	Determination of pH of unknown solution
	SLO-2					
S 5-6	SLO-1	Synthesis of silica nanospheres using stober's method	Synthesis of metal oxide nanoparticles using sol-gel technique	Repeat/revision of experiments	Fabrication of polymer membrane using phase inversion technique and characterization using scanning electron microscope (SEM) technique	Thin film preparation by spin coating technique and to determinethe dislocation density and strain of given sample by XRD method
	SLO-2					

Learning Resources	
1. Nanoscale chemistry laboratory course manual, 2016 2. Kenneth J. Klabunde, Nanoscale Materials in Chemistry, WileyInterscience publications,2001 3. Vincenzo Turco Liveri, Controlled Synthesis of Nanoparticles in Microheterogeneous Systems,Springer,2006	4. L.H. Sperling, Introduction to Physical Polymer Science, Wiley Inter science, 2006 5. http://chemistry.beloit.edu/classes/Chem150/index.html

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	*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. P. Sudhakara, CLRI – CSIR, Jalandhar, sudhakarp@clri.res.in	*1. Dr. Kothandaraman Ramanujam, IITM Chennai, rkraman@iitm.ac.in*	*1. Dr. N.Angeline Little Flower, SRMIST*
2. Dr. Sudhakar selvakumar, CSIR-Central Electrochemical Research Institute, ssudhakar79@gmail.com	*2. Dr. Arthanreeswaran, NIT, Trichy,arthanareeg@nitt.edu*	*2. Dr. S. HariniPriya, SRMIST*

Course Code	18NTC104T	Course Name	THERMODYNAMICS AND STATISTICAL MECHANICS	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Utilize the basic principles and laws of thermodynamics			
CLR-2 :	Identify the thermodynamic properties of pure substances and different kinds of equilibrium			
CLR-3 :	Utilize the concept of ensembles and classical statistics			
CLR-4 :	Analyze the concepts of quantum statistics			
CLR-5 :	Analyze the principles of nanothermodynamics			
CLR-6 :	Apply the concepts of Non-equilibrium thermodynamics to Nanoscale systems			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 various thermodynamic processes and concepts explained by laws	2	80	75	M	H	H	H	M	M	L	M	M	H	L	H	H	H	H
CLO-2 :	Analyze the concepts of enthalpy, entropy, chemical potential, fugacity	2	80	70	H	M	H	H	M	M	M	H	M	H	L	M	M	M	M
CLO-3 :	Describe the postulates of statistical mechanics	2	75	70	M	M	H	M	H	H	L	M	H	M	M	H	H	H	H
CLO-4 :	Enumerate on Bose-Einstein condensation and Fermi gas	2	80	75	M	H	M	H	H	M	M	H	M	H	L	M	H	H	H
CLO-5 :	Describe the concept of Hill's nanothermodynamics	2	80	70	H	H	H	H	M	H	L	M	H	H	M	H	H	H	H
CLO-6 :	Analyze the fluctuations in small systems	2	80	75	M	H	H	H	M	M	L	M	M	H	L	H	H	H	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Properties of a thermodynamic system-concept of system and boundaries	Thermodynamic properties of pure substances in solid, liquid, vapor phases	Fundamentals of statistical physics-microscopic approach	Quantum statistics for identical particles	Thermodynamics of small systems and Gibbs equation for nanosystems
	SLO-2	Concept of continuum	Phase diagrams of a pure substance	Concept of phase space	Distinguishable and indistinguishable particles	Features of Hill's nanothermodynamics
S-2	SLO-1	Thermodynamic equilibrium	Gibb's phase rule	Concept of gamma space and μ space	Grand canonical ensemble	Comparison with classical equilibrium thermodynamics
	SLO-2	Path and point functions	Different kinds of equilibrium	Volumes in phase space	Determination of Gibbs factor	Nanoensemble and its thermodynamic parameters
S-3	SLO-1	Extensive and intensive properties	Entropy and energy criteria for equilibrium	Difference between microstate and macrostate	Photons in an oven	Gibbs energy of single-component nanoparticles
	SLO-2	Zeroth law of thermodynamics and concept of temperature	Ideal gas equation of a state	Most probable distribution	Principle of detailed balance	Fluctuations in small systems
S-4	SLO-1	Energy transfer by heat and work	Deviation from ideal gas behavior	Equal apriori probability and ergodicity	Energy flux	Jarzyanki's inequality
	SLO-2	Isothermal process	VanderWaal's equation of state	Ensemble averages	Bose gas	Classical nucleation thermodynamics
S-5	SLO-1	Adiabatic process	Law of corresponding states	Derivation of Boltzmann equation S=KlnW	Structureless Bose gas	Phase diagrams of small systems
	SLO-2	Isochoric process	Determination of critical constants	Thermodynamics of Ensembles	Bose Einstein distribution law for bosons	Thermodynamics of metastable phase nucleation at the nanoscale
S-6	SLO-1	Isobaric process	Temperature and entropy (T-dS) relations	Canonical Ensemble and its thermodynamic parameters	Bose-Einstein condensation	Nanoscale thermodynamic approach in CVD diamond
	SLO-2	First law of thermodynamics	Helmholtz Function Gibbs Function	Microcanonical Ensemble and its thermodynamic parameters	Observation of BECs of cold atoms	Nucleation thermodynamics of cubic boron nitride

S-7	SLO-1	*Specific Heat at constant Pressure and constant volume*	*General Thermodynamic equations*	*Stirling Approximation*	*Superfluid liquid helium*	*Nonextensivity of nanosystems*
	SLO-2	*Second law of thermodynamics*	*Joule-Thomson coefficient*	*Classification of statistical distributions*	*Fermi gases for electrons*	*Nonintensivity of nanosystems*
S-8	SLO-1	*Reversibility, irreversibility and Carnot cycle*	*Co-efficient of volume expansion*	*Maxwell-Boltzmann distribution for classical particles*	*Structureless degenerate Fermi gas*	*Principles of non-equilibrium thermodynamics*
	SLO-2	*Reversed Carnot Cycle as a refrigeration cycle*	*Adiabatic and isothermal compressibility*	*Concept of degrees of freedom*	*Fermi Dirac distribution law for fermions*	*Concept of Pseudo equilibrium and benard cells*
S-9	SLO-1	*Third law of thermodynamics*	*Clapeyron equations*	*Law of equipartition of energy*	*Fermions at low temperatures*	*Out of equilibrium nanosystems*
	SLO-2	*Unattainability of absolute zero*	*Clapeyron-Clausius equations*	*Specific heat capacities of gases*	*Fermi temperature and degenerate pressure*	*Cooling by heating in nonequilibrium nanosystems*

Learning Resources	1. *Keith Stowe, An Introduction to Thermodynamics and Statistical Mechanics, Cambridge University, 2007* 2. *Richard E.Sonntag, Gordon J.VanWylen, Introduction to Thermodynamics, Classical and Statistical, Wiley Publishing, 2010*	3. *Yunus, A.Cengel, Michael Boles, Thermodynamics-An Engineering Approach, Tata McGraw Hill,2008* 4. *Pathria, R. K., Statistical Mechanics, Oxford: Pergamon Press, 1972*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*30 %*	-	*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. D.K. Aswal, National Physical Laboratory, New Delhi, dkaswal@nplindia.org	*1. Prof. V. Subramaniam, IITM, Chennai, manianvs@iitm.ac.in*	*1. Dr. Annie Sujatha, SRMIST*
2. Dr. Vinay Kumar Gupta, National Physical Laboratory, New Delhi, guptavinay@nplindia.org	*2. Dr. R.Gnanamoorthy,IITM,Chennai, gmoorthy@iitm.ac.in*	*2. Dr. BibhuRanjanSarangi, SRMIST*

Course Code	18NTC105T	Course Name	BIOLOGICAL PRINCIPLES FOR NANOSCALE SCIENCE	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Know about various biological molecules
CLR-2 :	Understand the structure and functions of various biological membranes and transportation across membrane
CLR-3 :	Know about various molecular biology principles
CLR-4 :	Acquire insight into bioenergetic cycles
CLR-5 :	Gain knowledge about various gene transfer technologies
CLR-6 :	Understand the basic biological principles and mechanisms

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1 Level of Thinking (Bloom)	Learning 2 Expected Proficiency (%)	Learning 3 Expected Attainment (%)	PLO 1 Engineering Knowledge	PLO 2 Problem Analysis	PLO 3 Design & Development	PLO 4 Analysis, Design, Research	PLO 5 Modern Tool Usage	PLO 6 Society & Culture	PLO 7 Environment & Sustainability	PLO 8 Ethics	PLO 9 Individual & Team Work	PLO 10 Communication	PLO 11 Project Mgt. & Finance	PLO 12 Life Long Learning	PLO 13 PSO - 1	PLO 14 PSO - 2	PLO 15 PSO - 3
CLO-1 :	Describe importance of biological molecules	2	80	75	H	H	H	H	H	M	H	H	H	H	M	H	H	H	M
CLO-2 :	Analyze the various biological membranes and transportation process across membrane.	2	80	70	H	M	H	H	M	M	M	H	M	H	M	H	M	M	M
CLO-3 :	Describe the obtained knowledge on molecular biology	2	75	70	H	M	M	H	H	H	H	H	H	H	M	M	H	H	H
CLO-4 :	Analyze the techniques of Bio energetics	2	80	75	H	H	H	H	H	H	H	H	M	H	H	H	H	H	H
CLO-5 :	Apply measuring the concept of gene transfer technology	2	80	70	H	H	H	H	H	H	H	H	H	H	H	H	H	H	M
CLO-6 :	Describe various biological principles and mechanisms	2	80	75	H	H	H	H	H	M	H	H	H	H	M	H	H	H	M

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Carbohydrates: classification	Models of membrane	DNA replication	Principles of bioenergetics	Introduction of foreign genes into animal cells
	SLO-2	Configurations and conformations	Membrane structure	Enzymology of DNA replication	Biological Oxidation reduction reactions	Transgenic technology
S-2	SLO-1	Sugar derivatives – structural polysaccharides	Erythrocytes	Transcription	Carbohydrate metabolism	Transgene transfer techniques
	SLO-2	Storage polysaccharides	Erythrocytes membrane	Types of RNA molecules	Glycolysis	DNA Microinjection
S-3	SLO-1	Amino acids: general properties	Plant cell	RNA splicing	Glucogenesis	Embryonic stem cell mediated gene transfer
	SLO-2	Peptide bonds	Cell membrane	Splicing mechanism	Gluconeogenesis	Retrovirus mediated gene transfer
S-4	SLO-1	Essential amino acids	Bacterial cell	Translation	Glycogenolysis	Plant tissue culture
	SLO-2	Non-essential amino acids	Bacterial cell wall	Genetic code	Pentose-phosphate pathway	Totipotency
S-5	SLO-1	Lipids: classification	Membrane lipids	Codon-Anticodon	Coordinated regulation of glycolysis and gluconeogenesis	Transgenic plants
	SLO-2	Fatty acids	Structure and function	Codon-Anticodon interaction	Citric acid cycle	Agrobacterium mediated gene transfer
S-6	SLO-1	Biological significance of lipids	Membrane proteins	Ribosomes	Reactions of the citric acid cycle	Ti plasmid
	SLO-2	Functions of lipids	Membrane carbohydrates	Protein synthesis	Glyoxylate cycle	Vectors

S-7	SLO-1	*Nucleic acid*	*Thermodynamics of transport*	*Posttranslational Modification of Proteins*	*Electron transport chain*	*Animal cell culture*
	SLO-2	*Chemical structure and base composition*	*Kinetics of transport*	*Difference between protein synthesis in eukaryotic and prokaryotic cells*	*Oxidative phosphorylation*	*Basic tissue culture techniques*
S-8	SLO-1	*Double helical structures*	*Mechanism of transport*	*Protein structures*	*Electron-Transfer Reactions in mitochondria*	*Concepts of transgenic animal technology*
	SLO-2	*Supercoiled DNA*	*Active and passive transport*	*Primary, secondary, tertiary and quaternary structures of protein*	*Proton pumping*	*Strategies for the production of transgenic animals and their importance*
S-9	SLO-1	*Vitamins, water and fat soluble vitamins*	*ATP-driven active transport*	*Gene regulation*	*ATP molecule*	*Gene therapy*
	SLO-2	*Deficiency and diseases*	*Ion gradient driven active transport*	*Concept of operon*	*ATP synthesis mechanism*	*Clinical significance*

Learning Resources	1. *David L Nelson, Michael M. Cox, Lehninger Principles of Biochemistry, 7th ed., WH Freeman & Co, 2012* 2. *Donald Voet, Judith G. Voet, Biochemistry, Wiley, 2003* 3. *David Freifelder, Molecular Biology, 2nd ed., Narosa, 2004*	4. *George M Malacinski, Freifelders Essentials of Molecular Biology, 4th ed., Jones & Bartlett, 2015* 5. *S.B. Primrose and R.M. Twyman, Principles of Gene Manipulation and Genomics, 7th ed., Wiley, 2006*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*30 %*	-	*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. K. Chandru, Trivitron Healthcare Pvt. Ltd. Chennai, chandru.k@trivitron.com	*1. Prof. K. Chandraraj, IITM, Chennai, kcraj@iitm.ac.in*	*1. Dr. G. Devanand Venkatasubbu, SRMIST*
2. Dr. Achuth Padmanaban, Baylor College of Medicine, USA, achuthz@gmail.com	*2. Dr. P. Balasubramanian, NIT Rourkela, biobala@nitrkl.ac.in*	*2. Mrs. J. Jositta Sherine, SRMIST*

Course Code	18NTC106T	Course Name	DESIGN AND SYNTHESIS OF NANOMATERIALS	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Gain insight into fundamental principles involved in the growth of nanomaterials			
CLR-2 :	Familiarize with zero dimensional materials and their synthesis techniques			
CLR-3 :	Know the concept of one dimensional materials and fabrication procedures			
CLR-4 :	Understand the fundamentals of thin films growth			
CLR-5 :	Acquire knowledge on special nanomaterials and their fabrication methods			
CLR-6 :	Evaluate the potential of various growth approaches in designing nanomaterials			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 concepts involved in nanoparticle synthesis	2	80	75	M	H	H	M	M	M	M	H	M	H	L	H	H	H	M
CLO-2 :	Identify various synthesis techniques involved in synthesis of quantum dots and nanoparticles	2	80	70	H	M	H	H	M	M	M	H	H	H	M	H	M	M	M
CLO-3 :	Distinguish nanowires, nanorods and nanotubes from bulk materials and 1D nanostructures	2	75	70	M	H	H	M	H	H	H	M	M	H	L	M	H	H	H
CLO-4 :	Apply the knowledge of thin films growth using PVD and CVD techniques	2	80	75	H	M	H	H	M	H	M	H	M	M	M	H	H	H	H
CLO-5 :	Describe the concept of self-assembly, biosynthesis and green synthesis of nanomaterials	2	80	70	M	H	H	M	H	M	H	H	M	H	L	H	H	H	H
CLO-6 :	Design experiments on the growth of nanomaterials	2	80	75	M	H	H	M	M	M	M	H	M	H	L	H	H	H	M

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Introduction to nanomaterials	Classification of nanoparticle synthesis techniques	1-Dimensional nanostructures: introduction	Fundamentals of thin film growth	Self assembly
	SLO-2	Nanomaterials classification based on dimension	Top down and bottom up approach of nanoparticles synthesis	Various examples of 1D nanostructures	Fundamentals of thinfilm growth (Quantitative approach)	Self-assembled monolayers
S-2	SLO-1	Surface energy	Nanoparticle synthesis by mechanical alloying	Spontaneous growth of 1D nanostructures	Physical vapor deposition	Monolayers of organosilicon
	SLO-2	Surface energies of different surfaces of FCC structure	Nanoparticle synthesis by mechanical milling	Evaporation (dissolution) condensation growth	Evaporation	Monolayers of alkanethiols and sulfides
S-3	SLO-1	Chemical potential as a function of surface curvature	Vapor-phase synthesis of nanoparticles	Fundamentals of evaporation (dissolution) condensation growth	Molecular beam epitaxy (MBE) - principle	Langmuir-Blodgett (LB) technique
	SLO-2	Gibbs-Thompson relation	Inert gas condensation of nanoparticles	quantitative approach	Epitaxial growth of thin films using MBE	Monolayer thin film formation using LB technique
S-4	SLO-1	Concept of Ostwald ripening	Plasma-based synthesis of nanoparticles	Fundamental aspects of (vapour-liquid-solid) VLS growth	Sputtering and Sputtering targets	Graphene preparation methods
	SLO-2	Role of Ostwald ripening in nanoparticle synthesis	Spark plasma method for nanoparticles synthesis	Fundamental aspects of SLS growth	DC and RF sputtering	Mechanical exfoliation
S-5	SLO-1	Fundamentals of homogeneous nucleation	Flame-based synthesis of particles	Au-Si phase diagram	Chemical vapor deposition (CVD)	Liquid phase exfoliation
	SLO-2	Critical radius and critical energy	Combustion synthesis of nanoparticles	VLS growth of various nanowires	Basic chemical reactions in CVD	Role of intercalation in graphene exfoliation
S-6	SLO-1	Effect of temperature on critical size and critical free energy	Spray pyrolysis based synthesis of nanoparticles	Control of the size of the nanowires	Reaction kinetics in CVD	Large area synthesis of graphene
	SLO-2	Process of nucleation and subsequent growth	Nanoparticle nucleation and growth in spray pyrolysis	Catalyst size dependent nanowires growth	Transport phenomena	CVD synthesis of graphene

S-7	SLO-1	*Growth controlled by diffusion*	*Solution processing of nanoparticles*	*Various precursor sand catalysts used for nanowires growth*	*Atomic layer deposition (ALD)*	*Biological synthesis of nanoparticles*
	SLO-2	*Growth controlled by diffusion (quantitative approach)*	*Sol-gel processing*	*SLS growth of various nanowires*	*Self-limiting growth using ALD*	*Nanoparticles synthesis using viruses*
S-8	SLO-1	*Growth controlled by surface process*	*Kinetically confined synthesis of nanoparticles*	*Stress induced recrystallization growth*	*Electrochemical deposition*	*Nanoparticles synthesis using bacteria*
	SLO-2	*Growth controlled by surface process (quantitative approach)*	*Nanoparticle synthesis using micelles*	*Template based synthesis of NWs,*	*Electrochemical deposition – Nernst equation and film growth*	*Role of bacteria in nanoparticle synthesis*
S-9	SLO-1	*Fundamentals of heterogeneous nucleation*	*Nanoparticle synthesis using microemulsion*	*Template filling*	*Sol-Gel Films - spin coating*	*Green chemistry of nanoparticles*
	SLO-2	*Fundamentals of heterogeneous nucleation (Quantitative approach)*	*Aerosol synthesis of nanoparticles*	*Nanofibres producion using Electrospinning*	*Dip coating, Electrophoretic deposition*	*Nanoparticles synthesis using plant extract*

Learning Resources	*1. C. Cao, Nanostructures & Nanomaterials –Synthesis, Properties & Applications, Imperial College Press, 2004* *2. Abdullaeva Zhypargul, Synthesis of Nanoparticles and Nanomaterials -Biological Approaches, Springer, 2017*	*3. Rai M and Poston C, Green biosynthesis of nanoparticles: mechanisms and applications, Cabi, 2013.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*30 %*	-	*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. M. Krishna Surendra, Saint-Gobain Research, Chennai, krishna.muvvala@saint-gobain.com	*1. Prof. S. Balakumar, University of Madras, balakumar@unom.ac.in*	*1. Dr. E. Senthil Kumar, SRMIST*
2. Dr. M. Sathish, CSIR-CECRI, Karaikudi, msathish@cecri.res.in	*2.* Prof. *S.* Ramaprabhu, *IIT Madras, ramp@iitm.ac.in*	*2. Dr. S. Chandramohan, SRMIST*

Course Code	18NTC107J	Course Name	ADVANCED CHARACTERIZATION OF NANOMATERIALS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Utilize the concepts of SEM, TEM, SPM, XPS, AES and SIMS to characterize nanomaterials			
CLR-2 :	Utilize materials characterization techniques at the morphological, structural and chemical level			
CLR-3 :	Analyze different types of nanostructures			
CLR-4 :	Asses the performance of broad range of advanced characterization techniques used in nanotechnology			
CLR-5 :	Apply the advanced techniques for solving problems in materials science and engineering			
CLR-6 :	Demonstrate skills in the use of advanced experimental techniques			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 the principles of optical, electron and scanning probe microscopies and photoelectron, Auger electron spectroscopic and secondary ion mass spectrometric techniques.	1	80	75	H	M	H	H	H	H	H	H	M	H	L	H	H	H	H
CLO-2 :	Describe the construction and operation of different characterization techniques.	1	80	70	H	M	H	H	M	M	M	H	M	H	L	H	M	M	M
CLO-3 :	Perform experiments using SEM, TEM, SPM, XPS, AES, SIMS and optical microscopies.	2	75	70	H	H	H	H	H	H	H	H	M	H	L	H	H	H	H
CLO-4 :	Apply suitable techniques for characterizing nanomaterials and devices.	2	80	75	H	H	H	H	H	H	H	H	M	H	M	H	H	H	H
CLO-5 :	Analyze the morphology, structure, elemental composition and chemical state of the given /synthesized nanomaterials using advanced techniques,	2	80	80	H	H	H	H	H	H	H	H	M	H	L	H	H	H	H
CLO-6 :	Apply skills acquired for advanced experimental characterization	2	80	80	H	H	H	H	H	M	H	H	H	H	M	H	H	H	H

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Image formation, numerical aperture resolution, effective magnification	Scanning electron microscopy; electron optics; imaging with electrons	TEM imaging system	Scanning probe microscopy	Basic principles: X-ray photoelectron spectroscopy(XPS)
	SLO-2	Brightness and contrast, depth of field, aberrations	Magnetic and electrostatic lenses	Instrumentation of TEM	Scanning probe microscopy: Instrumentation	Auger electron spectroscopy(AES)
S-2	SLO-1	Instrumentation: illumination system, objective lens and eyepiece	Signal detection	Electron sources	Scanning tunneling microscopy, tunneling current	Instrumentation: XPS
	SLO-2	Steps for optimum resolution, steps to improve depth of field	Detector	Specimen stage and specimen preparation	Probe tips and working environments	Instrumentation: AES
S-3	SLO-1	Imaging modes bright-field and dark-field imaging	Probe size and current	Kinematics of scattering by nucleus	Atomic force microscopy	Photoelectron spectra
	SLO-2	Kohler illumination	Electron–specimen interactions	Electron – electron scattering	Cantilevers and deflection measurements	Auger electron spectra
S 4-5	SLO-1	Lab 1:Introduction to the basics of laboratory	Lab 4: Morphological study of nanostructured material using SEM	Lab 7: Imaging and analysis using transmission electron microscope	Lab 10: Tunneling measurements using scanning tunneling microscope (STM)	Lab 13: Interpretation of XPS spectra
	SLO-2					
S-6	SLO-1	Phase-contrast microscopy	Topographic contrast	Image modes: Mass–density contrast	Contact AFM	Qualitative analysis
	SLO-2	The behavior of waves from phase objects in brightfield microscopy	Compositional contrast	Diffraction contrast, phase contrast	Non-contact AFM	Peak identification, chemical shifts, composition imaging
S-7	SLO-1	Properties of polarized light	Working distance and aperture size	Selected-area diffraction (SAD) and characteristics	Dynamic contact AFM	Quantitative analysis: peaks and sensitivity factors
	SLO-2	Polarized-light microscopy	Acceleration voltage and probe current	Single-crystal diffraction, polycrystalline diffraction	Taping AFM	Composition depth profiling

S-8	SLO-1	*Differential interference contrast microscopy and modulation contrast microscopy: DIC optical system*	*Astigmatism*	*Dark field images*	*Force modulation*	*Secondary ion mass spectrometry (SIMS): Basic principles*
	SLO-2	*Modulation contrast microscopy*	*Specimen preparation*	*Phase control*	*Manipulation of atoms*	*Secondary ion generation*
S 9-10	SLO-1	*Lab 2: Optical microscope based investigation of microfabricated structures*	*Lab 5: SE and BSE imaging with SEM*	*Lab 8: Selected area electron diffraction using TEM (SAED)*	*Lab 11: Nanoparticle size determination using atomic force microcopy (AFM)*	*Lab 14: Peak identification of in AES spectra, analysis of the AES depth profile*
	SLO-2					
S-11	SLO-1	*Physical basis of fluorescence*	*Elemental imaging using EDS*	*High resolution images*	*Advanced SPM techniques*	*Dynamic and static SIMS*
	SLO-2	*Fluorescence microscopy*	*Applications of elemental imaging*	*Interpretation of high resolution images*	*Kelvin probe force microscopy*	*SIMS -instrumentation*
S-12	SLO-1	*Confocal laser scanning microscopy: the optical principle of confocal imaging*	*Field emission SEM*	*Ultrahigh resolution TEM*	*Scanning capacitance microscopy*	*Sample handling*
	SLO-2	*Techniques for improving imaging of nanoscale materials*	*Environmental SEM*	*Dynamic TEM*	*Scanning thermal microscopy*	*Spectrum interpretation*
S-13	SLO-1	*Diffraction limit*	*Time resolved microscopy*	*z-contrast imaging*	*Magnetic force microscopy*	*Element identification*
	SLO-2	*Breaking the diffraction limit*	*Time resolved microscopy:Applications*	*Coherent and incoherent imaging*	*Piezoelectric force microscopy*	*SIMS depth profiling*
S 14-15	SLO-1	*Lab 3: Bioimaging using fluorescence microscopy*	*Lab 6: EDS for chemical identification*	*Lab 9: Repeat/Revision of the experiments*	*Lab 12: Surface morphology by STM and roughness determination by AFM*	*Lab 15: Analysis of SIMS profile spectra*
	SLO-2					

Learning Resources

1. *Douglas B. Murphy, Michael W. Davidson, Fundamentals of light microscopy and electronic imaging, 2nd ed., John Wiley & Sons, 2013*
2. *Yang Leng, Materials characterization, introduction to microscopic and spectroscopic methods, 2nd ed., Wiley, 2013*
3. *Guy Cox, Optical imaging techniques in cell biology, CRC press, 2012*
4. *Ray, F. Egerton, Physical principles of electron microscopy, Springer, 2005*
5. *Bharat Bhusan, Scanning probe microscopy in nano-science and nanotechnology, Springer, 2013*
6. *Nan Yao, Zhong Lin Wang, Handbook of microscopy for nanotechnology, Kluwer Academic Publisher, 2005*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. N. Vijayan, CSIR-NPL, nvijayan@nplindia.org	*1. Prof. S. Balakumar, University of Madras, balakumar@unom.ac.in*	*1. Dr. C. M. Navaneethan, SRMIST*
2. Mr.K.R. Navaneethakrishnan, GLR Laboratories Pvt Ltd	*2. Dr. N. Vijayan, CSIR-NPL, nvijayan@nplindia.org*	*2. Dr. A. Karthigeyan,SRMIST*

Course Code	18NTC108T	Course Name	MODELING AND COMPUTATIONAL TOOLS	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Know the basics of MATLAB and C++
CLR-2 :	Acquire detailed knowledge of Density Functional Theory
CLR-3 :	Utilize and gain knowledge of Molecular Dynamics
CLR-4 :	Solve in detail the Monte Carlo Method and problems
CLR-5 :	Understand the basics of modeling and computational tools
CLR-6 :	Know the materials modeling and to determine the desired properties

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 :	Execute and solve problems with the basics of computational tools	2	80	75	M	M	H	H	H	M	M	H	H	H	M	H	H	H	H
CLO-2 :	Utilize the principles of DFT	2	80	70	H	M	H	M	M	M	M	H	M	M	M	H	M	M	M
CLO-3 :	Apply the knowledge of molecular dynamics to solve problems	2	75	70	M	M	H	H	H	H	H	M	M	H	M	H	H	H	H
CLO-4 :	Solve and perform modeling with Monte Carlo method	2	80	75	H	H	M	H	H	M	H	H	H	M	H	M	H	H	H
CLO-5 :	Execute the computational codes and tools	2	80	70	M	M	H	H	H	H	M	H	H	H	M	H	H	H	H
CLO-6 :	Predict the physical properties from modeling and simulation	2	80	70	M	H	H	H	H	M	M	M	H	H	M	H	H	H	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Introduction to MATLAB-Arrays and Matrices-Matrix operation	Introduction to MATLAB	Schrodinger equation	Classical molecular dynamics	Monte-Carlo method: Introductory examples
	SLO-2	Eigen value problem	Arrays	Schrodinger equation for Many Body problem	Discussions on Classical molecular dynamics	Brief history
S-2	SLO-1	Solution of simultaneous equation	Matrices-Matrix operation	Born-Oppenheimer approximation	Tight bindingmolecular dynamics	Fundamental key concepts
	SLO-2	Arithmetic operations	Inverse of a Matrix	Introduction to DFT	Discussions on Tight bindingmolecular dynamics	Transformation methods
S-3	SLO-1	Logical operations	Eigen value problem	Hohenberg-Kohn Theorem 1	The basics of molecular dynamics (MD) algorithm	Rejection sampling
	SLO-2	If-else clause	Problems on Eigen value problem	Discussions on Hohenberg-Kohn theorem 1	Discussions with examples on MD algorithim	Discussions of Rejection sampling
S-4	SLO-1	Loop control structure and statements	Arithmetic operations	Hohenberg-Kohn Theorem 2	Verlet algorithms	Importance sampling
	SLO-2	Break statement, Switch statement	Logical operations	Discussions on Hohenberg-Kohn theorem 2	Discussions Verlet algorithms	Discussions on Importance sampling
S-5	SLO-1	Self-consistent method	Loop control structure and statements	Kohn-Sham Equation	Predictor - Corrector algorithm	Integration by importance sampling-theory
	SLO-2	Functions-data visualization in 2D and 3D	Break statement	Discussion on Kohn-Sham Equation	Discussions on - Corrector algorithm	Integration by importance sampling-example
S-6	SLO-1	Introduction to C++	Switch statement	Exchange-correlation functions LDA (Basic Concept)	MD in different ensembles	Metropolis algorithm
	SLO-2	Algorithms	If and else if statements	LDA (explanation of the equation)	Discussions MD in different ensembles	Discussions on Metropolis algorithm

S-7	SLO-1	*Structured-programing*	*Functions-data visualization in 2D*	*Exchange-correlation functions GGA (Basic Concept)*	*Examples of MD simulation*	*Introduction to Kinetic Monte Carlo (KMC)*
	SLO-2	*I/O statements*	*Examples on data visualization in 2D*	*GGA (explanation of the equation)*	*Discussions on qualitative results*	*Qualitative discussions and basic concept*
S-8	SLO-1	*Controlstatements*	*Functions-data visualization in 3D*	*Basis set*	*Temperature variation effects in MD*	*Introduction to Quantum Monte Carlo (QMC)*
	SLO-2	*Looping (loop statement)*	*Examples on data visualization in 3D*	*Types of basis set (basic level)*	*Examples on Temperature variation effects in MD*	*Qualitative discussions and basic concept*
S-9	SLO-1	*Matrix: Basic matrix operations*	*Basic concept of Computer clusters, Master Node, Working Node*	*Flow chart of DFT scfprocedure*	*Limitations of MD*	*Merits and demerits of KMC and QMC*
	SLO-2	*Basic idea of parallel programing*	*Bewolf and Shared memory clusters in introductory level*	*Discussions on Flow chart*	*Case study examples*	*Case study examples*

Learning Resources	1. *Jörg-Rüdiger Hill, Lalitha Subramanian, AmiteshMaiti, Molecular modeling techniques inmaterial sciences, Taylor & Francis 2005* 2. *J.M. Thijssen, Computational Physics, Cambridge University Press, 2007* 3. *Andrew R. Leach, Molecular modelling: principles and application, Pearson Education, 2001* 4. *Rizwann Butt, Introduction to Numerical Analysis using MATLAB, Jones and Bartlett Publishers, 2008*	5. *Daan Frenkel and BerendSmit, Understanding molecular simulation: from algorithms to applications, Academic Press, 2001* 6. *Feliciano Giustino, Materials Modelling using Density Functional Theory: Properties and Predictions, Oxford University Press, 2014*

Learning Assessment

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

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

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Hemant Dixit, GlobalFoundaries,USA, aplahemant@gmail.com	*1. Dr. Ranjit Kumar Nanda, IIT Madras, nandab@iitm.ac.in*	*1. Dr. RanjitThapa, SRMIST*
2. Dr. Murali Kota, Global Foundaries,USA, kvrmmurali@gmail.com	*2. Dr. Biswarup Pathak, IIT Indore, biswarup@iiti.ac.in*	*2. Dr. Saurabh Ghosh, SRMIST*

Course Code	18NTC109T	Course Name	SOLID STATE ENGINEERING	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Acquire knowledge on various chemical bonding in solids			
CLR-2 :	Understand theory of crystal diffraction, vibrations and heat capacity			
CLR-3 :	Describe the concept of free electron Fermi gas and transport properties			
CLR-4 :	Classify semiconductors, metals and insulators via band theory			
CLR-5 :	Gain knowledge on excitons, plasmons, polarons and polaritons			
CLR-6 :	Understand the principles of Raman and optical spectroscopy			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 of chemical bonding to understand elastic properties of solids	2	80	75	H	M	H	H	H	M	M	H	H	H	M	H	H	H	H
CLO-2 :	Analyze crystalline materials and their thermal properties using the concept of phonons	2	80	70	H	M	M	H	M	M	M	H	M	H	M	H	M	M	M
CLO-3 :	Utilize the Fermi-Dirac distribution function for electrical transport properties of solids	2	75	70	H	M	H	H	H	H	H	M	H	H	H	H	H	H	H
CLO-4 :	Calculate carrier concentration and mobility of metals and intrinsic and extrinsic semiconductors	2	80	75	M	H	H	M	H	H	H	H	H	H	M	H	H	H	H
CLO-5 :	Apply the concept of quasi-particles to understand the optical properties of solids	2	80	70	H	M	H	H	H	M	M	H	M	H	M	H	H	H	H
CLO-6 :	Utilize the spectroscopic concepts to analyze the properties of materials	2	80	75	H	M	M	H	H	M	M	H	H	H	M	H	H	M	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Interatomic forces: Understanding of crystal binding	Crystal diffraction	Free electron gas	Nearly free electron model	Electronic interband transitions
	SLO-2	Bonding in solids	Bragg's law	Energy levels of free electron gas in one dimension	Nearly free electron model (Quantitative approach)	Direct and indirect transitions
S-2	SLO-1	Van der Waals interaction	Reciprocal lattice vectors and Brillouin Zones (BZ)	Fermi- Dirac distribution	Origin and magnitude of the energy gap	Concept of excitons
	SLO-2	Quantitative approach of London interaction	BZ of square lattice and oblique lattice	Effect of temperature on the Fermi – Dirac distribution function	Bloch function	Energy level diagram of excitons
S-3	SLO-1	Equilibrium lattice constants	Vibration of crystals with monoatomic basis	Free electron gas in three dimensions (Quantitative approach)	Classification of solids using band gap	Frenkelexcitons
	SLO-2	Cohesive energy	Dispersion relation	Fermi energy, density of states	Metals, semiconductors and insulators	Frenkelexcitons in alkali halides and molecular crystals
S-4	SLO-1	Nature of bonding in ionic crystals	Group velocity	Heat capacity of the free electron gas	Direct and indirect band gap semiconductors	Mott-Wannierexcitons
	SLO-2	Madelung constant	Quantization of elastic waves (concept of phonon)	Heat capacity of the free electron gas (Quantitative approach)	Relation between bandgap energy, photon and phonon energy	Modified Rydberg's equation
S-5	SLO-1	Madelung energy	Phonon heat capacity-Planck's distribution	Electrical conductivity	Concept of holes in semiconductors	Quantitative approach for Raman effect
	SLO-2	Evaluation of Madelung constant	Normal modes	Ohm's law	Effective mass	Application: Raman effect in solids
S-6	SLO-1	Covalent bonding	Phonon -density of states (modes) in one dimensions	Electrical resistivity	Intrinsic carrier concentration	Concept of plasmons in metals
	SLO-2	Metallic and hydrogen bonding	Phonon- density of states (modes) in three dimensions	Matthiessen's rule	Intrinsic carrier concentration – quantitative approach	Plasma frequency

S-7	SLO-1	*Hooke's law in solids*	*Debye model for density of states (modes)*	*Motion of electron in magnetic field*	*Impurity conductivity: doping*	*Concept of polarons*
	SLO-2	*Elastic strain components (Quantitative treatment)*	*Cutoff frequency in Debye solids*	*Cyclotron frequency*	*Donor and acceptor states*	*Concept of polaritons*
S-8	SLO-1	*Dilation in solids*	*Debye – T^3 law*	*Hall effect: quantitative approach*	*Zener tunneling, Zener breakdown and Zener diodes*	*Defects in solids – lattice vacancies*
	SLO-2	*Elastic stress components*	*Debye – T^3 law (Quantitative approach)*	*Hall coefficient*	*Avalanche bvreakdown and Avalanche diodes*	*Schottky and Frenkel defects*
S-9	SLO-1	*Elastic compliance components*	*Einstein model for density of states*	*Thermal conductivity of metals: Wiedemann-Franz law*	*Super lattices and quantum wells*	*Color centers: F centers*
	SLO-2	*Elastic stiffness components*	*Einstein model for density of states – quantitative approach*	*Lorentz number*	*Multi Quantun well light emitting diodes (MQW-LEDs)*	*Other centers in alkali halides*

Learning Resources	1. *C. Kittel, Introduction to Solid State Physics, 8th ed., Wiley, 2015* 2. *Fundamentals of Solid State Engineering, ManijehRazeghi, Kluwer Academic Publishers, 2002*	3. *Solid State Electronic Devices, Ben. G. Streetman amd Sanjay Banerjee, 7thEdison, Pearson, 2006*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*30 %*	-	*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. Hemant Dixit, GlobalFoundaries,USA, aplahemant@gmail.com	*1. Dr. Ranjit Kumar Nanda, IIT Madras, nandab@iitm.ac.in*	*1. Dr. E. Senthil Kumar, SRMIST*
2. Dr. Krishna Surendra Muvvala, Saint Gobain Research, India, Krishna.muvvala@saintgobain.com	*2. Dr. M. S. Ramachandra Rao, IIT Madras, msrrao@iitm.ac.in*	*2. Dr. Kamala Bharathi, SRMIST*

ACADEMIC CURRICULA

Professional Elective Courses

ELECTRONICS AND COMMUNICATION ENGINEERING

Regulations - 2018

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

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

Kattankulathur, Kancheepuram, Tamil Nadu, India

Course Code	18ECE203T	Course Name	SEMICONDUCTOR DEVICE MODELING	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	18ECC102J	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Utilize the properties of semiconductor materials			
CLR-2 :	Utilize the mechanisms that occur in a PN junction			
CLR-3 :	Utilize the characteristics and modeling of BJT			
CLR-4 :	Utilize the modeling aspects of MOSFET			
CLR-5 :	Identify the effects of MOSFET scaling and special MOSFETs			
CLR-6 :	Understand the fundamental physical processes of semiconductor devices to meet the challenge of these dynamic fields.			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 Choose semiconductor materials for various applications	2	80	70	H	H	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Interpret the characteristics of Junction devices	3	85	75	H	H	-	H	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	Modify and model the BJT parameters for better performance	3	75	70	H	H	-	H	-	-	-	-	-	-	-	-	-	-	H
CLO-4 :	Evaluate and optimize the performance of MOSFET	3	85	80	H	H	-	H	-	-	-	-	-	-	-	-	-	-	H
CLO-5 :	Build new devices with small channel	3	85	75	H	-	-	H	-	-	-	-	-	-	-	-	-	-	H
CLO-6 :	Explain the equations, approximations and techniques available for deriving a model with specified properties, for a general device characteristic with known qualitative theory	3	80	70	H	H	-	H	-	-	-	-	-	-	-	-	-	-	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Electron, Hole Densities In Equilibrium: Distribution of quantum states in energy band	PN Junction under thermal equilibrium: Built in potential, concept of space charge layer	Current components, Basic BJT parameters,	MOS diode	Scaling of MOSFETS
	SLO-2	Fermi – Dirac Statistics	Problem Solving	Limitations on the junction voltage	Operation of Ideal MOS diode (at VGB >0)	Effect of Gate voltage on carrier mobility
S-2	SLO-1	Electron concentration conduction band	Distribution of electric filed and potential within the space charge layer for abrupt junctions at Zero bias	Capacitances in a BJT,	Operation of ideal MOS diode (at VGB <0)	Effect of Drain voltage on carrier mobility
	SLO-2	Hole concentration Valence band	Distribution of electric filed and potential within the space charge layer for abrupt junctions at Zero bias	Switching of BJT	Operation of ideal MOS diode with and without oxide charge	Effect of Drain voltage on carrier mobility
S-3	SLO-1	Carrier concentration in intrinsic semiconductors	Distribution of electric filed and potential within the space charge layer for linearly graded junctions at Zero bias	Ebers-Moll model	Effects of mobile Ionic charges	Channel length modulation
	SLO-2	Position of Fermi level in extrinsic semiconductors	Distribution of electric filed and potential within the space charge layer for linearly graded junctions at Zero bias	Problem Solving	Problem Solving	Breakdown and punch through
S-4	SLO-1	Ionization of impurities, Equilibrium electron and hole concentration	PN Junction under applied bias: Depletion layer capacitance in an abrupt PN junctions	Early effect (CB & CE)	Oxide charges and Interface states	Sub threshold current
	SLO-2	Problem Solving	Problem Solving	Operation of BJT at high frequencies: Charge control model	C-V Characteristics	Sub threshold current
S-5	SLO-1	Fermi level at thermal equilibrium	Depletion layer capacitance with arbitrary doping profiles	Small signal equivalent circuit,	Problem Solving	Short channel effects

	SLO-2	*Problem Solving*	*Static current voltage characteristics of PN junction,*	*Problem Solving*	*Threshold voltage of MOSFET*	*Short channel effects*
S-6	SLO-1	*Excess Carriers: Generation and recombination of carriers*	*Current-voltage relationship in an infinitely long diode,*	*Design of high frequency transistors*	*Bulk charge model*	*Meyer's model*
	SLO-2	*Mobility of carriers*	*Quasi Fermi level under bias condition*	*Problem Solving*	*Problem Solving*	*Small signal model*
S-7	SLO-1	*Charge transport in semiconductors: Drift current*	*Current –voltage relation in practical diodes having finite lengths*	*Second order effects in BJT: Non-uniform doping in the base*	*square law method (Level 1 in SPICE*	*MOSFET scaling*
	SLO-2	*Hall effect*	*Ideality factor*	*Non-uniform doping in the base*	*square law method (Level 1 in SPICE*	*Non-uniform doping in channel*
S-8	SLO-1	*Diffusion current*	*Transient analysis: Time variation of stored charge*	*Variation of ϐ with collector current*	*Level 3 model in SPICE*	*SOI MOSFET*
	SLO-2	*Problem Solving*	*Problem Solving*	*High injection in collector*	*BSIM Models*	*SOI MOSFET*
S-9	SLO-1	*Current density equations*	*Reverse recovery of a diode, charge storage capacitance*	*Heavy doping effects in the emitter*	*Comparison of Models*	*Buried channel MOSFET*
	SLO-2	*Current density equations*	*Problem Solving*	*emitter crowding in bipolar transistors*	*Comparison of Models*	*Fin FET*

Learning Resources	1. *Nandita Das Gupta, Amitava Das Gupta, Semiconductor devices, modeling and Technology, Prentice Hall of India, 2004* 2. *Philip. E. Allen Douglas, R. Hoberg, CMOS Analog circuit Design, 2nd ed., Oxford Press, 2002*	3. *S.M. Sze, Semiconductor Devices-Physics and Technology, John Wiley and Sons, 1985.* 4. *Kiat Seng Yeo, Samir R.Rofail, Wang-Ling Gob, CMOS/BiCMOS VLSI-Low Voltage, Low Power, Pearson 2003*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*30 %*	-	*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*	*1. Dr. P. Aruna Priya, SRMIST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	*2. Dr. J. Manjula, SRMIST*

Course Code	18ECE206J	Course Name	ADVANCED DIGITAL SYSTEM DESIGN	Course Category	E	Professional Elective	L	T	P	C
							2	0	2	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Understand advanced Boolean theorems for logic simplification and implementation
CLR-2 :	Understand the formal procedures for the analysis and design of synchronous and asynchronous sequential circuits
CLR-3 :	Understand concept of Programmable Devices (PROM, PLA, PAL, CPLD and FPGA) and implement combinational and sequential logic circuits using them.
CLR-4 :	Adopt systematic approach with the use of ASM chart ASMD chart, RTL representation for the design of digita circuits and systems
CLR-5 :	Use VHDL as a design-entry language for FPGA in electronic design automation of digital circuits
CLR-6 :	Develop the ability to simulate circuits for more advanced design projects.

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 advanced theorems to simplify the design aspects of various practical circuits	3	80	75	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Analyze and design synchronous sequential circuits	3	80	70	-	M	M	-	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	Identify methods to analyze and design Asynchronous sequential circuits	3	75	70	-	M	M	-	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	Implement various digital circuits using Programmable Logic Devices	3	80	75	-	M	M	-	-	-	-	-	-	-	-	-	-	-	-
CLO-5 :	Design and implement digital circuits using VHDL.	3	80	70	-	H	H	H	H	-	-	L	H	M	-	-	-	-	L
CLO-6 :	Perform experiments in the laboratory with hardware and as well with software (VHDL) to simulate and verify the design	3	80	70	-	-	-	-	-	-	-	-	-	-	-	H	H	-	L

Duration (hour)		12	12	12	12	12
S-1	SLO-1	Shannon's Expansion theorem	state reduction	Analyze asynchronous sequential circuit	Dynamic hazards	Xilinx 3000 series FPGA
	SLO-2	Shannon's Expansion theorem application	state reduction	flow table reduction	Essential hazards	Xilinx 3000 series FPGA
S-2	SLO-1	Shannon's Expansion theorem and its application	state assignment	races-state assignment	Programming logic device families	Xilinx 4000 series FPGA
	SLO-2	Consensus theorem	state assignment	Variables Signals, Constants, Sequential statements VHDL processes	Designing synchronous sequential circuit using PROM	Xilinx 4000 series FPGA
S 3-4	SLO-1	Lab 1: Implement six-variable function using four-variable function generators	Lab 4: Implement hazard-free circuits	Lab 7: VHDL Programming Practice	Lab 10: Construct multiplexers, de-multiplexers in VHDL	Lab13: Implement BCD adder, comparator in VHDL
	SLO-2					
S-5	SLO-1	Reed-Muller Expansion technique	Design of synchronous sequential circuits	races-state assignment	Designing synchronous sequential circuit using PROM	Design of sequential circuits (using VHDL)
	SLO-2	Reed-Muller Expansion technique	Design of synchronous sequential circuits	Transition table and problems in transition table	Designing synchronous sequential circuit using PROM	Design of sequential circuits (using VHDL)
S-6	SLO-1	Multiplexer logic as function generators	Introduction to VHDL, Entity and Architecture description	Transition table and problems in transition table	Programmable Array Logic (PAL)	Design of sequential circuits (using VHDL)
	SLO-2	Implementation of Multiple output logic functions	VHDL Data types and Operators	Design of asynchronous sequential circuit	Programmable Array Logic (PAL)	Design of sequential circuits (using VHDL)
S 7-8	SLO-1	Lab 2: Implement Reed-Muller expressions using logic gates.	Lab 5: Demo of VHDL programmes, Simple programmes	Lab 8: Combinational Circuit Design using Structural, behavioral, data flow modeling	Lab 11: Construct code converters, 4-bit binary adders in VHDL	Lab 14: Mini Project Work
	SLO-2					
S-9	SLO-1	Mealy and Moore machines	ASM chart and realization using ASM	Design of asynchronous sequential circuit	Programmable Logic Array (PLA)	Additional circuit designs using VHDL

	SLO-2	*Clocked synchronous sequential circuit design procedure*	*ASM chart and realization using ASM*	*Design of asynchronous sequential circuit*	*Programmable Logic Array (PLA)*	*Additional circuit designs using VHDL*
S-10	SLO-1	*State diagrams*	*Concurrent, Sequential Assignment Statements, Types of Modeling in VHDL*	*Static hazards*	*FPGA-Xilinx FPGA*	*Additional system designs using VHDL*
	SLO-2	*State table*	*Behavioral, dataflow and structural modeling*	*Static hazards*	*FPGA-Xilinx FPGA*	*Additional system designs using VHDL*
S 11-12	SLO-1	*Lab 3: Implementation of Sequence detector circuit.*	*Lab 6: VHDL Programming Practice*	*Lab 9: Implement Combinational Circuits using Structural, behavioral and data flow modeling- Arithmetic circuits, decoders, encoders.*	*Lab 12: BCD adder, comparator, Design of Sequential circuits (using VHDL)*	*Lab 15: End-Semester Practical Examinations*
	SLO-2					

Learning Resources	1. *Charles H. Roth, Jr. University of Texas at Austin. Larry L. Kinney, Fundamentals of Logic Design, 7th ed., Cengage Learning, 2012* 2. *Richard S. Sandige, Michal L. Sandige, Fundamentals of digital and computer design with VHDL, Mc Graw Hil, 2014*	3. *Jayaram Bhasker, A VHDL Primer, 3rd ed., Prentice Hall, 2011* 4. *Charles. H. Roth, Jr, Digital Systems Design using VHDL, CENGAGE Learning, 2010* 5. *Morris Mano M, Michael D. Ciletti, Digital Design with an Introduction to the Verilog HDL, 5th ed., Pearson, 2014*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. Mr. B. Viswanathan, SRMIST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECE222T	Course Name	ADHOC AND SENSOR NETWORKS	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Utilize the Ad hoc Networks and its various routing protocols
CLR-2 :	Learn the MAC Layer and the concept of Quality of Service
CLR-3 :	Analyze energy management in Ad hoc Networks
CLR-4 :	Identify insights of Sensor network
CLR-5 :	Analyze various aspects Hybrid networks and routing configuration
CLR-6 :	Expose to the different types of adhoc network routing protocols and sensor networks

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Acquire knowledge about Ad hoc Networks and various routing protocols used in Ad hoc networks	3	80	75	H	M	L	M	-	-	H	-	-	-	-	M	-	-	H
CLO-2 :	Analyze the various functional areas such as MAC Layer and QOS	3	80	70	H	M	-	M	-	-	H	-	-	-	-	M	M	-	H
CLO-3 :	Identify energy management in Ad hoc Networks	3	75	70	L	H	-	M	-	-	M	-	-	-	-	H	-	-	L
CLO-4 :	Analyze the Sensor network	3	80	75	H	L	-	M	-	-	-	-	-	-	-	-	-	M	H
CLO-5 :	Identify Hybrid networks and routing configuration	3	80	70	-	-	H	M	-	-	M	-	-	-	-	-	-	-	-
CLO-6 :	Understand the various types of adhoc networks and sensor networks	3	80	70	H	M	-	L	-	-	H	-	-	-	-	M	-	-	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Cellular and Ad hoc Wireless Networks	Quality of service in Ad hoc wireless networks, Real-Time Traffic support	Energy Management-Needs	Sensor Networks, Applications. Comparison with Ad hoc network,	Hybrid wireless network, Introduction, classification
	SLO-2	Applications of Ad hoc Wireless Networks	Issues and challenges in providing QoS	Classifications of Energy Management Schemes	Issues, challenges in designing sensor network Sensor Network Architecture	Multi-hop cellular network (MCN) Architecture
S-2	SLO-1	Issues in Ad hoc Wireless Networks	Classifications of QoS solutions	Battery Management Scheme-Overview,	Layered Architecture, Clustered Architecture	Mobile assisted data forwarding (MADF) Architecture
	SLO-2	MAC Protocol for Ad hoc Networks Issues in Designing and Design Goals	MAC Layer solution-cluster TDMA, IEEE 802.11e, DBASE	Data link layer solution-Lazy packet scheduling scheme,	Data Dissemination, Flooding, Gossiping, Rumor Routing, Sequential Assignment Routing	Hybrid wireless Network (HWN) Architecture
S-3	SLO-1	Classifications of MAC protocols-Floor Acquition Multiple Access protocols	Network Layer solution-QOS routing protocols,	Battery Aware MAC protocol	Cost field approach	Routing in Hybrid wireless network Base assisted ad hoc routing (BAAR)
	SLO-2	Collision Avoidance Time Allocated Protocol	Ticket Based QOS Routing protocols,	Network Layer solution	Data Gathering, Direct Transmission, Binary scheme	Operation of BAAR protocol
S-4	SLO-1	Routing Protocol for Ad hoc wireless network-Classification	Predictive location based QOS routing	Transmission Power Management Schemes-Data link layer solution	Chain Based Three level scheme	Base driven multi-hop bridging protocol(BMBP)-Message used
	SLO-2	Table driven Routing Protocols-Wireless Routing Protocol	QOS frame work	Dynamic power adjustments policies, Distribute topology control Algorithm	MAC protocols for sensor Networks-Self organizing MAC, CSMA Based MAC	BMBP procedure
S-5	SLO-1	On demand routing protocols-Dynamic Source Routing protocol	QOS models	Construct distributed power control loop, Centralized Topology control Algorithm	Location discovery-Indoor and sensor network localization	Issues in pricing Multi-Hop wireless networks
	SLO-2	Multicast Routing Architecture Reference model	QOS Resource Reservation Signaling	Network layer solution-common power protocol	Quality of Sensor Networks-coverage,	Pricing in Multi-Hop wireless WANs
S-6	SLO-1	Tree Based Routing	INSIGNIA-QOS framework	Minimum power consumption Technique	Exposure	Pricing in Ad hoc Wireless Networks

	SLO-2	*Mesh Based Routing*	*Operation of INSIGNIA framework, Advantages and disadvantages*	*Minimum battery cost Routing*	*Recent Trends in Sensor Networks-Energy Efficient Design, synchronization*	*Power control scheme in Hybrid Wireless Networks, Issues in using variable power in IEEE 802.11*
S-7	SLO-1	*Energy Efficient Multicasting-Routing protocols*	*INORA-Coarse feedback scheme,*	*Higher Layer solution*	*Transport Layer Issue*	*Power optimization scheme*
	SLO-2	*Cluster Adaptation of Multicast protocols*	*Class based fine feedback scheme*	*System power management scheme, Processor power management*	*Security-Localized Encryption and Authentication protocols (LEAP)*	*Load Balancing in Hybrid Wireless Networks*
S-8	SLO-1	*Multicast with QOS Guarantees-Real Time Multicasting Protocols*	*SWAN-Model*	*Power saving Mode Power Aware Multi-Access Signaling*	*Intrusion Tolerant Routing in Wireless Sensor Network (INSENS)*	*Preferred Ring Based Routing Scheme*
	SLO-2	*Priority Scheduling Protocols*	*Advantages and Disadvantages*	*Addition of separate signaling scheme*	*Real –Time communication*	*Preferred inner Routing Scheme(PIRS)*
S-9	SLO-1	*Application Dependent Multi Cast Routing-Role Based,*	*Proactive RTMAC framework*	*Device power Management Scheme-Low Power Design of Hardware*	*SPEED Protocol*	*Preferred outer Ring Routing Scheme (PORS)*
	SLO-2	*Content Based, Location Based*	*Advantages and Disadvantages*	*Hard Disk Drive (HDD) power consumption*	*RAP protocols*	*Preferred Destination/Source Ring Based Routing Scheme*

Learning Resources	1. *Siva Ram Murthy C., Manoj B.S, Ad hoc Wireless Networks – Architectures and Protocols, 2nd ed., Pearson, 2004* 2. *Feng Zhao, LeonidasGuibas,Wireless Sensor Networks, 1st ed., Morgan Kaufman Publishers, 2004*	3. *C.K.Toh, Ad hoc Mobile Wireless Networks, 7th ed., Pearson, 2002* 4. *Thomas Brag, Sebastin Buettrich, Wireless Mesh Networking, 3rd ed., O'Reilly Publishers, 2007*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*30 %*	-	*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*	*1. Mrs. S. T. Aarthy, SRM IST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECE224T	Course Name	CRYPTOGRAPHY AND NETWORK SECURITY	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Utilize classical and modern encryption methods
CLR-2 :	Utilize the different key generation standards
CLR-3 :	Utilize the various techniques in authentication of information
CLR-4 :	Analyze the aspects in network security
CLR-5 :	Identify the effect of various malwares and counter measures
CLR-6 :	Understand various conventional and modern cryptography techniques with its added security features

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Identify the methods of classical and modern Encryption	3	80	75	-	-	M	L	-	-	-	-	-	-	-	H	-	-	H
CLO-2 :	Identify the concepts of Number theory, Key generation and distribution standards	3	80	70	L	H	M	-	-	-	-	-	-	-	-	-	-	H	-
CLO-3 :	Analyze Message authentication and Digital Signature algorithm.	3	75	70	-	M	L	-	-	-	-	-	-	-	-	H	-	-	M
CLO-4 :	Obtain information about various forms of network security	3	80	75	H	M	L	-	-	-	-	-	-	-	-	-	-	-	M
CLO-5 :	Analyze the effects of intrusion, viruses, firewalls and various levels of system security	3	80	70	L	-	-	-	-	-	-	-	-	-	-	M	-	M	-
CLO-6 :	Obtain the knowledge about various encryption techniques, standards and security aspects	3	80	70	M	-	-	L	-	-	-	-	-	-	-	-	-	-	M

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Security Services Mechanisms	Number Theory	Basics of Message authentication codes	IP Security	Intruders
	SLO-2	Attacks	Basics of Modulo operations, additive and multiplicative inverse	Basics of Message authentication codes	Overview of techniques	Intrusion
S-2	SLO-1	Network Security Model	Euclidean algorithm	Requirements of MAC	Architecture	Intrusion Detection
	SLO-2	Block cipher, stream cipher, symmetric and Assymetric	Extended Euclidean algorithm	MAC logic	Authentication Header	Techniques
S-3	SLO-1	Conventional Encryption techniques	Fermet's theorem	MD5 Logic, MD5 Compression Function,	Authentication Protocols	Password Management
	SLO-2	Substitution and transposition techniques	Euler's theorem	MD4, Strength of MD5	Mututal authentication, one way authentication	Techniques
S-4	SLO-1	Steganography	Key cryptography	Requirements for a Hash Function, simple Hash Function,	Encapsulating Security Payload	Viruses
	SLO-2	Basics of LSB, Histogram,DE techniques	Key cryptography	Birthday Attacks, Block Chaining Techniques	Encapsulating Security Payload	Worms
S-5	SLO-1	DES	RSA	Securities	Security Associations	Advanced Security
	SLO-2	Algorithm and examples	Algorithms and examples	HASH - MAC	Techniques overview	OS Security
S-6	SLO-1	SDES	Key distribution	Birthday Attack	Kerbros V4, V5 certificate	WLAN Security
	SLO-2	Block cipher modes operation	Algorithms	SHA	Authentication Procedure	Ad hoc Network Security

S-7	SLO-1	*Overview of IDEA*	*Key Management*	*Digital Signature standard*	*PGP*	*GSM Security*
	SLO-2	*Overview of Blowfish*	*Algorithms*	*Overview of blocks*	*Email Security*	*E-commerce Security*
S-8	SLO-1	*Overview of RC5*	*Diffie Hellman key exchange*	*Digital Signature Algorithms*	*Web security requirements*	*Cloud Computing Security*
	SLO-2	*Overview of CAST-128*	*Diffie Hellman key exchange*	*Examples*	*SSL -TLS - SET*	*Introduction to Firewall*
S-9	SLO-1	*Characteristics of advanced symmetric Block ciphers*	*Elliptic curve cryptography*	*Basics of proof*	*Port Scanning*	*Firewall-Types, configurations*
	SLO-2	*Characteristics of advanced symmetric Block ciphers*	*Elliptic curve cryptography*	*Proof of DSS Message Authentication Codes.*	*Port Knocking*	*Trusted System*

Learning Resources	1. *William Stallings, Cryptography & Network Security,6th ed., Pearson, 2014* 2. *Bruce Schneier, Applied Cryptography, 2nd ed., 2015* 3. *Eric Maiwald,Fundamentals of Network Security, Tata McGraw Hill, 2011*	4. *BehrouzA.Forouzan, Debdeep Mukhopadhyay, Cryptography and Network Security, 2nd ed., Tata McGraw Hill, 2010* 5. *Bernard Menezes, Network Security and Cryptography, Cengage Learning, 2010*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*30 %*	-	*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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Course Code	18ECE321T	Course Name	RF AND MICROWAVE SEMICONDUCTOR DEVICES	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	18ECC102J	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
CLR-1 :	Study microwave semiconductor materials and to understand the fundamental of electronic components under microwave signal	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-2 :	Learn about microwave components and devices that are used in modern microwave radar and communication systems			
CLR-3 :	Know the characteristics and operation of microwave transistor.			
CLR-4 :	Know the fundamentals of RF power transistors and challenges			
CLR-5 :	Discuss the main issues and challenges encountered in developing the products at microwave frequencies			
CLR-6 :	Acquire deep understanding of development of RF and modern semiconductor devices			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Understand the properties of Semiconductor Junction Diodes under microwave signals	3	80	75	H	-	-	H	-	-	-	-	-	-	-	-	H	-	-
CLO-2 :	Analyze the development of negative resistance characteristics in tunnel diode and transit time devices	3	80	70	H	-	-	M	-	-	-	-	-	-	-	-	H	-	-
CLO-3 :	Characterize the microwave components and circuits in terms of their performance parameters	3	75	70	H	-	-	H	-	-	-	-	-	-	-	-	H	-	H
CLO-4 :	Compare the characteristics of RF power transistors	3	80	75	H	-	-	M	-	-	-	-	-	-	-	-	M	-	-
CLO-5 :	Appreciate IC packaging issues and challenges involved at microwave frequencies	3	80	70	H	-	H	-	-	-	-	-	-	-	-	-	H	-	M
CLO-6 :	Understand the concepts of RF and semiconductor devices and apply in the design of electronic systems.	3	80	70	H	H	-	-	-	-	-	-	-	-	-		H	-	H

		Semiconductor P-N Junction	Negative Resistance and Transit Time Devices	Microwave BJT Transistors	HEMT Transistors and RF Power Transistor	RF Package Design and Development
Duration (hour)		9	9	9	9	9
S-1	SLO-1	Review of properties of semiconductors	Negative Resistance Devices	Microwave Transistor	Introduction to HEMT	Introduction to RF Package
	SLO-2	Review of properties of semiconductors	Negative Resistance Devices	High frequency limitations of BJT	Short channel effects	Introduction to RF Package
S-2	SLO-1	Transient and ac behavior of p-n junctions	Tunnel Diode, Tunneling process in p-n junction	Microwave bipolar transistors – introduction	Device operation	Thermal Management
	SLO-2	Transient and ac behavior of p-n junctions	V-I characteristics and device performance	Microwave bipolar transistors – operation	Device operation	Thermal Management
S-3	SLO-1	Effect of doping profile on the capacitance of p-n junctions	MIS tunnel diodes	Hetero junction bipolar transistors	Device design	Mechanical Design
	SLO-2	Effect of doping profile on the capacitance of p-n junctions	V-I characteristics and device performance	Basic principle of operation	Scaling issues	Mechanical Design
S-4	SLO-1	Noise in p-n junctions	Backward Diode	Kirk effect	Material Systems for HEMT Devices	Package electrical and electromagnetic Modeling
	SLO-2	Noise in p-n junctions	V-I Characteristics	High frequency response	GaAs HEMT	Package electrical and electromagnetic Modeling
S-5	SLO-1	Varactor diode	Transferred Electron Devices	MESFET	InP HEMT	Design verification
	SLO-2	Construction and Operation of Varactor Diode	Impact ionization	Principle of operation	Technology comparisons	Design verification

S-6	SLO-1	*Applications of Varactor Diode*	*IMPATT*	*Properties of semiconductor materials used in MESFET*	*Technology comparisons*	*Materials testing*
	SLO-2	*Schottky effect*	*Small-signal analysis of IMPATT diodes*	*MESFET Technology*	*Introduction of RF power transistor*	*Reliability testing*
S-7	SLO-1	*Schottky barrier diode*	*TRAPATT, BARITT Diodes*	*MESFET Modeling*	*Figure of Merit for RF Power Transistor*	*computer integrated Manufacturing*
	SLO-2	*Applications of Schottky Diode*	*Two-valley model of compound semiconductors*	*I-V Characteristics*	*Common RF power devices*	*computer integrated Manufacturing*
S-8	SLO-1	*Hetero junctions*	*vd-E characteristics*	*High frequency performance*	*Material properties*	*Thermal modeling*
	SLO-2	*Hetero junctions*	*Gunn Effect, modes of operation*	*MISFET-Introduction*	*State-of-the-art-wide bandgap microwave transistor data*	*Thermal analysis of resistance networks*
S-9	SLO-1	*Construction and operation of microwave PIN diode*	*small-signal analysis of Gunn diode*	*Operating characteristics of MISFET*	*Challenges to production*	*Introduction to computer aided design*
	SLO-2	*Applications*	*Power-frequency limit.*	*Operating characteristics of MISFET*	*Challenges to production*	*Benefits, limitations and applications of CAD*

Learning Resources	*1. Golio, M., "RF and Microwave Semiconductor Devices Handbook", CRC Press (2002).* *2 Sze, S.M., and Ng, K.K., "Physics of Semiconductor Devices", 3rd Ed., Wiley-Interscience (2006).*	*3. Glover, I.A., Pennoek, S.R. and Shepherd P.R., "Microwave Devices, Circuits and Sub-Systems", 4th Ed., John Wiley & Sons (2005)* *4. Liao, S.Y., "Microwave Devices and Circuits", 4th Ed., Pearson Education (2002).*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*30 %*	-	*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. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	

Course Code	18ECE240T	Course Name	WAVELETS AND SIGNAL PROCESSING	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	18ECC104T	Co-requisite Courses	Nil	Progressive Courses	18ECE341T
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Learn about multiresolution analysis and wavelet signal processing
CLR-2 :	Identify the families of wavelets required to apply the transformation to various real time applications
CLR-3 :	Study the of discrete systems that employs wavelet transformation
CLR-4 :	Study various filter banks of discrete systems used in wavelet transformation
CLR-5 :	Analyze various real time applications that employs filter banks
CLR-6 :	Acquire knowledge about wavelet transforms, types and applications of multiresolution analysis

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Understand multi resolution analysis for discrete signals	3	80	75	H	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CLO-2 :	Know the families of wavelets	3	80	70	H	-	M	-	-	-	-	-	-	-	-	-	-	-	M
CLO-3 :	Identify Discrete wavelet transform	3	75	70	M	M	M	-	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	Analyze and design filter banks	3	80	75	H	-	M	-	-	-	-	-	-	-	-	-	-	-	-
CLO-5 :	Utilize wavelet transformations on various applications	3	80	70	H	-	M	L	-	-	-	-	-	-	-	-	-	M	H
CLO-6 :	Know about wavelet transforms, types and applications of multiresolution analysis	3	80	70	M	H	-	-	-	-	-	-	-	-	-	-	-	-	-

		Multiresolution Analysis (MRA)	Families of wavelets	Discrete Wavelet Transform (DWT)	Filter banks	Applications
Duration (hour)		9	9	9	9	9
S-1	SLO-1	Introduction to multiresolution/ multiscale analysis	Orthogonal	Discretization in steps	Introduction to Variants of the wavelet transform	Transient analysis
	SLO-2	Introduction to multiresolution/ multiscale analysis	Orthogonal	Discretization in steps	Introduction to Variants of the wavelet transform	Transient analysis
S-2	SLO-1	Time-frequency analysis and wavelets	Biorthogonal wavelets	Discretization of scale	Implementational structures	Singularity detection
	SLO-2	Time-frequency analysis and wavelets	Biorthogonal wavelets	Discretization of scale	Implementational structures	Singularity detection
S-3	SLO-1	Piecewise constant approximation	Daubechies' family of wavelets	Generalized filter bank	The wavepacket transform	Biomedical signal processing applications
	SLO-2	Piecewise constant approximation	Daubechies' family of wavelets	Generalized filter bank	The wavepacket transform	Biomedical signal processing applications
S-4	SLO-1	Haar wavelet	Daubechies' family of wavelets	Discretization of translation	Computational efficiency in realizing filter banks	Efficient signal design and realization
	SLO-2	Haar wavelet	Conjugate Quadrature Filter Banks (CQF) and their design	Discretization of translation	Computational efficiency in realizing filter banks	Efficient signal design and realization
S-5	SLO-1	Building up the concept of dyadic Multiresolution Analysis (MRA)	Conjugate Quadrature Filter Banks (CQF) and their design	Generalized output sampling	Computational efficiency in realizing filter banks	Wavelet based modulation and demodulation
	SLO-2	Building up the concept of dyadic Multiresolution Analysis (MRA)	Conjugate Quadrature Filter Banks (CQF) and their design	Generalized output sampling	Polyphase components	Wavelet based modulation and demodulation
S-6	SLO-1	Relating dyadic MRA to filter banks	Data compression	Discretization of time/ space (independent variable)	Polyphase components	Applications in mathematical approximation

	SLO-2	*Relating dyadic MRA to filter banks*	*Data compression*	*Discretization of time/ space (independent variable)*	*Polyphase components*	*Applications in mathematical approximation*
S-7	SLO-1	*A review of discrete signal processing*	*Fingerprint compression standards*	*Going from piecewise linear to piecewise polynomial*	*The lattice structure*	*Applications to the solution of some differential equations.*
	SLO-2	*A review of discrete signal processing*	*Fingerprint compression standards*	*Going from piecewise linear to piecewise polynomial*	*The lattice structure*	*Applications to the solution of some differential equations.*
S-8	SLO-1	*Elements of multirate systems*	*JPEG-2000 standards*	*The class of spline wavelets*	*Solving Problems*	*Solving Problems*
	SLO-2	*Elements of multirate systems*	*JPEG-2000 standards*	*The class of spline wavelets*	*Solving Problems*	*Solving Problems*
S-9	SLO-1	*Two-band filter bank design for dyadic wavelets.*	*Solving problems*	*A case for infinite impulse response (IIR) filter banks*	*The lifting scheme.*	*Solving Problems*
	SLO-2	*Two-band filter bank design for dyadic wavelets.*	*Solving problems*	*A case for infinite impulse response (IIR) filter banks*	*The lifting scheme.*	*Solving Problems*

Learning Resources

1. *M. Vetterli, J. Kovacevic, Wavelets and Subband Coding, Prentice Hall, 1995*
2. *S. Mallat, A Wavelet Tour of Signal Processing, 2nd ed., Academic Press, 1999*
3. *P.P. Vaidyanathan, Multirate Systems and Filter Banks, Pearson Education, 1993*
4. *C.S.Burrus, Ramesh A. Gopinath, and Haitao Guo, Introduction to Wavelets and Wavelet Transforms: A Primer, Prentice Hall, 1997*
5. *Gilbert Strang, Truong Nguyen, Wavelets and Filter Banks, 2nd ed., Wellesley-Cambridge Press,1998.*
6. *Ingrid Daubechies, Ten Lectures on Wavelets, SIAM, 1992*
7. *Howard L. Resnikoff, Raymond O. Wells, "Wavelet Analysis: The Scalable Structure of Information", Springer, 1998*

Learning Assessment

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

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Course Code	18ECE241J	Course Name	SIGNAL PROCESSING FOR AUDITORY SYSTEMS	Course Category	E	Professional Elective	L	T	P	C
							2	0	2	3

Pre-requisite Courses	18ECC104T	Co-requisite Courses	Nil	Progressive Courses	18ECE343T
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Learn basics of signal processing			
CLR-2 :	Know Feature Extraction technique used in Speech Processing			
CLR-3 :	Identify Frequency characteristics of Speech signal			
CLR-4 :	Construct the Digital model of speech signal			
CLR-5 :	Identify the Ethical issues of elements of music			
CLR-6 :	Learn the basic of speech signal processing and its model			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Appreciate the functioning of the human vocal and auditory systems	3	80	75	H	-	H	-	H	-	-	-	-	-	-	-	M	-	H
CLO-2 :	Analyze the function of feature extraction in speech and audio signal processing using Time Domain Characteristics	3	80	70	H	-	H	-	-	M	-	M	-	-	-	-	M	-	H
CLO-3 :	Explore the frequency characteristics of speech signal	3	75	70	H	-	H	H	-	-	-	-	-	-	-	-	M	-	H
CLO-4 :	Apply appropriate Digital models for speech signal	3	80	75	H	-	-	-	H	-	-	-	-	-	-	-	H	M	M
CLO-5 :	Analyze the elements of music	3	80	70	-	-	-	M	-	-	-	-	-	-	-	-	M	-	H
CLO-6 :	Know about speech signal processing and its model	3	80	70	H	-	H	-	H	-	-	-	-	-	-	-	H	-	M

		Basic Audio Processing using MATLAB	Speech Signal Analysis in Time Domain	Speech Signal Analysis in Frequency Domain	Digital Models for Speech Signal	Time Elements in Music
Duration (hour)		12	12	12	12	12
S-1	SLO-1	Introduction to Digital audio	Speech signal analysis	Short Time Fourier analysis	Introduction to Acoustic Phonetics	Sound vibrations – pure tones and perception of pitch
	SLO-2	Capturing and converting sound	Segmental analysis	Filter bank analysis	Introduction to Acoustic Phonetics	Sound vibrations – pure tones and perception of pitch
S-2	SLO-1	Sampling of sound wave	Sub-segmental	Formant extraction	Acoustic theory of speech production:- Sound propagation	Auditory coding in the nervous system
	SLO-2	Handling audio in MATLAB	Supra segmental levels	Pitch Extraction	Acoustic theory of speech production:- Sound propagation	Auditory coding in the nervous system
S 3-4	SLO-1	Lab 1: Read & write a speech signal, Record a speech signal, playback, convert into a wave file, plot the speech signal, and spectrogram plot.	Lab 4: Short-term energy of a speech signal	Lab 7: Estimation of pitch period using simplified inverse filter tracking (SIFT) algorithm	Lab 10: Phoneme-level segmentation of speech	Lab 13:Feature Extraction of speech signal
	SLO-2					
S-5	SLO-1	Normalization	Time domain parameters of speech signal	Homomorphic speech analysis	Vocal tract transfer function of vowels	Subjective pitch and role of nervous system
	SLO-2	Audio processing	Time domain parameters of speech signal	Homomorphic speech analysis	Vocal tract transfer function of vowels	Subjective pitch and role of nervous system
S-6	SLO-1	Segmentation	Methods for extracting the parameters Energy	Formant and Pitch Estimation	Effect of nasal coupling	Acoustical energy –perception of loudness, pitch, timbre
	SLO-2	Analysis of window sizing	Methods for extracting the parameters Average Magnitude	Formant and Pitch Estimation	Excitation of sound in vocal tract	Pitch contour Musical Structure
S 7-8	SLO-1	Lab 2: Convert into a wave file, plot the speech signal, and spectrogram plot	Lab 5: Short-time Fourier transform magnitude spectrum	Lab 8: Estimation of pitch period using harmonic product spectrum	Lab 11: Estimation of sound in vocal tract	Lab 14: Speech production mechanism
	SLO-2					

S-9	SLO-1	*Visualization*	*Zero crossing Rate*	*Linear Predictive analysis of speech*	*Vocal tract transfer function of vowels*	*Detecting beats, rhythm, meter*
	SLO-2	*Sound generation*	*Zero crossing Rate*	*Linear Predictive analysis of speech*	*Vocal tract transfer function of vowels*	*Recognizing pitch – melody*
S-10	SLO-1	*Speech production mechanism*	*Silence Discrimination using ZCR and energy*	*Autocorrelation method, Covariance method*	*Effect of nasal coupling*	*Auditory streaming*
	SLO-2	*Speech production mechanism*	*Silence Discrimination using ZCR and energy*	*Solution of LPC equations*	*Excitation of sound in vocal tract*	*Tonality and context – algorithms*
S 11-12	SLO-1	*Lab 3: Cepstrum smoothed magnitude spectrum*	*Lab 6: (i)Linear prediction magnitude spectrum (ii) Estimation of formant frequencies using linear prediction*	*Lab 9: Pitch and duration modification using time-domain pitch synchronous overlap and add (TD-PSOLA) method*	*Lab 12: Sound vibrations*	*Lab 15:Study of Feature extraction and SVM classifier*
	SLO-2					

Learning Resources	1. *Ian McLaughlin, Applied Speech and Audio processing, with MATLAB examples, 1st ed., Cambridge University Press, 2009* 2. *Ben Gold, Nelson Morgan, Dan Ellis, Wiley, Speech and Audio Signal Processing: Processing and Perception of Speech and Music, 2nd ed., John Wiley & Sons, 2011*	3. *Lawrence Rabiner,B.H.Juang, Fundamentals of Speech Recognition, 2nd ed., Prentice-hall, 1993* 4. *Ken Pohlmann, Principles of Digital Audio, 6th ed., McGraw-Hill, 2007* 5. *A.R.Jayan, Speech and Audio Signal Processing, PHI Learning Pvt. Ltd,2016*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. Mrs. K. HariSudha, 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	18ECE242J	Course Name	PATTERN RECOGNITION AND NEURAL NETWORKS	Course Category	E	Professional Elective	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	18ECE340T
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Learn the concepts of pattern recognition
CLR-2 :	Analyze few parameter estimation methods for pattern recognition
CLR-3 :	Acquire knowledge on the fundamental neural networks
CLR-4 :	Apply the neural network recurrence for pattern recognition studies
CLR-5 :	Utilize the practical applications of neural networks in pattern recognition
CLR-6 :	Understand the pattern and apply neural network based learning algorithm to analyze the data from real world applications

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO–1: Professional Achievement	PSO – 2: Project Management Techniques	PSO – 3: Analyze & Research
CLO-1 :	Identify the fundamentals of recognition of patterns, regularities in data and classifiers	3	80	75	L	-	L	H	M	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Classify error estimation, such as definitions, test-set error estimation and training-set error estimation	3	80	70	M	-	-	H	-	-	-	-	-	-	-	-	-	-	H
CLO-3 :	Analyze the neuron model and fundamentals on learning algorithms	3	75	70	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	Realize the error model and calculate the deviation with back propagation networks	3	80	75	M	-	M	H	-	-	-	-	-	-	-	-	M	-	H
CLO-5 :	Identify the applications of neural networks in the area of pattern recognition	3	80	70	L	-	M	H	-	-	-	-	-	-	-	-	-	-	H
CLO-6 :	Analyze and compare a variety of pattern classification techniques to real-world problems such as document analysis and recognition.	3	80	70	M	-	M	H	M	-	-	-	-	-	-	-	L	-	H

		Introduction To Pattern Recognition	Parameter Estimation Methods	Introduction to Neural Networks	ANN for Classification and Regression	ANN for Organization and Recognition
Duration (hour)		12	12	12	12	12
S-1	SLO-1	Introduction to Statistical Pattern Recognition	Introduction to parameter estimation	Introduction to neural networks	Introduction to Hopfield networks	Self-organizing map
	SLO-2	Overview of Pattern Classifiers	Maximum-Likelihood estimation	Neuron model	Hop-field network- architecture	SOM algorithm
S-2	SLO-1	Process of Classifier Design, Decision making theory	Maximum a Posteriori estimation	Learning methods of ANN, Supervised, Unsupervised and reinforced	Recurrent networks	Learning vector quantization
	SLO-2	Bayesian decision making	Bayesian estimation	Basic learning rules of ANN-	Sample recurrent network structure	Kohonen self-organizing map
S 3-4	SLO-1	Lab1: Digitization of analog signals	Lab4: Programs on Estimation	Lab 7: Logic gate function description with Hebb rule	Lab 10: Programs on training a Hopfield network	Lab 13: programs on orthogonality and evaluating input and output for association
	SLO-2					
S-5	SLO-1	Bayes Classifier	Unsupervised learning and clustering	McCulloh pitt neuron	Associative memories- Introduction:	Feature selection
	SLO-2	Bayes Classifier for minimizing Risk	Clustering vs. Classification-Supervised vs. unsupervised	Problems on McCulloh pitt	Auto and hetero associative memory	Feature map classifier, applications
S-6	SLO-1	Estimating Bayes Error	Criterion functions for clustering Algorithms for clustering	Hebb learning rule	Bi directional memories	Architecture of Adaptive Resonance Theory
	SLO-2	Effect of sample size in estimation	K-Means clustering	Problems on Hebb learning rule	XOR problem	ATR1 algorithm
S 7-8	SLO-1	Lab 2: Program to count the white pixels from the image	Lab 5: Loading a data set and selecting predictive features	Lab 8: Evaluating function with different learning rules	Lab 11: Programs on Auto and hetero association of memory	Lab 14: Character Recognition
	SLO-2					
S-9	SLO-1	Minimax Classifiers	Hierarchical methods of clustering	Single layer perceptron architecture Training algorithm	Back-propagation Algorithm	ART2 algorithm - Training

	SLO-2	*Neymann Classifiers*	*Comparison of methods, cluster distance and validation*	*Multilayer perceptron*	*Counter propagation networks- architecture*	*ART2- network architecture*
S-10	SLO-1	*Pearson Classifiers*	*Sequential Pattern Recognition*	*Adaline architecture*	*Simulated annealing*	*Hand written digit recognition*
	SLO-2	*Applications*	*Sequential Pattern Recognition*	*Madaline architecture*	*Boltzmann machine*	*Character recognition networks*
S 11-12	SLO-1 SLO-2	*Lab3: Analysis of a data set with classifiers*	*Lab 6: Programs on clustering technique*	*Lab 9 : XOR problem with Perceptron network*	*Lab 12: Evaluation of error in BPN*	*Lab 15: Mini Project*

Learning Resources	1. *Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer Verlag, 2016* 2. *Dionisis Cavouras , S.Theodoridis , K. Koutroumbas , A. Pikrakis , An Introduction to Pattern Classification: A Matlab Approach, Elsevier Science Publishing Co Inc, 2010* 3. *Martin T.Hagan, Neural network design, Cengage publications, 2010*	4. *Simon O. Haykin, Neural Network and Learning Machines, 3rd ed., Pearson Education, 2009* 5. *Ke-Lin Du ,M. N. S. Swamy, Neural Networks and Statistical Learning, Publisher Springer, 2014* 6. *Kosko B, Neural Networks and Fuzzy Systems: A dynamical system approach to machine intelligence, Prentice Hall, 2009*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. A. Ruhan Bevi, 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	18ECE260J	Course Name	BIOMEDICAL INSTRUMENTATION	Course Category	E	Professional Elective	L	T	P	C
							2	0	2	3

Pre-requisite Courses	18ECC201J	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Measure and interpret various physiological parameters			
CLR-2 :	Utilize the working of different monitoring equipment's			
CLR-3 :	Utilize the principle and working of different equipment's available for hemodynamic measurements			
CLR-4 :	Utilize the principle and working of different types of pulmonary function analyzers			
CLR-5 :	Utilize the principle and working of clinical laboratory equipment's			
CLR-6 :	The learner gains knowledge in application of various diagnostic medical devices and issues related to device safety			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	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 origin of bio potential and its measurements using different type of electrodes	3	80	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-2 :	Illustrate working principle of cardiac function monitors and devices used for measurement of parameters such as blood pressure, blood flow, heart rate, cardiac output and blood oxygen content	3	80	70	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-3 :	Analyze the components and working principle of pulmonary function measuring devices and patient monitoring systems	3	75	70	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-4 :	Interpret the working principle of different clinical laboratory equipment	3	80	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-5 :	Predict various electrical hazards and implement safety methods while using biomedical equipment	3	80	70	-	M	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-6 :	Summarize the working principles of different diagnostic instruments available for measuring the physiological variables	3	80	70	M	M	-	-	-	-	-	-	-	-	-	-	M	-	-

		Biopotential Electrodes	Bio Signals Recording	Cardiac Function Measurements	Pulmonary Function Measurements and Patient Monitoring System	Bioanalytical Equipments and Patient Safety
Duration (hour)		12	12	12	12	12
S-1	SLO-1	Cell structure and its functions, Physiological systems of the body	Electrical conduction system of the heart, Cardiac cycle	Haemodynamic pressure, Measurement of blood pressure: direct methods	Mechanism of respiration	Types of blood cells
	SLO-2	Cardiovascular system Respiratory system, Nervous system	ECG: origin, waveforms, characteristics, Einthoven triangle Lead configurations	Indirect methods: Oscillometric method, Auscultatory method, Rheographic method, Ultrasonic method for blood pressure measurement	Pulmonary function measurements, Respiratory volumes and capacities	Calculation of cell size
S-2	SLO-1	Basic Medical Instrumentation system, Sources of Biomedical Signals	Electrocardiograph, 12 lead ECG machine block diagram,	Blood flow measurement: Electromagnetic blood flow meters, Sine and square wave blood flowmeter	Spirometry: Basic spirometer, wedge spirometer, Ultrasonic spirometer	Blood cell counters –Microscopic method, Automatic optical method
	SLO-2	Resting and Action potential, Nernst equation, Goldman equation, Hodgkin-Huxley model	Common mode and interference reduction circuits	Ultrasonic blood flow meter: Doppler shift principle, Pulsed Doppler blood flowmeter	Pneumotachometers: turbine type Pneumotachometer, Fleisch-type & Venturi type Pneumotachometers	Electrical conductivity based method, Coulter counter, Automatic recognition
S 3-4	SLO-1	Lab1: Language of Anatomy, Overview of organ system	Lab4: Recording and analysis of ECG signal	Lab7: Recording and analysis of heart sounds	Lab10: Pulmonary function measurement and analysis using spirometer	Lab13: Mini project
	SLO-2					
S-5	SLO-1	Recording Electrodes: Electrode tissue interface, Metal electrolyte interface	Cardiac arrhythmias	NMR blood flow meter	Measurement of gas volume: Flow-Volume curve, Area of the flow volume, Nitrogen wash out technique	Differential counting of cells, Spectrophotometer Colorimeters
	SLO-2	Electrolyte skin interface	Characteristics and origin of heart sound, Phonocardiography	Laser Doppler blood flowmeter	Electro spirometer	Flame photometers, Selective ion electrodes, ion analyser
S-6	SLO-1	Polarization: polarizable and non-polarizable electrodes, Skin contact	EEG : origin, waveforms and their characteristics, 10-20 electrode placement	Cardiac output measuring techniques: dye dilution method, Indicator dilution, thermal	Pulmonary function analyzers	Patient safety: Electric shock hazards

		impedance	*system*	*dilution method*		
	SLO-2	*Surface Electrodes: Silver-Silver chloride electrodes, Floating and pre-gelled electrodes , Pasteless electrodes*	*Block diagram and working of EEG*	*Measurement of cardiac output from aortic pressure waveform*	*Impedance pneumography*	*Gross shock and effects of electric current on human body*
S 7-8	SLO-1	*Lab2: Study of different types of electrodes*	*Lab5: Recording and analysis of EEG signal*	*Lab8: Measurement of blood pressure using Sphygmomanometer/LabVIEW Biomedical workbench*	*Lab11: Measurement of Heartrate using LabVIEW Biomedical workbench*	*Lab14: Mini project*
	SLO-2					
S-9	SLO-1	*Air jet electrodes, Micro Electrodes*	*Other Biomedical recorders: Vectorcardiograph*	*Impedance technique and bioreactance method*	*Respiratory gas analyzers: Infrared gas analyser, Paramagnetic oxygen analyser*	*Micro current shock*
	SLO-2	*Needle Electrodes, Ion sensitive field effect transistors, Transcutaneous electrodes*	*Apexcardiograph*	*Ultrasound method and CO2 rebreathing method*	*Thermal conductivity analyser, nitrogen gas analyser, Polarographic oxygen analyser*	*Ventricular fibrillation- electrophysiology*
S-10	SLO-1	*Biochemical electrodes: pH*	*Recording and analysis of EMG signal, Biofeedback Instrumentation*	*Oximeters- Invitro, Invivo oximetry and types of oximeters*	*Heart rate measurement, Monitoring of foetal heart rate*	*Leakage current and its types*
	SLO-2	*Biochemical electrodes: pO2, pCO2*	*Measurement of BSR, Measurement of GSR*	*Central monitoring & Bedside monitoring system*	*Measurement of respiration rate: displacement method, thermistor method, CO2 method, Apnoea detector*	*Precautions and safety codes, Electrical safety analyser*
S 11-12	SLO-1	*Lab3: Design of bio amplifier*	*Lab6: Recording and analysis of EMG signal*	*Lab9: Recording and analysis of signals using patient monitoring system*	*Lab12: Mini project*	*Lab15: Model Practical Exam*
	SLO-2					

Learning Resources	1. *R.S. Khandpur, Handbook of Biomedical instrumentation, 3rd ed., Tata McGraw Hill, 2014*	2. *John G. Webster, Medical Instrumentation application and design, 4th ed., Wiley, 2015*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. Sathyanarayanan J, Mindray Medical India Pvt Ltd, sathyanarayananjayagopal@mindray.com	*1. Dr. S. Poonguzhali, Anna University, poongs@annauniv.edu*	*1. Dr. A. K. Jayanthy, SRMIST*
2. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*2. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*2. Dr. T. Jayanthi, SRMIST*

Course Code	18ECE261T	Course Name	MEDICAL IMAGING TECHNIQUES	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Utilize the physics behind x ray imaging and Computed tomography			
CLR-2 :	Utilize the hardware and techniques involved in nuclear imaging			
CLR-3 :	Utilize the properties and techniques in ultrasound imaging			
CLR-4 :	Utilize the physics behind magnetic resonance and techniques in resonance imaging			
CLR-5 :	Utilize the principle behind modern imaging techniques			
CLR-6 :	Utilize the imaging techniques for various applications			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 behind x ray imaging and Computed tomography	3	80	75	M	-	-	-	-	-	-	-	-	-	-	-	L	-	L
CLO-2 :	Illustrate the hardware and techniques involved in nuclear imaging	3	80	70	L	-	-	-	-	-	-	-	-	-	-	-	L	-	L
CLO-3 :	Describe the properties and techniques in ultrasound imaging	3	75	70	L	-	-	-	-	-	-	-	-	-	-	-	L	-	L
CLO-4 :	Analyze the physics behind magnetic resonance and techniques in resonance imaging	3	80	75	M	-	-	-	-	-	-	-	-	-	-	-	L	-	L
CLO-5 :	Identify the principle behind modern imaging techniques	3	80	70	M	-	-	-	-	-	-	-	-	-	-	-	L	-	L
CLO-6 :	Apply the imaging modality for interpretation	3	80	70	M	-	-	-	-	-	-	-	-	-	-	-	L	-	L

		X-ray and Computed Tomography	Nuclear Imaging	Ultrasound Imaging	Nuclear Magnetic Resonance Imaging	Modern optical imaging
Duration (hour)		9	9	9	9	9
S-1	SLO-1	Production of x-ray – Basic principle and its block diagram	Nuclear medicine – Radio isotopes in medical diagnosis	Diagnostic ultrasound	Principles of NMR imaging system	Spectroscopy – Introduction
	SLO-2	Voltage Generators , Collimators and Grids , Automatic Exposure Control	Physics of radioactivity	Physics of ultrasound	Free induction decay	Types of light sources
S-2	SLO-1	Visualization of x rays – X ray film and processing, Fluorescent screen	Radiation detectors – Ionization chamber	Generation and detection of ultrasound	NMR signal – Spin echo	Optical filters – Types
	SLO-2	Image intensifier	Scintillation detectors , Semiconductor detectors, Solid state detectors	frequency, active element diameter and focusing	T1 and T2 relaxation	Need for filters
S-3	SLO-1	Computed radiography - CR imaging	Pulse height analyser	Basic pulse echo apparatus	Pulse sequence	Monochromators - Prism
	SLO-2	CR image manipulation	Uptake monitoring system	System description	Repetition time, Echo time	Grating monochromators
S-4	SLO-1	Digital radiography	Rectilinear scanner	A scan - Introduction	Spin Echo Contrast Weighting – T1 weighting	Optical fibers – Need
	SLO-2	Flat panel detector	Radioisotope rectilinear scanner	Applications of A scan	T2 weighting , Spin proton density weighting	Various configurations using optical fibers
S-5	SLO-1	Mammography – Automatic exposure control	Gamma camera	M Mode principle	Localization MR signal -Magnetic field gradients	Polarizers – Introduction
	SLO-2	Mammography equipment's	Multi crystal gamma camera	Block diagram of an echocardiograph circuit	Slice select gradients	Types of polarisers
S-6	SLO-1	CT – Principle of CT imaging	Emission computed tomography- Principle	B scanner - Introduction	Frequency encode gradient	Fractional Flow Reserve – procedure

	SLO-2	*Beers law, Hounsfield unit*	*Principle of PET and SPECT scanner*	*Types of B scanner*	*Phase encoded gradient*	*Measurement , Interpretation of results , Advantages*
S-7	SLO-1	*CT scan – Tomographic acquisition*	*SPECT system description*	*Multi element array scanners*	*2D image acquisition*	*Microwave imaging – Need*
	SLO-2	*Generations of CT*	*Various detector configurations*	*Sequential array scanner and phased array scanner*	*Echo planar image acquisition*	*Applications of microwave imaging*
S-8	SLO-1	*Detectors – Scintillation crystal and Photomultiplier*	*PET system description*	*Modern Imaging systems – block diagram description*	*MRI scanner components*	*Optical coherence imaging – Introduction*
	SLO-2	*Xenon , scintillarc*	*Gantry and detector modules*	*Frame grabbers , Digital scan converters*	*Artifacts*	*Types – Time domain and Fourier domain*
S-9	SLO-1	*Data acquisition and Image reconstruction*	*Dual modality imaging – SPECT/CT*	*Doppler ultrasound*	*Functional MRI*	*Thermal imaging in medicine*
	SLO-2	*Filtered back projection and artifacts*	*PET / CT*	*Intravascular ultrasound techniques*	*MR spectroscopy*	*IR detectors , Block diagram of IR imaging*

Learning Resources	1. *Khandpur R.S, Hand-book of Biomedical Instrumentation, 2nd ed., Tata McGraw Hill, 2003* 2. *Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, Biomedical Instrumentation and Measurements, 2nd ed., Prentice-Hall of India, 1997*	3. *William R. hendee, E, Russell Ritenour Medical imaging physics, 4th ed., 2002* 4. *Wolfgang Drexler James G. Fijimoto, Optical coherence tomography technology and applications, 1st ed., Springer, 2008*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*30 %*	-	*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. S. P. Angeline Kirubha, SRMIST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	*2. Dr. P. Vinupritha, SRMIST*

Course Code	18ECE262T	Course Name	BIOMATERIALS AND ARTIFICIAL ORGANS	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Identify the phenomena occurring between biomaterials and surrounding tissue in living organism			
CLR-2 :	Acquire the skills on different classes of biomaterials with its degradation process.			
CLR-3 :	Identify the suitable biomaterials for cardiovascular and orthopedic applications.			
CLR-4 :	Acquire skills to handle different biomaterials for dental, eye and ear applications			
CLR-5 :	Proficiency to have an insight on the regulatory approval procedure for artificial organs			
CLR-6 :	Acquire the skills on suitable burn dressings and skin substitutes			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 biocompatibility and testing of biomaterials	3	80	75	M	-	-	-	-	-	-	-	-	-	-	-	L	-	-
CLO-2 :	Identify relations between structure and properties of various biomaterials	3	80	70	M	-	-	-	-	-	-	-	-	-	-	-	L	-	-
CLO-3 :	Select materials with suitable properties in cardiovascular and orthopedic devices	3	75	70	M	-	-	-	-	-	-	-	-	-	-	-	-	-	L
CLO-4 :	Identify biomaterials in dental, vision and auditory devices	3	80	75	M	-	-	-	-	-	-	-	-	-	-	-	-	-	L
CLO-5 :	Analyze materials for artificial skin and drug delivery applications	3	80	70	M	-	-	-	-	-	-	M	-	-	-	-	-	-	-
CLO-6 :	Analyze the regulatory process for different artificial organs comprising codes, reliability, and device testing	3	80	70	M	-	-	-	-	-	-	-	-	-	-	-	L	-	-

		Properties of biomaterials	Metals and ceramics	Biomaterials for cardiovascular and orthopedic applications	Biomaterials for eye, ear & dental applications	Biomaterials for artificial skin and drug delivery applications
Duration (hour)		9	9	9	9	9
S-1	SLO-1	The nature of matter and materials	Metals: Basic Principles	Substitute Heart Valves	Dental implants to support dental prosthesis	Burn Dressings and Skin Substitutes: Artificial skin, Soft tissue replacement
	SLO-2	Mechanical properties of biomaterials	Stainless Steel, Titanium and Co-Cr alloys: Metallurgical and Chemical Considerations	Heart Valve Function and Dysfunction	Adhesives and Sealants to enhance bond strength and durability	Sutures and Alternatives to Suture
S-2	SLO-1	Physiochemical properties of biomaterials	Mechanical properties	Heart Valve Replacement and Repair	Ophthalmologic Applications: Overview of Eye Anatomy	Drug Delivery Systems: Principles, Origins, Evolution of Controlled Drug Delivery
	SLO-2	Biomaterial characterization – Analytical instruments	Corrosion behavior	Mechanical and Tissue Valve Replacement Devices: Types and Complications	Contact Lenses -General Properties and Corneal Requirements	Liposomes, Polymeric micelles
S-3	SLO-1	Cells: Function and response to Injury	Applications of Stainless steel, titanium, Co-Cr alloys	Trans catheter Valve Replacement	Contact Lens Materials - Surface Modifications	Polymeric and Albuminated Drug Nanoparticles, Dendrimers
	SLO-2	Tissues, the Extracellular Matrix, and Cell–Biomaterial Interactions	Various other types of metals with its biomedical applications	Engineered Heart Valves	Specialty Lenses - Contact Lens Solutions	Injected Depot DDS
S-4	SLO-1	Host Reaction to biomaterials and their evaluation	Polymers: Basic principle	Angioplasty and Stents	Intraocular Lens Implants (IOLS): Scientific Perspective	Implants and Inserts, Infusion Pumps, Inserts
	SLO-2	Inflammation, Wound healing, and the foreign body response	Polyacrylate, Polyamide and Polyolefins: Properties of biomaterials	Vascular Grafts	Optics of the Eye and Cataracts Emerging Functional Variations of IOLS	Smart DDS, Environmentally Response systems
S-5	SLO-1	Systemic toxicity and hypersensitivity	Applications of polymeric biomaterials	Stent Grafts	Biomaterials for IOLS	Transdermal DDS, Passive and Active Transdermal Delivery Systems
	SLO-2	In Vitro assays to assess cell and tissue compatibility in biomaterial/medical device	Various other types of metals with its biomedical applications	Engineered Vascular Grafts	IOLS with Variations of Optical Function	Oral drug delivery – Controlled release in the GI tract
S-6	SLO-1	Evaluation for regulatory purposes	Ceramics: Basic Principles, Bioactive Glasses and Glass-Ceramics	Cardiovascular Devices: Pacemakers and Icds (For Cardiac Arrhythmias)	Corneal Inlays and Onlays	Regulatory Overview of Medical Products Using Biomaterials: Global Regulatory

						Strategy - Design Control, Risk Analysis
	SLO-2	*Application-Specific In Vitro assays considered in proof of concept testing*	*Calcium Phosphate Ceramics, Natural and Synthetic Hydroxyapatites, Alumina: Synthesis of ceramic materials*	*Cardiac Assist and Replacement Devices (For Heart Failure)*	*Synthetic Biomaterials in the Cornea - Optical Requirements - Biological Requirements - Permeable Intracorneal Lenses*	*Biocompatibility Assessment for Biomaterials in Medical Devices - Manufacturing Controls and Post Market Oversight*
S-7	SLO-1	*Future challenges in In Vitro Assessment of cell and tissue compatibility*	*Mechanical Properties and Porosity*	*Miscellaneous Cardiovascular Devices*	*Impermeable Intracorneal Lenses - Synthetic Materials for Corneal Onlays*	*Premarket Clearance, Premarket Approval (PMA)*
	SLO-2	*Selection of In Vivo tests according to intended use*	*Stability and Biocompatibility*	*Implantable Cardiac Assist Devices and IABPs*	*Glaucoma Drains and Implants*	*Clinical and Animal Trials of Unapproved Devices*
S-8	SLO-1	*Biomaterial and Device perspectives in In Vivo testing*	*Applications of ceramics biomaterials*	*Ventricular Assist Device and Blood-Contacting Materials*	*Retinal Prostheses and concerned biomaterials*	*Sterilization, Shelf-Life, and Aging*
	SLO-2	*Specific biological properties assessed by In Vivo tests*	*Various other types of metals with its biomedical applications*	*Orthopedic applications: Total hip replacement*	*Cochlear Prostheses – Overview of the Auditory System*	*Ethical Issues in Biomaterials and Medical Devices: Protection of Patients*
S-9	SLO-1	*Selection of animal models for In Vivo tests*	*Degradation of metallic and polymeric biomaterials*	*Knee replacement*	*Cochlear Prostheses - Materials and Electrode Arrays*	*Good Laboratory, Manufacturing and Clinical Practice*
	SLO-2	*Future Perspectives on In Vivo medical device testing*	*Degradation of ceramic biomaterials*	*Miscellaneous orthopedic Devices*	*The role of biomaterials in stimulating bioelectrodes- Active chemical processes and Passive chemical processes*	*Protection of Research Subjects - Conflicts of Interest*

Learning Resources	1. *David Williams., Essential biomaterials science, 1st ed., Cambridge University Press, 2014* 2. *Lysaght M, Webster T J., Biomaterials for artificial organs, 1st ed., Woodhead Publishing Limited, 2011*	3. *Buddy Ratner, Allan Hoffman, Frederick Schoen, Jack Lemons., Biomaterials Science - An Introduction to Materials in Medicine, 3rd ed., Academic Press, 2012*

Learning Assessment

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

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2. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*2. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*2. Mr. S. Gnanavel, SRMIST*

Course Code	18ECE263T	Course Name	BIOSENSORS	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Utilize the various concepts and terminologies of measurement system
CLR-2 :	Utilize the working principles of transducers
CLR-3 :	Analyze the physiology of human sensory systems
CLR-4 :	Utilize the working principles of biological sensors
CLR-5 :	Analyze the medical applications of biosensors
CLR-6 :	Learn the modern sensors for medical diagnosis

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 concepts of measurements and the errors associated with measurement	3	80	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-2 :	Analyze the working principles of transducers	3	80	70	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-3 :	Evaluate the physiological functions of human sensory systems	3	75	70	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-4 :	Analyze the principles of various sensors used in medical diagnosis	3	80	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-5 :	Describe the various modern biosensors used in medical diagnosis	3	80	70	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-6 :	Implement the modern technologies in biosensors	3	80	70	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-

		Fundamentals of measurement system	Transducers	Biological sensors	Biosensors	Fiber optic sensors
Duration (hour)		9	9	9	9	9
S-1	SLO-1	Functional elements of an instrumentation system	Classification of transducers	Study of biological sensors in the human body: neuronal mechanism	Biosensors – Introduction	Fiber optic sensors: Introduction
	SLO-2	Functional elements of an instrumentation system	Classification of transducers	Study of biological sensors in the human body: neuronal mechanism	Biosensors – Introduction	Fiber optic sensors: Introduction
S-2	SLO-1	Static characteristics	Characteristics for selection of transducers	pacinian - functions	components of Biosensors	Fiber optic biosensors: Introduction
	SLO-2	Static characteristics	Characteristics for selection of transducers	pacinian - functions	components of Biosensors	Working and principle
S-3	SLO-1	Static characteristics	Resistive transducers: RTD	Chemoreceptor	Classification of biosensors	Optical biosensors for measurement of blood glucose level
	SLO-2	Static characteristics	Thermistor	Chemoreceptor	Classification of biosensors	Optical biosensors for measurement of blood glucose level
S-4	SLO-1	Dynamic characteristics	Resistive transducers: Strain gauge	hot and cold receptors	Biocatalysts based biosensor	Smart sensor: Introduction
	SLO-2	Dynamic characteristics	Resistive transducers: Strain gauge	hot and cold receptors	Biocatalysts based biosensor	Working
S-5	SLO-1	Errors in measurements: sources of errors	Piezoelectric effect transducer: Construction	baro receptors	Enzyme immobilisation	Applications of smart sensor
	SLO-2	Errors in measurements: sources of errors	Working	baro receptors	Enzyme immobilisation	Applications of smart sensor
S-6	SLO-1	Errors in measurements: types of errors	Hall effect transducer: Construction	sensors for smell	Glucose Biosensor	Lab on a chip- Introduction, Need

	SLO-2	*Errors in measurements: types of errors*	*Working*	*sensors for smell*	*Glucose Biosensor*	*Block diagram*
S-7	SLO-1	*Statistical analysis of data*	*Capacitive transducers*	*sensors for sound*	*bio affinity based biosensor*	*Applications*
	SLO-2	*Statistical analysis of data*	*Construction and Working*	*sensors for sound*	*bio affinity based biosensor*	*Advantages and Disadvantages*
S-8	SLO-1	*Standards: international standards, primary standards*	*Inductive transducers*	*sensors for vision*	*microorganism based biosensors*	*eNose: Construction*
	SLO-2	*secondary standards and working standards*	*Construction and Working*	*sensors for vision*	*microorganism based biosensors*	*Working*
S-9	SLO-1	*Calibration methodologies*	*Photomultiplier tube*	*Sensors for osmolality and taste*	*Advantages and limitations of Biosensor*	*Applications of eNose*
	SLO-2	*Calibration methodologies*	*Construction and Working*	*Sensors for osmolality and taste*	*Advantages and limitations of Biosensor*	*Applications of eNose*

Learning Resources	1. *Sawhney A.K, A Course in electrical and electronic measurements and instrumentation, 19th ed., Dhanpat Rai & Co (P) Ltd, 2014* 2. *Patranabis D, "ensors and transducers", 2nd ed., Prentice Hall of India, 2004*	3. *A. D. Helfrick, W. D. Cooper, Modern electronic instrumentation and measurement techniques, 4th ed., Prentice Hall of India, 1998.*

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	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*30 %*	-	*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*	*1. Dr. D. Kathirvelu, SRMIST*
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	*2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in*	*2. Mr. V. KarthikRaj, SRMIST*

Course Code	18ECE264T	Course Name	DIAGNOSTIC AND THERAPEUTIC EQUIPMENT	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Gain thorough knowledge about the working principle of coronary care equipments			
CLR-2 :	Understand the functioning and uses of different surgical equipments			
CLR-3 :	Utilize different components of respiratory care equipment and Bone mineral density measuring techniques			
CLR-4 :	Comprehend about the different components and working principle of sensory diagnosis and therapeutic equipments			
CLR-5 :	Understand the functioning of different types of physiotherapy and electrotherapy equipments			
CLR-6 :	Understand the functioning of electrotherapy equipments			

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 the working principle of coronary care equipments	3	80	75	H	-	-	-	-	-	-	-	-	-	-	-	L	-	-
CLO-2 :	Describe the functioning and uses of different surgical equipments	3	80	70	L	-	-	-	-	-	-	-	-	-	-	-	L	-	-
CLO-3 :	Give an overview about the different components and working principle of respiratory care equipments and Bone mineral density measuring techniques	3	75	70	M	-	-	-	-	-	-	-	-	-	-	-	L	-	-
CLO-4 :	Give an overview about the different components and working principle of sensory diagnosis and therapeutic equipments	3	80	75	M	-	-	-	-	-	-	-	-	-	-	-	L	-	-
CLO-5 :	Illustrate the functioning of different types of physiotherapy and electrotherapy equipments	3	80	70	M	-	-	-	-	-	-	-	-	-	-	-	L	-	-
CLO-6 :	Illustrate the functioning of different types of electrotherapy equipments	3	80	70	H	-	-	-	-	-	-	-	-	-	-	-	L	-	-

		Coronary care equipments	Surgical equipments	Respiratory care equipments and Bone mineral density measuring equipments	Sensory diagnosis equipments	Physiotherapy and electrotherapy equipments
Duration (hour)		9	9	9	9	9
S-1	SLO-1	Need for cardiac pacemaker	Principles of surgical diathermy unit	Mechanics of respiration, Artificial ventilation	Mechanism of hearing, sound conduction system	Short wave diathermy, Simplified circuit diagram, Methods of applying electrodes
	SLO-2	Types of pacemaker and different modes of operation	Surgical diathermy machine Block diagram and description	Respiratory care equipment: humidifier	Measurements of sound, Transducers used to measure sound	Inductive and condenser method, Inductive heating by coil in drum
S-2	SLO-1	External pacemaker – Block diagram	Endoscopy basic components	Nebulizer, aspirators	Block diagram and description of basic audiometer	Micro wave diathermy, Production of microwaves
	SLO-2	Three types of External pacemaker based on the type of output waveform	Types of endoscopy – Fiber optic and rigid types	Ventilators –Functional diagram, Types of ventilator	pure tone audiometer	Simplified circuit diagram of micro wave diathermy
S-3	SLO-1	Implantable pacemakers, requirements, Classification codes for pacemakers	Applications of endoscopy- Laparoscope, gastro scope	Classification of ventilator	Speech audiometer	Ultrasonic therapy unit- Block diagram description
	SLO-2	Types of implantable pacemakers, Various pacing modalities in demand pacemaker	Applications of endoscopy- bronchoscope, arthroscopy	Ventilator- Microprocessor controlled ventilator	Calibration of audiometers	Dosage control in ultrasonic therapy unit
S-4	SLO-1	Ventricular synchronous demand pacemaker	Cobalt T-60 machine – Basic components	Electronics block diagram of ventilator	Block diagram and description of Bekesy audiometer system	Electro diagnosis and electrotherapy basics – Intensity time curve of muscles,
	SLO-2	Rate responsive pacemaker	Gamma Knife	Capnography – Block diagram description	Block diagram and description of Evoked response audiometry system	Different types of waveforms used in electrotherapy
S-5	SLO-1	Need for Defibrillator, AC Defibrillator	Cryogenic surgical techniques	Anesthesia machine – schematic diagram of an anesthesia machine	Hearing aids, Conventional analog type hearing aid	Electro diagnostic/ Stimulating unit – Schematic block diagram
	SLO-2	DC Defibrillator – schematic diagram	Applications of cryogenic surgery	Block diagram & description of an anesthesia monitor	Digital hearing aid	Interferential current therapy – Principle of generation of interference currents

S-6	SLO-1	*Defibrillator electrodes, DC Defibrillator with synchronizer*	*Operating microscope – basic principle*	*Baby incubator – Principle of operation*	*cochlear implants*	*Transcutaneous electrical nerve stimulation*
	SLO-2	*Automatic or advisory external defibrillator (AED)*	*Operating microscope – components*	*Baby incubator – Block diagram description*	*Different types of cochlear implants*	*Spinal cord stimulator*
S-7	SLO-1	*Implantable Defibrillator architecture and types*	*Lithotripsy- Schematic of an acoustic shock wave pulse*	*BMD measurements: Single X-ray absorptiometry (SXA) – basic principle*	*Tonometry – Impression type, Applanation tonometry*	*Diaphragm pacing by radio frequency for treatment of Chronic ventilator insufficiency*
	SLO-2	*Pacer cardioverter defibrillator*	*The first Lithotripter machine*	*Single X-ray absorptiometry (SXA) – Instrumentation*	*Non-contact type tonometry*	*Deep brain stimulation*
S-8	SLO-1	*Defibrillator analyzer – block diagram*	*Modern lithotripter system – Block diagram description*	*Dual X-ray absorptiometry (DXA) - basic principle*	*Measurement of basal skin response and galvanic skin response - Principle*	*Bladder stimulator – schematic diagram of bladder stimulator*
	SLO-2	*Defibrillator protection circuit in ECG*	*Shock wave generator, Shock wave sources,*	*Dual X-ray absorptiometry (DXA) - Instrumentation*	*Measurement of basal skin response and galvanic skin response - Block diagram*	*Circuit diagram of bladder stimulator*
S-9	SLO-1	*Heart lung machine*	*Focussing system, Coupling, Imaging systems in Lithotripsy machine*	*Quantitative ultrasound bone densitometer - basic principle*	*Biofeedback instrumentation – Basic principle*	*Phototherapy unit – Principle of operation and application*
	SLO-2	*Types of oxygenators used in Heart lung machine*	*laser lithotripsy*	*Quantitative ultrasound bone densitometer - Instrumentation*	*EMG feedback for rehabilitation study*	*Types of phototherapy unit*

Learning Resources

1. *R.S.Khandpur, Handbook of Bio-Medical instrumentation, 3rd ed., Tata McGraw Hill, 2014*
2. *Albert M.Cook and Webster. J.G, Therapeutic Medical Devices", 1st ed., Prentice Hall, 1982*
3. *Sydney Lou Bonnick, Lori Ann Lewis, Bone Densitometry and Technologists, 3rd ed., Springer, 2013*
4. *Cotton.P. B, and Williams. C. B., Endoscopic Equipment, in Practical Gastrointestinal Endoscopy: The Fundamentals, 6th ed., Wiley-Blackwell, 2008*
5. *Marc. Safran, Bobby. Chhabra. A., Mark. Miller.D, Primer of Arthroscopy, 2nd ed., Elsevier Health Sciences, 2010*
6. *Ventura, Risegari, The Art of Cryogenics Low-Temperature Experimental Techniques, 1st ed., Elsevier Science, 2007*
7. *Leslie Cromwell, Fred J.Weibell, Erich A.Pfeiffer, Bio-Medical Instrumentation and Measurements, 2nd ed., Pearson Education, 2007*
8. *John G.Webster, Specifications of Medical Instrumentation Application and Design, 4th ed., Wiley, 2015*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*30 %*	-	*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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Course Code	18ECE265J	Course Name	BIOMEDICAL SIGNAL PROCESSING	Course Category	E	Professional Elective	L	T	P	C
							2	0	2	3

Pre-requisite Courses	18ECC204J	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Utilize the characteristics of various bio signals			
CLR-2 :	Utilize knowledge in time domain and frequency domain filtering techniques to remove noise from bio signals			
CLR-3 :	Apply various signal processing techniques in analysis of ECG signals			
CLR-4 :	Utilize knowledge in Wavelets and speech signal analysis			
CLR-5 :	Analyze the characteristics of non-stationary signals			
CLR-6 :	Analyze the classification of normal and abnormal ECG signal.			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 physiological origin and characteristics of various biomedical signals	3	80	75	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Apply time-domain and frequency domain filtering techniques to remove noise from biomedical signals	3	80	70	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-3 :	Analyze various signal processing methods to process the ECG and HRV signals.	3	75	70	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-4 :	Apply wavelet transform techniques to analyze the biomedical signal	3	80	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-5 :	Analyze the characteristics of non-stationary signals and perform the classification of normal and abnormal signal	3	80	70	M	-	M	-	M	-	-	-	L	L	M	-	M	-	L
CLO-6 :	Perform the classification of normal and abnormal signal	3	80	70	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Duration (hour)		12	12	12	12	12
S-1	SLO-1	Bioelectric signals-ENG, ERG	Time domain filters-Synchronized averaging	ECG waveform analysis	Introduction to wavelets	Analysis of non-stationary signals
	SLO-2	EOG , EEG signal characteristics	Moving averaging filters	Envelope Extraction and Analysis	Continuous and Discrete wavelet	Time variant system
S-2	SLO-1	ECG signal physiological origin	Frequency domain filters Removal of high frequency noise-Butterworth low pass filter	P wave detection	Discrete wavelet transform	Fixed segmentation
	SLO-2	characteristics	Design procedure	Estimation of R-R Interval	pyramid algorithm	Short time Fourier transform
S 3-4	SLO-1 SLO-2	Lab1: Representation of basic biosignals	Lab4: Design of Butterworth Low pass filter to remove high frequency noise	Lab7: Analysis of ECG signal	Lab 10: Wavelet transform for 1-D Signal Processing	Lab 13: Mini project
S-5	SLO-1	PCG signal	Removal of low frequency noise-Butterworth high pass filters	QRS complex detection-Template subtraction method	Comparison of Fourier transform and wavelet transform	Adaptive segmentation
	SLO-2	Characteristics	Removal of periodic artefacts-Notch & Comb Filter	Template correlation method	Comparison of Fourier transform and wavelet transform	Algorithm
S-6	SLO-1	VAG	Introduction to Adaptive filter	Derivative based method-High speed QRS detection algorithm,	Speech analysis – Cepstrum	Autocorrelation function method
	SLO-2	VMG	Adaptive noise canceller	High speed QRS detection algorithm	Homomorphic filtering of speech signals	generalized likelihood ratio
S 7-8	SLO-1 SLO-2	Lab2: Correlation of Biosignals	Lab5: Design of Butterworth high pass filter to remove low frequency noise	Lab8: Detection of QRS complex from ECG	Lab11: Analysis of speech signal	Lab 14: Mini project
S-9	SLO-1	Bioacoustic signal-Auscultation	Optimal Filtering: Wiener Filter	Simple high speed QRS width detection algorithm-Differentiation, smoothing	Time frequency representation	Classification of signal: Normal and ectopic ECG beats
	SLO-2	Voice, Korotkoff sound	Wiener Filter(Contd.)	Moving average integrator, thresholding	Spectrogram	Algorithm

S-10	SLO-1	*Biomechanical Signal*	*Wiener Filter(Contd.)*	*Heart rate variability (HRV)-Introduction*	*Time scale representation*	*Case studies- in ECG and PCG*
	SLO-2	*Biochemical Signal*	*Wiener Filter*	*Time & Frequency domain methods*	*Scalogram*	*PCG and carotid pulse*
S 11-12	SLO-1	*Lab3: Analysis of EEG signal*	*Lab6: Design of Adaptive filters*	*Lab9: Analysis of Heart rate variability*	*Lab 12: Mini project*	*Lab 15: Model Practical Exam*
	SLO-2					

Learning Resources	1. *Rangaraj.M.Rangayyan, Biomedical signal processing, 2nd ed., Wiley-IEEE press, 2015* 2. *Reddy D.C, Biomedical signal processing: Principles and techniques, 2nd ed., Tata McGraw-Hill, 2005*	3. *Willis J. Tompkins, Biomedical Digital Signal Processing, PHI, 2004*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. Sathyanarayanan J, Mindray Medical India Pvt Ltd, sathyanarayananjayagopal@mindray.com	*1. Dr. S. Poonguzhali, Anna University, poongs@annauniv.edu*	*1. Dr. U. Snekhalatha, SRMIST*
2. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*2. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*2. Dr. T. Rajalakshmi, SRMIST*

Course Code	18ECE266T	Course Name	BIOMEMS	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Get an idea about the MEMS and Microsystem basics
CLR-2 :	Understand the microsystem fabrication processes and materials used for MEMS
CLR-3 :	Understand the micromachining processes
CLR-4 :	Acquire the knowledge required for the development of microfluidic systems
CLR-5 :	Identify the applications of bioMEMS in healthcare industry
CLR-6 :	Understand the applications of MEMS and BioMEMS

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 working principle of MEMS & Microsystems in healthcare domain	3	80	75	M	-	L	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Explain the microsystem fabrication processes and materials used for MEMS	3	80	70	-	-	L	-	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	Differentiate the various Micromanufacturing techniques in miniature applications	3	75	70	-	-	M	-	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	Analyze the working principle of Microfluidic Systems in healthcare	3	80	75	-	-	M	-	-	-	-	-	-	-	-	-	M	-	-
CLO-5 :	Illustrate the concepts of BioMEMS with suitable examples	3	80	70	-	-	M	-	-	-	-	-	-	-	-	-	M	-	-
CLO-6 :	Analyze the applications of MEMS in Biomedical domain	3	80	70	M	-	L	-	-	-	-	-	-	-	-	-	-	-	-

		Microsensor and Microactuator	Materials for MEMS & fabrication Techniques	Basics of Micromachining	Microfluidics	BioMEMS
Duration (hour)		9	9	9	9	9
S-1	SLO-1	MEMS and Microsystems- Introduction	Substrates and Wafers	Bulk micromanufacturing	Microfluidics Introduction	BioMEMS Introduction
	SLO-2	Advantages of MEMS & Microsystems	Silicon as a Substrate Material	Isotropic etching	Fluid Properties	Application of BioMEMS
S-2	SLO-1	Typical MEMS and Microsystem Products	Materials for MEMS: Silicon compounds	Anisotropic etching	Applications of Microfluidic Systems in biomedical	Lab on a chip
	SLO-2	Application of Microsystems in Healthcare Industry	Silicon Piezoresistor	Etch Stop Techniques	Fluid actuation methods	DNA Sensors
S-3	SLO-1	Microsensors- Acoustic wave sensor	Gallium arsenide	Etch Stop Techniques	Dielectrophoresis (DEP)	Hybridization Types
	SLO-2	Microsensors- Optical Sensors	Quartz	Dry Etching	Electrowetting	Microsystem approaches to PCR
S-4	SLO-1	Microsensors- Biomedical Sensors & Biosensors	Piezoelectric crystals	Dry Etching Techniques	Electrothermal	Microsystem approaches to PCR
	SLO-2	Chemical Sensors	Polymers	Dry Etching Techniques	Thermocapillary	Mobile Point of Care Monitors
S-5	SLO-1	Pressure Sensors	Packaging Materials	Surface Micromachining	Electroosmosis	Implantable MEMS for glaucoma therapy
	SLO-2	Thermal Sensors	Photolithography	Surface Micromachining Process Sequence	Optoelectrowetting (Light-actuated microfluidic device)	Implantable MEMS for glaucoma therapy
S-6	SLO-1	Microactuator	Ion Implantation	LIGA Introduction	Microfluidic channel	MEMS based Implantable Drug Delivery System

	SLO-2	*Different types of actuation*	*Diffusion*	*Application*	*Microdispenser*	*MEMS based Implantable Drug Delivery System*
S-7	SLO-1	*Application of Microactuations: Microgrippers*	*Oxidation*	*LIGA Process*	*Microneedle*	*Integrated microsystems for artificial retinal implants*
	SLO-2	*Application of Microactuations: Microvalve and Micropump*	*Chemical vapor deposition (CVD)*	*LIGA Process*	*Microfilter*	*Integrated microsystems for artificial retinal implants*
S-8	SLO-1	*Inch-Worm Technology*	*CVD Types*	*Merits and Demerits of Bulk Micromachining*	*Microseparator*	*MEMS-based neuronal intervention devices*
	SLO-2	*Micro-accelerators*	*Physical vapor deposition (PVD)*	*Merits and Demerits of Surface Micromachining*	*Microreactor*	*MEMS-based neuronal intervention devices*
S-9	SLO-1	*Examples of biomedical microsensors and microactuators*	*Epitaxy*	*Merits and Demerits of LIGA Process*	*Micromixer*	*Current Point of Care Technology*
	SLO-2	*Examples of biomedical microsensors and microactuators*	*Etching*	*Summary of Micromachining*	*Capillary Electrophoresis*	*Current Point of Care Technology*

Learning Resources

1. *Tai-Ran Hsu, MEMS & Microsystems- Design, Manufacture and Nanoscale Engineering, 2nd ed., John Wiley & Sons, 2008*
2. *Nitaigour Premchand Mahalik, MEMS, Tata McGraw Hill, 2008*
3. *Steven S.cSaliterman, Fundamentals of BioMEMS & Medical Microdevices,1st ed., International Society for Optical Engineering, 2006*
4. *Ellis Meng, Biomedical Microsystems, 1st ed., CRC Press, 2011*
5. *Simona Badilescu, Muthukumaran Packirisamy, BioMEMS Science and Engineering Perspectives, 1st ed., CRC Press, 2011*
6. *Albert Folch, Introduction to BioMEMS, 1st ed., CRC Press, 2013*
7. *Gerald A Urban, BioMEMS, 1st ed., Springer, 2006*
8. *Chang Liu, Foundations of MEMS, 2nd ed., Prentice Hall, 2012*
9. *Abraham P. Lee and James L. Lee, BioMEMS and Biomedical Nanotechnology, Vol. 1, 1st ed., Springer, 2006*
10. *Wanjun Wang & Steven A.Soper, BioMEMS- Technologies and applications, 1st ed., CRC Press, 2007*
11. *Walter Karlen and Krzysztof Iniewski, Mobile Point-of-Care Monitors and Diagnostic Device Design, 1st ed., CRC Press, 2015*
12. *Nam-Trung Nguyen & Steven T Wereley, Fundamentals and Applications of Microfluidics, 2nd ed., Artech House, 2006*
13. *Dongqing Li, Encyclopedia of Microfluidics and Nanofluidics, 1st ed., Springer, 2008*
14. *Chao-Min Cheng, Chen-MengKuan & Chien-Fu Chen, In-Vitro Diagnostic Devices: Introduction to Current Point of Care Diagnostic Devices, 1st ed., Springer, 2016*
15. *Mel L. Mendelson, Learning Bio-Micro-Nanotechnology, 1st ed., CRC Press, 2013*

Learning Assessment

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

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

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. Mr. Karthik Raj V, 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. Ashok Kumar, SRMIST*

Course Code	18ECE267J	Course Name	BIOMECHANICS	Course Category	E	Professional Elective	L	T	P	C
							2	0	2	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Utilize concepts of kinematics and kinetics of human motion and functioning of bone.			
CLR-2 :	Utilize the mechanics of joints, skeletal muscle, elbow and hand			
CLR-3 :	Analyze mechanics applied in various movement and loads on shoulder, hip and knee.			
CLR-4 :	Analyze movements and loads applied on spine, foot and its effect on human gait.			
CLR-5 :	Utilize the fluid medium in human movement and application of sports biomechanics.			
CLR-6 :	Understand the concepts of reactive services applied in human movements			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 principles and concepts of biomechanics in the field of kinematics and kinetics of human motion	3	80	75	M	M	-	-	-	-	-	-	-	-	-	L	L	-	-
CLO-2 :	Identify the basic functionalities of joints, skeletal muscle, elbow and hand.	3	80	70	-	M	-	L	M	-	-	-	-	-	-	L	L	L	-
CLO-3 :	Analyze the functionality and various forces applied on shoulder, hip and knee.	3	75	70	M	M	L	M	M	-	-	-	-	-	-	-	-	L	M
CLO-4 :	Apply various loads on spine and foot to analyze the information on various human gait.	3	80	75	-	-	M	M	M	-	-	-	-	-	-	-	-	L	M
CLO-5 :	Communicate and implement the knowledge in various applications related to human movement	3	80	70	M	M	-	-	-	-	-	-	-	-	-	L	L	-	-
CLO-6 :	Apply rehabilitation services in all biomechanical activities	3	80	70	-	M	-	L	M	-	-	-	-	-	-	L	L	L	-

		Kinetic, kinematics of human motion & Biomechanics of human bone	Biomechanics of skeletal muscle, Elbow and hand	Biomechanics of Shoulder, hip and knee	Biomechanics of spine Analysis of gait	Sports Biomechanics
Duration (hour)		12	12	12	12	12
S-1	SLO-1	Forms of motion, Spatial reference systems, analysis of human movement	Joint architecture	Structure of the shoulder	Structure of the spine, Spinal curves	Biomechanics in physical education- Qualitative analysis of kicking
	SLO-2	Standard reference terminology, Joint movement terminology	Articular cartilage and connective tissue	Movements of the shoulder	Movements of the spine	Qualitative analysis of batting
S-2	SLO-1	Basic concepts related to kinetics	Joint stability, Joint flexibility	Muscles of the shoulder	Loads on the spine	Human movement in fluid medium- Nature of fluids
	SLO-2	Mechanical loads on the human body, Effects of loading	Techniques for increasing joint Flexibility, Joint injuries	Loads on the shoulder and common injuries of the shoulder	Common injuries of the back and neck	Laminar and turbulent flow and flow properties
S 3-4	SLO-1	Lab 1: Analysis of mechanical stress and strain	Lab 4: Study of joints	Lab 7: 3D modeling of radius and ulna	Lab 10: Segmentation and modeling of lumbar spine	Lab 13: Mini project
	SLO-2					
S-5	SLO-1	Linear and angular kinematic quantities	Structural organization of skeletal muscle- Muscle fibers	Structure of the hip	Gait analysis	Buoyancy
	SLO-2	Relationships between linear and angular motion	Motor units and fiber types	Movements at the hip	Various methods in Gait analysis	Drag and lift force
S-6	SLO-1	Kinematics of projectile motion, Factors influencing Projectile trajectory	Factors affecting muscular force generation	Muscles and loads on the hip	Types of phases	Biomechanics in Strength and conditioning Qualitative analysis of squat technique
	SLO-2	Analyzing projectile motion	Muscular strength, power and endurance	Common injuries of the hip Joint	Measurement approaches and systems for gait	Qualitative analysis of Drop jumps
S 7-8	SLO-1	Lab 2: Projectile motion analysis using MATLAB	Lab 5: Study of Body composition parameters	Lab 8: Segmentation and modeling of femur bone	Lab 11: Analysis of gait	Lab 14: Mini project
	SLO-2					
S-9	SLO-1	Composition and structure of bone tissue	Structure of the elbow	Structure of the knee	Structure of the foot	Qualitative analysis of Throwing technique

	SLO-2	*Bone growth and development*	*Loads on the elbow and common injuries of the elbow*	*Movements at the knee*	*Movements of the foot*	*Qualitative analysis of Dribbling technique*
S-10	SLO-1	*Bone response to stress*	*Structure of the joints of the hand*	*Muscles and loads on the knee*	*Loads on the foot*	*Biomechanics in sports medicine and rehabilitation*
	SLO-2	*Osteoporosis*	*Movements of the hand*	*Common injuries of the knee and lower leg*	*Common injuries of foot*	*Dealing with sports injuries*
S 11-12	SLO-1 SLO-2	*Lab 3: Measurement of bone mineral density*	*Lab 6: Segmentation of radius and ulna*	*Lab 9: Segmentation and modeling of fibula and tibia*	*Lab 12: Repeat class*	*Lab 15: Model Exam*

Learning Resources	1. *Susan J Hall, Basic Biomechanics, 4th ed., Tata McGraw hill, 2004* 2. *Duane Knudson, Fundamentals of Biomechanics, 2nd ed., Springer, 2007*	3. *Roger Bartlett, Introduction to Sports Biomechanics: Analysing Human Movement Patterns, 2nd ed., Taylor and Francis, 2007*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. Sathyanarayanan J, Mindray Medical India Pvt Ltd, sathyanarayananjayagopal@mindray.com	*1. Dr. S. Poonguzhali, Anna University, poongs@annauniv.edu*	*1. Dr. D Ashok Kumar, SRMIST*
2. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	*2. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu*	*2. Ms. A. Bhargavi Haripriya, SRMIST*

Course Code	18ECE180J	Course Name	TRANSDUCER ENGINEERING	Course Category	E	Professional Elective	L	T	P	C
							2	0	2	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Utilize methods of measurement, & know about various types of errors in instruments			
CLR-2 :	Analyze the behavior of transducers under static and dynamic conditions and to model the transducers			
CLR-3 :	Analyze different types of resistive, inductive and capacitive transducers			
CLR-4 :	Identify applications of resistive, inductive and capacitive transducer			
CLR-5 :	Utilize methods of measurement, & know about various types of errors in instruments			
CLR-6 :	Locate the different type of sensors used in real life applications and paraphrase their importance			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 mathematical knowledge, science, engineering fundamentals to solve problems pertaining to various measurements	3	80	75	H	H	-	-	-	-	-	-	-	-	-	-	H	-	H
CLO-2 :	Determine the static and dynamic characteristics of transducer	3	80	70	H	H	-	M	-	-	-	-	-	-	-	-	H	-	H
CLO-3 :	Analyze the resistive, inductive and capacitive transducers which are used for measuring various parameters	3	75	70	H	-	M	M	-	-	-	-	-	-	-	-	H	-	H
CLO-4 :	Select the right transducer for the given application	3	80	75	H	H	-	M	-	-	-	-	-	-	-	-	H	-	H
CLO-5 :	Identify the various miscellaneous transducers	3	80	70	H	-	H	-	-	-	-	-	H	M	-	-	H	-	H
CLO-6 :	Select the right transducer for the given application	3	80	70	H	H	-	-	-	-	-	-	-	-	-	-	H	-	H

Duration (hour)		12	12	12	12	12
S-1	SLO-1	General configuration and description of measuring Instruments	Characteristics of instruments : Static characteristics: Accuracy, precision, resolution, sensitivity	Inductive sensor: common types- brief discussion with respect to material, construction and input output variable	Miscellaneous Transducers: Piezoelectric transducer	Smart Transducers: Smart Sensors, Components of Smart Sensors
	SLO-2	Basic methods of measurement	Characteristics of instruments : linearity, span and range, threshold, Hysterisis, Dead Time	Reluctance change type	Hall Effect transducer	General architecture of Smart Sensors
S-2	SLO-1	Functional Elements of Measurement Systems	Dynamic characteristics	Magnetostrictive type	Magneto elastic sensor	Evolution of Smart Sensors
	SLO-2	Definition, principles of sensing and transduction	Resistive Transducers: RTD Materials, Temperature measurement change in physical properties, 3 wire and 4 wire RTD	Mutual inductance change type	Digital transducers	Advantages of Smart Sensors
S 3-4	SLO-1	Lab1: Identifying the components of measuring instruments.	Lab 4: Characteristics of RTD	Lab 7: Characteristics of Thermistor	Lab10: Characteristics of Hall effect transducer	Lab13: Temperature measurement using LABVIEW and DAQ Hardware
	SLO-2					
S-5	SLO-1	Units, Standards	Potentiometer Type- Forms, material	Transformer Type	Radiation sensors: Materials	Application area of Smart Sensors
	SLO-2	Unit conversions	Potentiometer Types- resolution, accuracy, sensitivity.	LVDT: Construction, material, output input relationship, I/O curve, discussion.	Radiation sensors: construction, response	MEMS sensor
S-6	SLO-1	Error: Classification of errors, Limiting error and probable error	Strain gauge: Theory, type, materials, design consideration, sensitivity	RVDT: Construction, material	Photo emissive cell types	NEMS sensor
	SLO-2	Error analysis– Statistical methods	Derivation of gauge factor, variation with temperature, adhesive, rosettes	Synchros, Microsyn	Photovoltaic cells	Proximity sensors
S 7-8	SLO-1	Lab2: Determining the transfer function of a first order transducer	Lab 5: Characteristics of strain gauge	Lab 8: Characteristics of LVDT	Lab11: Characteristics of Synchros	Lab14: Displacement measurement using LABVIEW and DAQ Hardware
	SLO-2					

S-9	SLO-1	*Problems in Statistical methods- mean, median mode,variance*	*Thermistor: Material, shape, ranges and accuracy specification*	*Capacitive Transducers: Variable distance-parallel plate type*	*Photodiodes*	*Fiber optic sensors*
	SLO-2	*Problems in Statistical methods- standard deviation, probable error of one reading*	*Thermocouple:Thermo emf sensor: types, Laws of thermo couple. Reference junction compensation*	*Capacitive Transducers: variable area-parallel plate, cylindrical type, variable dielectric constant type*	*Light Dependent Resistor*	*Biosensors*
S-10	SLO-1	*Classification of transducers*	*Load cell-Principle, construction*	*Capacitive Transducers: calculation of sensitivity. Stretched diaphragm type*	*Geiger counters*	*Film sensors*
	SLO-2	*Selection of transducers*	*Hot-wire anemometer*	*Capacitor Microphone, response characteristics*	*Scintillation detectors*	*Environmental Monitoring sensors (Water Quality & Air pollution)*
S 11-12	SLO-1	*Lab3: Statistical Error analysis- Mean, SD, variance for an open loop response of thermocouple*	*Lab 6: Characteristics of Thermistor*	*Lab 9: Characteristics of capacitive transducer*	*Lab12: Characteristics of LDR*	*A mini project on MEMS / Nano/ smart/ fiber/ sensor using any software tools*
	SLO-2					

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

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*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. D. Karthikeyan, Controlsoft Engineering India Pvt Ltd, karthikeyan.d@controlsoftengg.in	*1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com*	*1. Mrs.N.Deepa, SRMIST*
2. V. Venkateswaran, Instrumentation Consultant, vvenkat99@gmail.com	*2. Dr. D. Nedumaran, Madras University, dnmaran@gmail.com*	*2. Mrs.Indirani, SRMIST*

Course Code	18ECE181T	Course Name	MEASUREMENTS AND INSTRUMENTATION	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Utilize the various techniques that are used to measure Current and Voltage			
CLR-2 :	Utilize the various techniques that are used to measure power and energy			
CLR-3 :	Design circuits to measure resistance, capacitance and inductance			
CLR-4 :	Analyze different techniques to measure noise and signal processing			
CLR-5 :	Analyze the working of various display devices and recorders			
CLR-6 :	To study the working of various recorders			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 techniques used to measure current and voltage	3	80	75	H	-	-	-	-	H	-	-	-	-	-	H	H	-	H
CLO-2 :	Analyze the techniques to measure power and energy	3	80	70	H	-	-	-	-	H	-	-	-	-	-	H	-	-	H
CLO-3 :	Design circuits for measuring resistance, inductance and capacitance	3	75	70	H	H	M	H	M	H	-	-	-	-	-	H	H	-	H
CLO-4 :	Apply the knowledge and practices for signal conditioning to the real-world problem	3	80	75	H	H	M	H	M	-	-	-	H	-	-	H	-	-	H
CLO-5 :	Apply knowledge of measurement and instrumentation in display and recording devices	3	80	70	H	-	M	-	H	-	-	-	-	-	-	H	-	-	H
CLO-6 :	Apply knowledge of measurement and instrumentation in recording devices	3	80	70	H	-	-	-	-	H	-	-	-	-	-	H	H	-	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Introduction to measurements and Instrumentation. Classification of Instruments.	Introduction of power energy measurements	Introduction to measurement of resistance, capacitance, inductance and frequency	Introduction to measurement of Non-Electric Quantities	Introduction to display devices and recorders
	SLO-2	Galvanometer Introduction and its type.	Measurement of power in A.C. circuits	Classification of resistance types	Non-electric parameters	Digital display methods
S-2	SLO-1	D'Arsonval Galvanometer – construction, working and torque derivation.	Derivation of total power in A.C circuits	Methods of Low resistance measurement – Ammeter Voltmeter, Kelvins Double bridge method, Potentiometer.	Measurement of Pressure	Digital Storage Oscilloscope,
	SLO-2	PMMC – construction, working and torque derivation	Measurement of power in D.C. circuits	Methods of Medium resistance measurement	low and high pressure	Digital Voltmeter
S-3	SLO-1	Vibration galvanometer – construction, working and derivation	Derivation of total power in D.C. circuits	Substitution method & Voltmeter - ammeter method	Measurement of Vibration	Ramp type, integrating, potentiometric
	SLO-2	Introduction to Moving iron instruments	Introduction to Electrodynamic wattmeter	Wheatstone bridge method	Nature & its quantities	Recorders
S-4	SLO-1	Attraction type – construction and working	Electrodynamic wattmeter - Construction, Working and derivation	Methods of High resistance measurement	Measurement of Temperature	Continuous and discrete recorders
	SLO-2	Repulsion type– Construction and working	Errors in Electrodynamic wattmeter	Megger	Thermistor, thermocouple	Strip chart recorder
S-5	SLO-1	Electro dynamometer – working principle	Numerical Problem	Methods of Earth resistance measurements	Measurement of Radiation	X-Y recorder
	SLO-2	Dynamometer type Instrument-Construction and working	Power measurement in polyphase systems- basics	Introduction and general equations of A.C. Bridges	Pyrometers	UV Recorder
S-6	SLO-1	Induction type Instruments	Three Wattmeter method	Methods of Inductance measurements	Measurement of Flow	Direct recording

	SLO-2	*Construction and Working*	*Two & One Wattmeter method*	*problems*	*Ultrasonic flow transducer, electromagnetic flow meter*	*Audio recorder*
S-7	SLO-1	*Introduction to ammeter and voltmeter*	*Numerical Problems*	*Methods of Capacitance measurements*	*Measurement of Humidity*	*Advantages and Disadvantages*
	SLO-2	*Extension of ammeter ranges*	*Introduction to Single phase induction type energy meter*	*problems*	*Using Hygrometers*	*Video Recorder*
S-8	SLO-1	*Extension of voltmeter ranges*	*Single phase induction type energy meter - Construction, working principle*	*Methods of Mutual inductance*	*Measurement of Sound*	*Advantages and Disadvantages*
	SLO-2	*Calibration of ammeters*	*Testing of energy meters*	*Methods of Mutual inductance*	*Using microphones*	*Case Study on Plasma, LCD and Led Displays*
S-9	SLO-1	*Calibration of voltmeter*	*Phantom loading*	*Methods of Frequency measurements*	*Measurement of Level*	*Case Study on digital voice recorder*
	SLO-2	*summary*	*Meter testing circuits*	*problems*	*Ultrasonic method, capacitive methods*	*Summary*

Learning Resources	1. *Sawhney, A.K., A Course in Electrical & Electronic Measurements & Instrumentation, Dhanpat Rai and Co., 2010* 2. *Golding. E. W, and Widdis F.C, Electrical Measurements and Measuring Instruments, 5th ed., A.H. Wheeler & Company, 2003* 3. *Carr, J.J., Elements of Electronic Instrumentation and Measurement, Pearson Education India, 2011*	4. *Copper. W.D., Helfrick.. A.D, Modern Electronic Instrumentation and Measurement Technique , 5th ed., Prentice Hall of India, 2002* 5. *Bell, A.D., Electronic Instrumentation and Measurements, 2nd ed., Prentice Hall of India, 2003* 1. *Northrop, R.B., Introduction to Instrumentation and Measurements, Taylor & Francis, New Delhi, 2008*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*30 %*	-	*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. V. Venkateswaran, Instrumentation Consultant, vvenkat99@gmail.com	*2. Dr. D. Nedumaran, Madras University, dnmaran@gmail.com*	*2. Dr. A. Vimala Juliet, SRMIST*

Course Code	18ECE182T	Course Name	AUTOMOTIVE INSTRUMENTATION SYSTEMS	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Analyze the basics of automotive systems and requirements
CLR-2 :	Utilize the principles behind various sensors and its application across a vehicle
CLR-3 :	Utilize the various electrical systems pertaining to engine
CLR-4 :	Analyze different safety and security systems
CLR-5 :	Know about the basics of automotive systems and requirements
CLR-6 :	Know about the sensors and various systems of automotive domain.

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1 Level of Thinking (Bloom)	Learning 2 Expected Proficiency (%)	Learning 3 Expected Attainment (%)	PLO 1 Engineering Knowledge	PLO 2 Problem Analysis	PLO 3 Design & Development	PLO 4 Analysis, Design, Research	PLO 5 Modern Tool Usage	PLO 6 Society & Culture	PLO 7 Environment & Sustainability	PLO 8 Ethics	PLO 9 Individual & Team Work	PLO 10 Communication	PLO 11 Project Mgt. & Finance	PLO 12 Life Long Learning	PSO 1	PSO 2	PSO 3
CLO-1 :	Analyze the automotive domain and electronic systems in it	3	85	80	H	H	-	-	L	-	-	-	-	-	-	H	H	-	H
CLO-2 :	Identify the effect of electromagnetic interference	3	85	80	H	H	-	L	-	-	-	-	-	-	-	-	M	-	H
CLO-3 :	Identify the sensor and actuator technologies involved in a car	3	90	80	H	H	M	L	M	-	-	-	-	-	-	H	H	H	-
CLO-4 :	Analyze the various electrical systems and electronics involved in it for upgraded operation	3	90	80	H	H	M	L	M	-	-	-	-	-	-	H	M	-	H
CLO-5 :	Analyze new systems on safety, security and body of a car	3	85	80	H	H	M	L	M	-	-	-	-	-	-	H	M	H	M
CLO-6 :	Understand the automotive problems and provide solutions through new system design.	3	85	80	H	H	-	-	L	-	-	-	-	-	-	H	H	-	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Introduction to Automotive Electronics	Intake Air Temperature (IAT) Sensor	Starting Systems – Requirements	Tire pressure monitoring systems	Power Windows
	SLO-2	Outline to Automotive Sensors	Engine Coolant Oil Temperature Sensor	Starter Motor – selection and working principle	Capacitive based Pressure Sensor	Smart Window Lift Control Module
S-2	SLO-1	Requirements in Automotive Sensor	Exhaust Gas Recirculation Temperature Sensor	Diagnosing Faults – Symptoms	Anti-lock braking system	Central Locking System
	SLO-2	Open and Closed Loop Control Strategies	Exhaust Gas Temperature Sensor	Testing Procedures	Anti-lock braking system	Power Seat
S-3	SLO-1	Shop safety – General safety	Manifold Absolute Pressure (MAP) Sensor	Charging systems – Requirements	Traction Control System	Automatic Wiper systems
	SLO-2	Electrical Safety	High Pressure Fuel Sensor, Engine Oil Pressure Sensor	Components and operation	Adaptive Cruise Control	Electronic Vehicle Immobilizer
S-4	SLO-1	Office Safety	Crankshaft Angular Position Sensor	Diagnosing Faults – Symptoms	Types of Adaptive Cruise Control	Oil Pressure Warning System
	SLO-2	Lifting Procedures	Cam Position Sensor	Testing Procedures	Types of Adaptive Cruise Control	Engine Overheat Warning System
S-5	SLO-1	Electrical wiring, Terminals & Switching	Piston Position Sensor	Ignition systems – Requirements	Parking guide systems	Speed Warning System
	SLO-2	Multiplexed Networking	Throttle Plate Angular Position	Conventional Ignition System	Air Bag System	Door Lock Indicators
S-6	SLO-1	Circuit Diagrams and Symbols	Knock Sensor	Electronic Ignition System	Reversible Seat Belt Pre-tensioner	Gear Neutral Indicator
	SLO-2	Electromagnetic Interference	Oxygen Concentration Sensor	Programmed Ignition System	Electronic Power Steering systems	Anti-Theft Alarm System

S-7	SLO-1	*Electromagnetic Compatibility*	*Mass Air Flow (MAF) Rate Sensor*	*Distributor less Ignition System*	*Vehicle Stabilization System*	*Brake Actuation Warning System*
	SLO-2	*Use of Diagnostic Equipment*	*Rain Sensor*	*Direct Spark Ignition System*	*Vehicle Stabilization System*	*Computer Controlled Air Conditioning Systems*
S-8	SLO-1	*Look Up Tables*	*Acceleration Sensor*	*Fuel Injection System – Requirements*	*Collision Avoidance System*	*On Board Diagnostics*
	SLO-2	*Applications*	*Yaw Rate Sensor*	*Components and operation*	*Collision Avoidance System*	*Roof Control Module*
S-9	SLO-1	*Case Study I*	*Chassis Level Sensor*	*Types of Fuel Injection System*	*Case Study II*	*Case study III*
	SLO-2	*Case Study I*	*Fuel Level Sensor*	*Types of Fuel Injection System*	*Case Study II*	*Case study III*

Learning Resources	1. *Tom Denton, Automotive Electricals / Electronics System and Components, 3rd ed., 2004* 2. *BOSCH, Automotive Electrics, Automotive Electronics: Systems & Components, BOSCH, 4th ed., 2005.*	3. *Jack Erjavec, A Systems Approach to Automotive Technology, Cengage Learning, 2009* 4. *Ronald K.Jurgen, Automotive Electronics Reliability, Vol 2, SAE International, 2010*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*30 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Understand										
Level 2	Apply	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*30 %*	-	*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. V. Venkateswaran, Instrumentation Consultant, vvenkat99@gmail.com	*2. Dr. D. Nedumaran, Madras University, dnmaran@gmail.com*	*2. Dr. A. Vimala Juliet, SRMIST*

Course Code	18ECE183T	Course Name	SAFETY INSTRUMENTED SYSTEM	Course Category	E	Professional Elective	L	T	P	C
							3	0	0	3

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

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Know the standard and regulation of SIS design.
CLR-2 :	Know the Corrective and Preventive maintenance of SIS.
CLR-3 :	Know the requirement of field device and the control components.
CLR-4 :	Know the failure diagnostic technique.
CLR-5 :	Acquire the knowledge on the software development model and Industrial application of SIS.
CLR-6 :	Know the function of safety life cycle and hazard analysis.

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			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 :	Develop, operate and maintain the safety systems.	3	80	75	H	-	H	-	-	H	H	H	-	-	-	H	H	-	-
CLO-2 :	Perform the corrective and preventive maintenance of SIS.	3	80	70	H	-	-	H	-	H	-	-	-	-	-	H	-	H	-
CLO-3 :	Understand the knowledge of field devices and reliability.	3	75	70	-	-	-	-	-	H	-	-	H	H	-	-	H	-	-
CLO-4 :	Evaluate the failure diagnostic technique.	3	80	75	-	H	H	-	-	-	-	-	-	-	-	-	-	H	-
CLO-5 :	Develop, operate and maintain the safety systems.	3	80	70	-	-	H	-	H	-	-	-	-	-	-	H	-	-	H
CLO-6 :	gain knowledge on safety life cycle and function of protective layers.	3	80	70	H	-	H	-	-	H	H	H	-	-	-	H	H	-	-

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Industry Guidelines	Introduction to Safety Instrumentation	Importance of field device	Introduction of failure diagnostic mode	Selection of Technology
	SLO-2	Industry Standards and Regulations.	Hazards & risk	Impact of Field Devices on System Performance.	Equipment Failure mode	Relay systems-PLC based system
S-2	SLO-1	Set of Standards.HSE – PES, AIChE – CCPS,	Process Hazards Analysis (PHA)	Percentage Split of System Failures	Fail –Safe, Fail-danger, Annunciation	Safety PLCs
	SLO-2	IEC 61508, ANSI/ISA, OSHA (29 CFR 1910.119 - Process Safety Management of Highly Hazardous Chemicals)	Safety cycle	Issues relating to field devices. Wiring of Field Devices.	Reliability block diagram. Series system ,Parallel systems, Fault trees, Fault tree symbols	Safety System Complexity
S-3	SLO-1	Technology Choices, Redundancy Choices, Field Devices, Test Intervals.	Shutdown/Interlock/Instrumented Systems (Safety Instrumented Systems – SIS).	Sensors	Comparison of Reliability block diagram and Fault tree	Communication with others system
	SLO-2	Design Lifecycle	Physical Protection	Switches, Transmitters	Fault tree AND gates ,fault tree OR gates	Software development models for safety related system
S-4	SLO-1	Hazard & Risk Analysis- HAZOP analysis	Mitigation Layers	Sensor Diagnostics	Approximation technique	Rapid prototyping, V model
	SLO-2	Allocation of Safety Functions to Protective Layers	Containment Systems	Smart Transmitters	Common mistakes	Water model, spiral model
S-5	SLO-1	Requirements	Scrubbers and Flares	Final Elements	Markov models	Implementation Procedure
	SLO-2	Develop Safety Specification	Fire and Gas (F&G) Systems	Valve Diagnostics	Markov solution technique	case study- Introduction
S-6	SLO-1	SIS Design & Engineering	Evacuation Procedures.	Smart Valve Positioners	Realistic safety instrumented system modeling	The Safety Lifecycle and Its Importance

	SLO-2	*Installation , Commissioning*	*Diversification*	*Redundancy*	*Event tree analysis*	*Case Description: Furnace/Fired Heater Safety Shutdown System*
S-7	SLO-1	*Validation*	*Corrective and Preventive maintenance*	*Voting Schemes and Redundancy*	*Failure mode and effect analysis*	*Safety Instrumented system in PLC*
	SLO-2	*Operations and Maintenance*	*Types of corrective and preventive maintenance*	*Design Requirements for Field Devices*	*Mathematical and statistical basis for risk analysis of technical systems*	*Safety Instrumented system in oil and gas facilities*
S-8	SLO-1	*Modifications. Decommissioning.*	*Mathematical models for performing corrective measures*	*Operator Interface requirement, Communication Interface requirement*	*Factory Acceptance Test*	*Nuclear plant safety discussion*
	SLO-2	*Process Hazard Analysis (PHA)*	*SIS Requirement for system behavior on detection of a fault*	*Final Element Design Requirements,*	*Spurious trip rate*	*Safety Instrumented system in DCS*
S-9	SLO-1	*Failure mode, Effects, and criticality analysis(FMECA), Probability of failure on demand(PFD)*	*Hardware fault Tolerance*	*Differences between using certified vs. proven-in-use devices*	*Risk Assessment*	*Installation, Commissioning and Pre-startup Tests*
	SLO-2	*Examples of usage of standards on specific applications.*	*SIS Integration: Architectural Issues*	*Circuit measures to increase the reliability*	*safety integrity levels (SIL)*	*Operation and Maintenance Procedures*

Learning Resources	1. Paul Gruhn, *Harry Cheddie, Safety Instrumented Systems: Design, Analysis and Justification, 2nd ed., International Society of Automation, 2005* 2. *William M.Goble, Harry Cheddie, Safety Instrumented Systems Verifications: Practical Probabilistic Calculations, ISA-2005*	3. *Roger L. Brauer, Safety and Health for Engineers, John Wiley Sons, 2006* 4. *B.S. Dhillon, Maintainability, Maintenance and Reliability for Engineers, CRC Press, 2006* 5. *Swapan Basu, "Plant Hazard analysis and Safety Instrumentation systems" Academic Press, 2016*

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