ACADEMIC CURRICULA

UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES

(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021

Volume – 17
(Syllabi for Mechanical Engineering Programme Courses)
(Revised on July 2024)

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

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

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

ACADEMIC CURRICULA

Professional Core Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

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

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

Course Code	21MEC201T	Course Name	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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*utilize the fundamental concepts of thermodynamic systems and energy transfer*
CLR-2:	*utilize thermodynamic laws and their applications*
CLR-3:	*utilize the evaluation of properties of pure substances and vapor power cycles*
CLR-4:	*utilize the fundamental concepts of Psychometric processes*
CLR-5:	*utilize the evaluation of properties of gas and gas mixtures*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*apply the concept of thermodynamic properties to quantify energy transfer*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*apply thermodynamic laws to various thermodynamic systems, comprehend Entropy, Availability concepts*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	*determine the properties of pure substances and illustrate vapor power cycles*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	*apply the fundamentals of Psychometric processes and do basic calculations*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	*determine the properties of gas and gas mixtures*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Fundamentals and First Law of Thermodynamics	***9 Hour***
Thermodynamic system, Properties, Quasi-static process, Zeroth law of Thermodynamics, Pdv work for various quasi-static processes, First law of thermodynamics for a closed system, Process and cycle, First law applied to flow processes, Application of SFEE to various steady flow devices.	
Unit-2 - Second Law and its Applications	***9 Hour***
Cyclic heat engine, Carnot cycle, Reversed Carnot cycle, Carnot's theorem, Statements of second law and their equivalence - Reversible and irreversible process, Causes of irreversibility, Clausius theorem, Concept of entropy, Entropy generation in Closed systems, Concept of Availability	
Unit-3 - Steam Generation and Rankine Cycle	***9 Hour***
Pure substances, Phase change phenomenon of a pure substance, Property diagrams for phase change process, Use of Steam tables, Mollier chart, Rankine cycle, Rankine cycle efficiency, Reheat Rankine cycle and its efficiency, Concept of regeneration in Rankine cycle	
Unit-4 - Psychrometry	***9 Hour***
Properties of atmospheric air and Psychrometric chart, Psychrometric processes. Psychrometric processes, Winter air conditioning system, Year-round air conditioning systems, Heat load and simple calculations	
Unit-5 - Properties of Gases and Mixtures	***9 Hour***
Properties of ideal and real gases, Vander Waal's equation of state, compressibility chart, Properties of mixture of gases, Dalton's law of partial pressures, Amagat's law of additive volumes, simple problems, Maxwell's relations, T-ds relations, Clausius - Clapeyron Equation, Joule-Thomson experiment	

Learning Resources	1. *Mahesh M. Rathore, Thermal Engineering, Tata McGraw Hill Education, 2012* 2. *Yunus. ACengel., Michael A Boles, Thermodynamics – An Engineering Approach, 8th Tata McGrawHil Education, 2015 Edition* 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 (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*20%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*25%*	-	*30%*	-
Level 5	*Evaluate*	-	-	*10%*	-	-	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *PC M Velan Indian Navy*	1. *Dr G.Kumarasen, CEG, anna University*	1. *Dr G.Kasiraman, SRM IST*
2. *Mr . R.Karthick GM Operations Flexiflo India Pvt Limited Alwarpet Chennai,karthik@flexiflo.ae*	2. *Dr.Rajasekaran,University college of engineering,Villupuram*	2. *Dr K Suresh Kumar, SRM IST*

Course Code	21MEC202T	Course Name	MECHANICS OF SOLIDS	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 concepts of stress and strain to determine the axial deformations*
CLR-2:	*construct the shear force and bending moment diagram, and determine the stresses in beams*
CLR-3:	*determine the slope and deflection in beams for various loading conditions*
CLR-4:	*utilize concepts to design shafts based on strength and rigidity*
CLR-5:	*utilize concepts to design column and cylinders to predict the failure conditions*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*apply the concepts of theory of linear elasticity*	*3*	*2*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*analyze the force, bending moment and stresses in beams*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	*analyze the slope and deflection in beams*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	*apply the concept of torsion in shafts*	*3*	*2*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	*analyze the stresses in columns and pressure vessels*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Concepts of Stress and Strain	***12 Hour***
Free body diagram, Types of stresses, strain, Poisson's ratio, stress-strain diagram, Elastic Constants, Deformation in axially loaded members, Strain energy, Impact loading, Thermal stresses- Stress at a point, Stress Tensor, Equations of Equilibrium, Different states of stress, Transformation of plane stress, Principal stresses and maximum shear stress - Mohr's circle for plane stress	
Unit-2 - Theory of Beams	***12 Hour***
Types of beams, support reactions, Shear Force Diagram, Bending Moment Diagram, Bending Stress & Shear stress in beams,	
Unit-3 - Deflection of Beams	***12 Hour***
Deflection of beams by double integration method- Macaulay's method-Moment area method-Castigliano's theorems, Maxwell's reciprocal theorem	
Unit-4 - Torsion of Shafts	***12 Hour***
Stresses in a Shaft, Deformations in a Circular Shaft, Stresses and Angle of Twist in the Elastic Range, Comparison of hollow and solid shafts	
Unit-5 - Columns and Pressure Vessels	***12 Hour***
Crippling load - Euler's theory and Rankine's theory, thin and thick pressure vessels, Lame's theory-case study on pressure vessels	

Learning Resources	
1. *Ferdinand P. Beer, E. Russell Johnston, John T. DeWolf, David F. Mazurek, Sanjeev Sanghi, "Mechanics of Materials: 8th Edition" McGraw Hill, 2020* 2. *William A. Nash, Merle C. Potter, "Strength of Materials: Sixth* 3. *Edition, Schaum's Outlines Series, McGraw Hill Education, 2014*	4. *Egor P. Popov, Engineering Mechanics of Solid, 2nd ed., Prentice Hall of India Pvt. Ltd., 2009* 5. *James M. Gere, Mechanics of Materials, 8th ed., Brooks/Cole, USA, 2013* 6. *Shigley. J. E., Applied Mechanics of Materials, International Student edition, McGraw Hill, 2000*

Learning Assessment							
	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*25%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*30%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*30%*	-	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers		
Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. N. Babu, CVRDE, DRDO, Avadi, babu.n.cvrde@gov.in*	1. *Dr. Shankar Krishnapillai, IIT Madras skris@iitm.ac.in*	1. *Dr. E Vijayaragavan, SRMIST*
2. *Mr. Parameswaran, Nokia, Chennai parameswaran.s@nokia.com*	2. *Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	2. *Dr. A Vinoth, SRMIST*

Course Code	21MEC203T	Course Name	ENGINEERING MATERIALS AND METALLURGY	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	Mechanical Engineering	Data Book / Codes / Standards		Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	acquire knowledge about phase diagrams, salient features of iron-carbon system and heat treatment process
CLR-2:	apply mechanism of plastic deformation, principle of strengthening methods
CLR-3:	utilize the mechanical behavior of materials and learn about failure analysis
CLR-4:	identify about structure, properties and applications of metals and non-metals
CLR-5:	acquire knowledge about properties and applications of advanced engineering materials

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	interpret binary phase diagram, describe the micro-constituents in iron-carbon system, Effect of heat treatment and surface hardening on the properties of materials	3	-	1	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	explain different strengthening mechanisms, concepts related to plastic deformation	3	-	1	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	discuss the failure of engineering materials, material testing and characterization techniques	1	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	classify metals and non-metals for various engineering applications	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	apply advanced materials for specific applications based on their properties and describe computational methods related to materials	-	-	3	-	2	-	-	-	-	-	-	-	-	-	-

Unit-1 - Phase Diagram and Heat Treatment — **9 Hour**

Crystal structure, Imperfection in solids, Solid solutions – Types, factors governing solubility rules. Phase diagram – cooling curve, phase rule, types and interpretation. Iron- carbide (Fe-Fe3C) phase diagram, Microstructural aspects and invariant reactions in Fe-Fe3C diagram. Effect of alloying elements on Fe-Fe3C diagram. TTT and CCT diagrams. Various heat treatment and surface hardening process

Unit-2 - Elastic and Plastic Behaviour of Materials — **9 Hour**

Stress Strain relation in elastic and plastic region, Mechanism of plastic deformation – slip and twinning, Slip systems, critically resolved shear stress, Shear strength of perfect and real crystals. Dislocation – climb, interaction, multiplication and pile ups. Strengthening mechanisms – Solid solution, Grain boundary, Dispersion, Precipitation, Fiber, Martensite strengthening, Strain aging and Strain hardening.

Unit-3 - Characterization of Materials — **9 Hour**

Types of fracture in metals, Griffith's theory of brittle fracture, Stress intensity factor, Fracture toughness, Theory of Ductile to brittle transition. Creep – Creep curve, mechanism of creep deformation. Fatigue - S-N curve, low and high cycle fatigue, stages of fatigue. Sources of failure, Procedure of failure analysis. Hardness: Rockwell, Brinell, Vickers hardness, Nano-Indentation Technique. Introduction to characterization of materials - XRD, SEM and TEM.

Unit-4 - Properties of Advanced Materials — **9 Hour**

Properties of plain carbon steel, Tool steel, Stainless steel, Cast iron. Need of microalloying, HSLA steel - Dual phase steel, TRIP steel. Aluminium alloys – classifications, properties, applications, Titanium alloys. Polymers – Types, Properties and applications of PE, PP, PVC. Ceramics – Types, Properties and applications of Al2O3, ZrO2, SiC. Composites – classification, Reinforcement and matrix material, Rule of Mixture. Properties and applications of MMC, CMC and PMC. Functionally graded materials.

Unit-5 - Futuristic Materials and Computational Materials Design	***9 Hour***
Smart materials – Types, Shape memory alloys. Nanomaterials: Carbon nanotubes, Graphene – properties and applications. Metallic foams, Metallic glasses, Super alloys, High entropy alloys, biomaterials, Multi-scale materials modelling. Integrated Computational Materials Engineering with application to Industry 4.0. Materials Informatics, Machine learning for design of materials, Property Optimization	

Learning Resources	1. *Flake.C Campbell, Elements of Metallurgy and Engineering Alloys, ASM International, 2008* 2. *Dieter.G.E, Mechanical Metallurgy, McGraw Hill, Singapore, 2017* 3. *Budinski.K.G, Budinski.M.K, Engineering Materials Properties and selection, Edition 9, Pearson Publication, 2010* 4. *ASM Hand book, Failure analysis and prevention, Vol: 11, 2021* 5. *Reza Abbaschian, Lara Abbaschian& Robert E. Reed-Hill, Principles of Physical Metallurgy, Cengage Learning, 2013* 6. *Chaudhery Mustansar Hussain,,"Smart Materials and New Technologies", Springer, 2022.*	7. *James F. Shackelford et.al. CRC Materials Science and Engineering Handbook, Taylor & Francis, 2015.* 8. *William D. Callister, David G. Rethwisch, Materials Science and Engineering: An Introduction,10th ed., Wiley publication, 2018* 9. *Donald R. Askeland, Wendelin J. Wright, Essentials of Materials Science & Engineering, 4th ed., Cengage, 2018* 10. *Raghavan V. Physical Metallurgy: Principles and Practice, PHI Learning, 2015.* 11. *Shubhabrata Datta and J. Paulo Davim, Machine Learning in Industry, Springer, 2021* 12. *Shubhabrata Datta and J. Paulo Davim, Materials Design Using Computational Intelligence Techniques, CRC Press, Boca Raton, FL, USA, 2016*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*30%*	-	*30%*	-	*30%*	-
Level 3	*Apply*	*30%*	-	*30%*	-	*30%*	-
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr.V.S.Saravanan , Indo Shell Cast Private Limited, saravananvs@indoshellcast.com*	1. *Dr. Raju Abraham, Scientist-F, National Institute of Ocean Technology, Velachery-Tambaram Road, Pallikaranai, Chennai 601302, abraham@niot.res.in*	1. *Dr. Shubhabrata Datta, SRMIST*
2. *Mr. R.Sadagobaramanujam, TVS Sundram Fasteners Ltd, sadagobar@gmail.com*	2. *.Dr. N Arunachalam, IIT Madras, chalam@iitm.ac.in*	2. *Mr.M.Dhanasekaran, SRMIST*

Course Code	21MEC204T	Course Name	MANUFACTURING PROCESSES AND METROLOGY	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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*apply the concept of casting and mechanical metal working technology in manufacturing*
CLR-2:	*utilize the metal cutting principles and machine tool technology in manufacturing*
CLR-3:	*identify the various metal joining and additive manufacturing processes to make a component*
CLR-4:	*be familiar with basics of metrology and measurement of thread, gear and surface finish*
CLR-5:	*known the working of coordinate measuring machines and various optical methods for measurement*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*utilize metal casting and forming processes to create a product*	-	*2*	*3*	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*acquaint the theory behind metal cutting and recognize various milling, gear manufacturing and surface finishing processes*	-	*3*	*2*	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	*apply various metal joining and additive manufacturing processes in industries to develop the products*	-	-	*3*	-	*2*	-	-	-	-	-	-	-	-	2	-
CO-4:	*acquire the knowledge about the fundamentals of metrology, gear, thread and surface roughness measurement*	-	*3*	*2*	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	*implement the fundamentals of CMMs and apply the knowledge about the optical metrology in measurements*	-	-	-	*3*	*3*	-	-	-	-	-	-	-	-	-	-

Unit-1 - Metal Casting and Forming Technology ***9 Hour***

Introduction to casting, Patterns: Types and Materials-Types of Allowances and Moulding sand-Gates and Risering system-Numerical on Riser design- Special Casting Process - Die casting, Centrifugal Casting-Introduction to hot and cold working-Types of forging, Types of extrusion-Types of roll mills- Wire drawing-Sheet metal operation-Blanking, punching, stretch forming, bending, cup drawing, Embossing and coining-Numerical on bending and blanking

Unit-2 - Metal Cutting and Machine Tools ***9 Hour***

Orthogonal and oblique cutting - Classification of cutting tools: single, multipoint - Tool signature for single point cutting tool - Mechanics of orthogonal cutting – Numerical on Merchant Circle – Tool wear and tool life: Simple problems - Cutting Fluids- Gear Manufacturing and Generation Processes - Types of milling (up and down milling)-Computer numeric control (CNC) machine: Types and components - Types of grinding: Surface, Cylindrical and Center less Grinding

Unit-3 - Welding and Additive Manufacturing ***9 Hour***

Classifications of Welding Processes -Types of Welding Processes: Gas Metal Arc Welding, Cold metal transfer (CMT) welding, Spin Arc welding process, Laser welding, Friction welding process-Simple problems in welding-Basic Solidification Concepts and Grain structures in weld-Inspection and Testing Methods. Need and Development- Principle, working and applications of Additive Manufacturing process: Fused deposition Modelling (FDM), Laminated Object Manufacturing (LOM), Selective Laser Sintering (SLS) and Laser Engineered Net Shaping (LENS).

Unit-4 - Introduction to Metrology and Measurement of Various Elements ***9 Hour***

Introduction to metrology, Need for inspection- Sources and types of errors- Precision and accuracy-Classification of measuring instruments- Standards of measurements, Calibration Comparators: Types and need, Mechanical (Sigma) and Electrical- Measurements of various elements of threads: Major, minor diameters and pitch-Measurement of effective diameter: two wire methods, best size wire and tutorials - Measurements of tooth thickness of gear by gear tooth vernier and tutorials- Circular pitch and composite error measurement-Surface roughness parameters- surface finish measuring instruments- Methods of evaluation of surface finish and simple problems in roughness evaluation

Unit-5 - Co-Ordinate Measuring Machine and Optical Metrology	***9 Hour***
Introduction to coordinate metrology- Types and construction of CMM- Components of CMM: Bearings, Drive systems, Transducers, Probes- measuring accuracy, causes of errors and calibration of CMM - Application of laser scanning CMM in reverse engineering- Principle of light wave interference- Types of interferometers: Michelson, NPL flatness and Laser interferometer-Measurement of straightness, flatness using Autocollimator- Machine vision: Image processing technique	

Learning Resources	1. *Serope Kalpakjian, 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, 2014* 3. *A.C. Davies, The science and practice of welding, Vol. 1 and 2, 10th ed., Cambridge University Press, 2012* 4. *John C. Lippold, Welding Metallurgy and Weldability, John Wiley & Sons, 2015* 5. *Chua, C.K., Leong K.F. and Lim C.S., "Rapid prototyping: Principles and applications", second edition, World Scientific Publishers, 2015.* 6. *Jain, R. K., "Engineering Metrology", Khanna Publishers, New Delhi, 2012*	7. *Kevin Harding, "Handbook of Optical Dimensional Metrology", CRC Press, A Taylor & Francis group, 2013.* 8. *Robert J. Hocken, Paulo H. Pereira, "Coordinate Measuring Machines and Systems", CRC Press, Taylor & Francis Group, 2016.* 9. *Galyer, J. F. W., and Shotbolt, C. R., Metrology for Engineering, Cassell London, 5th Edition* 10. *Toru Yoshizawa, "Handbook of Optical Metrology: Principles and Applications", CRC Press, 2014.* 11. *Heinrich Schwenke, Ulrich Neuschaefer-Rube, Tilo Pfeifer, Horst Kunzmann ,"Optical Methods for Dimensional Metrology in Production Engineering", CIRP Annals - Manufacturing Technology, 51(2) (2012) 685–699* 12. *Duraivelu K, Karthikeyan S. 'Engineering Metrology and Measurement'. University Press. First Edition (2018)*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	*-*	*20%*	*-*	*15%*	*-*
Level 2	*Understand*	*25%*	*-*	*25%*	*-*	*25%*	*-*
Level 3	*Apply*	*30%*	*-*	*30%*	*-*	*30%*	*-*
Level 4	*Analyze*	*30%*	*-*	*25%*	*-*	*30%*	*-*
Level 5	*Evaluate*	*-*	*-*	*-*	*-*	*-*	*-*
Level 6	*Create*	*-*	*-*	*-*	*-*	*-*	*-*
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. B. Arivalagan, Scientific officer, IGCAR, Kalpakkam*	1. *Dr. P.Sathiya, Professor, NIT-Trichy*	1. *Dr A.Vijaya, SRMIST*
2. *Mr. Bharath Kumar, Assistant manager, Rane-NSK, bharathkumar@nsk.com*	2. *Dr. Raju Abraham, Scientist-F, National Institute of Ocean Technology, Velachery-Tambaram Road, Pallikaranai, Chennai 601302, abraham@niot.res.in*	2. *Dr. S.Muralidharan, SRMIST*

Course Code	21MEC201L	Course Name	MANUFACTURING PROCESSES AND METROLOGY 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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*be familiar of Machining operations in Centre lathe and CNC turning centers*
CLR-2:	*practice basic Gear making processes in Convention Milling Machines and Machining operations in CNC Milling Centers*
CLR-3:	*practice Cutting tool edge grinding, Surface finishing process and demonstration on MIG Welding*
CLR-4:	*be familiar on measuring profiles using profile projector and Machine vision system*
CLR-5:	*be familiar on geometric, form and surface roughness measurement using CMM and Calibration of Instruments*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*practice profile turning in Centre lathe and CNC lathe to create new components according to specified dimensions*	-	-	*1*	*3*	*1*	-	-	-	-	-	-	-	-	-	-
CO-2:	*practice Contour Milling, Gear Machining using CNC Milling and Special Machines*	-	-	*2*	*3*	*2*	-	-	-	-	-	-	-	-	-	-
CO-3:	*practice Surface and Cylindrical grinding, cutting tool edge grinding and acquire knowledge in MIG Welding*	-	-	*1*	*3*	-	-	-	-	-	-	-	-	-	-	-
CO-4:	*practice profile measurements profile projector and Machine vision*	-	-	*1*	*3*	*2*	-	-	-	-	-	-	-	-	-	-
CO-5:	*practice geometric, form and surface Measurements Using Coordinate Measuring Machine and Calibration of Instruments*	-	-	*2*	*3*	*1*	-	-	-	-	-	-	-	-	-	-

Unit-1 - Profile Turning Using Center and CNC Lathe	***6 Hour***
Lathe- Step turning and chamfering- taper turning by compound rest/offset - drilling, external thread cutting and internal thread cutting. CNC lathe -plain and step turning- peck drilling, boring and external thread cutting - profile turning using canned cycles	
Unit-2 - CNC Contour Milling and Gear Manufacturing	***6 Hour***
Milling machine -Spur gear cutting Hobbing machine- Helical gear cutting CNC Milling center- Straight and contour milling -Circular and square pocketing - operations using Mirror cycle and canned cycles. Additive Manufacturing	
Unit-3 - Surface, Cylindrical Grinding and Friction Welding Process	***6 Hour***
Tool and cutter grinding- Surface grinding in grinding machine - Cylindrical grinding- cutting tool edge grinding -Friction Welding	
Unit-4 - Profile Measurements Using Profile Projector and Machine Vision	***6 Hour***
Basic Measuring Instruments, Angular Measurements using sine bar- sine center apparatus and tool makers microscope, Optical Instruments- Profile Projector, Machine Vision	
Unit-5 - Geometric, Form and Surface Measurements Using CMM and Quality Control	***6 Hour***
Geometric Measurements - calibration of measuring Instruments, Form Measurements using mechanical & electrical Probe; Surface roughness measurements using surface roughness tester, 3D measurements using coordinate measuring machine. Process control charts.	

Learning Resources	1. *A Textbook of Manufacturing Technology (Manufacturing Processes, R K Rajput, Laxmi Publications (P) Ltd, 2018* 2. *S. K. H. Choudhury, A. K. H. Choudhury and N. Roy, Elements of Workshop Technology, Volume I: Manufacturing Processes, Media Promotors, 2008* 3. *CNC Machining Handbook: Building, Programming, and Implementation, Allan Overby, McGraw-Hill December-2010*	4. *Manufacturing Process Laboratory Manual,SRMIST, 2022* 5. *Laboratory observation manual* 6. *Machine manuals supplied by company/supplier.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*						*Final Examination (0% weightage)*	
		CLA-1 Average of first cycle experiments (30%)		*CLA-2 Average of second cycle experiments (30%)*		*Practical Examination (40%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	-	*15%*	-	*15%*	-	*15%*	-	-
Level 2	*Understand*	-	*25%*	-	*20%*	-	*25%*	-	-
Level 3	*Apply*	-	*30%*	-	*25%*	-	*30%*	-	-
Level 4	*Analyze*	-	*30%*	-	*25%*	-	*30%*	-	-
Level 5	*Evaluate*	-	-	-	*10%*	-	-	-	-
Level 6	*Create*	-	-	-	*5%*	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*		-	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr. Ramesh Ramanathan, COO -CONMET- North America*	1. *Dr. N.E.Arun Kumar PhD, Associate Professor Department of Mechanical Engineering St. Joseph's College of Engineering, OMR,Chennai*	1. *Mr. S. Shakthivel, SRMIST*
2. *S.A.Krishnan, Scientist, IGCAR, Kalpakkam*	2. *Mr.S.Samsudeen, National Skill Training Institute, CTI Campus, ssamsadt@gmail.com*	2. *.Mr.V.G.Umasekar, SRMIST*

Course Code	21MEC202L	Course Name	MATERIAL TESTING 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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*understand the specimen preparation procedures and correlate structure-property Relationship of ferrous and non-ferrous alloy specimens*
CLR-2:	*acquire knowledge to perform grain size analysis and determine coating thickness and hardenability*
CLR-3:	*evaluate the variation in hardness and microstructure of heat-treated steel specimens and also to understand the tensile characteristics and deflection of materials*
CLR-4:	*have a better understanding on the mechanical behaviour of materials under compression, double shear, three-point bend and torsional loads*
CLR-5:	*understand the behaviour of materials subjected to fatigue, impact loads and to know the procedure of wear analysis*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*prepare different metal specimens and identify specimens by examining their microstructures*	-	-	-	3	-	-	-	-	1	-	-	-	-	-	-
CO-2:	*determine hardenability, coating thickness and analyse microstructure*	-	-	-	3	2	-	-	-	1	-	-	-	-	-	-
CO-3:	*investigate the variation in hardness and microstructures of heat-treated specimens and study their tensile characteristics and deflection of simply supported beams*	-	-	-	3	-	-	-	-	1	-	-	-	-	-	-
CO-4:	*analyse the mechanical behaviour of materials subjected to compression, double shear, three- point bend and torsion loads*	-	-	-	3	-	-	-	-	1	-	-	-	-	-	-
CO-5:	*evaluate fatigue, impact and wear characteristics of materials*	-	-	-	3	-	-	-	-	1	-	-	-	-	-	-

Unit-1 - Specimen Identification	***6 Hour***
Study of metallurgical microscope, specimen preparation - mounting, polishing, etching. Identification of ferrous and non-ferrous alloys.	
Unit-2 - Coating Thickness and Phase Fraction	***6 Hour***
Determination of coating, case hardening thickness, hardenability. Evaluation of grain size and phase fraction.	
Unit-3 - Heat Treatment, Microstructure and Tensile Properties	***6 Hour***
Heat-treated steel specimens - investigation of microstructure and hardness. Tensile behaviour of steel specimens, deflection of simply supported beams.	
Unit-4 - Compression, Shear, Flexural and Torsion Properties	***6 Hour***
Compression, double shear, three-point bend and torsion tests of materials	
Unit-5 - Fatigue, Impact and Wear Properties	***6 Hour***
Fatigue test, impact test, wear analysis - pin-on-disc apparatus	

Learning Resources	1. *Sidney H Avnar, Introduction to physical metallurgy, 2nd ed., McGraw Hill Education, 2017* 2. *Donald R. Askeland, Wendelin J. Wright, Science and Engineering of Materials, 7th ed.,Cengage Learning, 2015*	3. *Ferdinand Beer, E. Russell Johnston, Jr., John DeWolf, David Mazurek, Mechanics of Materials, 7th ed., McGraw - Hill, 2017* 4. *Kazimi S. M. A, Solid Mechanics, 2nd ed.,Tata McGraw Hill, 2017* 5. *Laboratory Manuals - Metallurgy & Strength of materials laboratories*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*						*Final Examination (0% weightage)*	
		CLA-1 Average of first cycle experiments (30%)		*CLA-2 Average of second cycle experiments (30%)*		*Practical Examination (40%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	-	*15%*	-	*15%*	-	*15%*	-	-
Level 2	*Understand*	-	*25%*	-	*20%*	-	*25%*	-	-
Level 3	*Apply*	-	*30%*	-	*25%*	-	*30%*	-	-
Level 4	*Analyze*	-	*30%*	-	*25%*	-	*30%*	-	-
Level 5	*Evaluate*	-	-	-	*10%*	-	-	-	-
Level 6	*Create*	-	-	-	*5%*	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*		-	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Shankar Subburathinam, Engineering Manager – Caterpillar India Ltd*	1. *Dr. A. Suresh Babu, Associate Professor, CEG - Anna University*	1. *Mr. D. Selwyn Jebadurai,AP, SRMIST*
2. *Dr. N Saravanan, Principal Engineer, Smart Implements & Machinery and Sustainability, Mahindra Research Valley.*	2. *Dr. N. Arunachalam, Associate Professor, IITM*	2. *Mr. S. Arokya Agustin,AP, SRMIST*

Course Code	21MEC205T	Course Name	FLUID MECHANICS AND MACHINERY	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	*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:	*utilize the concept of boundary layer, lift and drag forces*
CLR-5:	*identify the working principle and design of hydraulic turbines and pumps*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*determine the properties of fluid*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*solve the fluid flow problems*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	*apply the mathematical techniques for practical fluid flow problem*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	*analyze the boundary layer theory and flow over submerged bodies*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	*identify the energy exchange process in fluid machinery*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Fluid Properties and Fluid Statics ***9 Hour***

Types of fluids, Properties of fluid, Dynamic and Kinematic viscosity - Newton's law of viscosity- Surface tension and capillarity- -Bulk modulus of elasticity and compressibility, Fluid statics: Pascal's law, Hydrostatic law, Buoyancy and Meta centre, Pressure, Manometers - Piezometer- Applications and limitation - U-Tube, Single column, Differential U-tube, Inverted differential U-tube manometers.

Unit-2 - Fluid Kinematics and Dynamics ***9 Hour***

Types of fluid flow, Lagrangian and Eulerian approach, Velocity and acceleration of fluid particles- Continuity equation- Euler equation of motion-Bernoulli's equation- Applications - Venturimeter- Orificemeter -Pitot tube-Nozzle flow meter- Types of flow lines, Stream line-Streak line and Path line-Impulse Momentum equation.

Unit-3 - Dimensional Analysis and Flow Through Pipes ***9 Hour***

Dimensions, Dimensional homogeneity-Buckingham's pi theorem-Model analysis-advantages and applications-similitude, Dimensionless numbers-Model laws- Reynold's, Froude, Weber, Mach, and Euler model laws, Concept of fully developed pipe flows - Darcy equation –Major and minor losses-Pipes connected in series and parallel-Equivalent pipe.

Unit-4 –Boundary Layer and Flow Around Submerged Bodies ***9 Hour***

Flow over flat plate - Laminar and turbulent boundary layers - Von Karman momentum integral equation - Boundary layer thickness – Displacement, momentum and energy thickness - Forces exerted by a flowing fluid on a stationary bluff and streamlined bodies -Separation of flow over bodies - Development of lift and drag forces.

Unit-5 - Hydraulic Machines ***9 Hour***

Pumps and turbines - Classification - Centrifugal and reciprocating pumps - Working principle - Design parameters -Velocity triangle - Performance curves – Pelton turbine, Francis turbine and Kaplan turbine, - Working principle - Design parameters - Velocity triangle – Performance curves - Cavitation in pumps and turbines.

Learning Resources	1. *Rajput.R.K, A text book of Fluid Mechanics and Hydraulic Machines, S.Chand& Company Ltd., 6th ed., 2015* 2. *Bansal.R.K, A text book of Fluid Mechanics and Hydraulics Machines, Laxmi publications (P) Ltd., 9th ed., 2015* 3. *Robert W. Fox & Alan T. McDonald & Philip J. Pritchard, Introduction to Fluid Mechanics, John Wiley & Sons Inc. 8TH ed 2011*	4. *Modi P.N, Seth S.M, Hydraulics and Fluid Mechanics, Standard Book House, 15th ed., 2002* 5. *Cengel, Y.A. and Cimbala, J.M. (2018) FluidMechanics. Fundamentals and Applications. 4th Edition. McGraw-Hill, New York.* 6. *White.F.M, Fluid Mechanics, Tata McGraw-Hill, 7th ed., 2011* 7. *Streeter.V.L, Wylie.E.B, Fluid Mechanics , McGraw Hill, 5th ed., 1984*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*30%*	-	*30%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*30%*	-	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Er. N. Palani, Scientist D/SAMEER – Chennai.*	1. *Dr.S.Mohammed Ibrahim, IITKanpur*	1. *Dr.R.Senthil Kumar, SRMIST*
2. *Er.D. Harihara Selvan,Technical Leader, GE Power,Noida - 201301*	2. *Dr.S. Jayavel, IITDM, Kancheepuram*	2. *Dr.V. Rajasekar, SRMIST*

Course Code	21MEC206T	Course Name	KINEMATICS AND DYNAMICS OF MACHINES	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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*apply the kinematic analysis concepts to familiarize the working principle of machine tools*
CLR-2:	*familiarize the IC engine's valve and port mechanism and design the gear-box for power transmission systems*
CLR-3:	*apply the concepts of static and dynamics forces in IC engines and flywheels*
CLR-4:	*familiarize the balancing of forces and moments in rotor bearings, ships and aeroplanes*
CLR-5:	*familiarize the fundamentals of vibrations in Single degree of freedom systems*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*apply the concepts of theory of mechanisms to perform kinematic analysis*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*analyze the kinematics of cam and follower, and gear trains*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	*perform the static and dynamic force analysis of mechanisms*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	*analyze the effect of unbalancing forces and gyroscopic effects in machines*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	*formulate the governing equations and solve for single DOF systems*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Kinematics of Mechanisms	***9 Hour***
Introduction to mechanism: Link, pair, kinematic chain, mechanism and machine - Degrees of Freedom - Mobility - Four Bar Chain, Grashof's law, Kutzback's and Grubler's criterion for planar mechanisms - Kinematic Inversions of kinematic chain, Kinematic Analysis: Velocity and acceleration analysis of Four bar and single slider crank mechanism by graphical method - Instantaneous center (IC) method, Kennedy's theorem, Velocity analysis of Four bar and single slider crank mechanism by Instantaneous center method	
Unit-2 - Kinematic Analysis of Machine Elements	***9 Hour***
Cams and Followers: Cam terminology, types of cams and followers, Types of follower motion - Kinematics of follower for parabolic, simple harmonic, uniform acceleration and cycloidal motions - construction of circular cam profile for radial and offset followers with different follower motions Gears: Gear terminology, types of gears - law of gearing - path of contact, arc of contact, sliding velocity - interference and undercutting of gears – Gear trains: types and applications - velocity ratio calculations in simple, compound and epicyclic gear train	
Unit-3 - Force Analysis	***9 Hour***
Applied and Constrained Forces – Free body diagrams – Static Equilibrium conditions – Two, Three and four force members – Static Force analysis in simple machine members – Dynamic Force Analysis – Inertia Forces and Inertia Torque – D'Alembert's principle – superposition principle – dynamic force Analysis in reciprocating engines - Turning moment diagrams - flywheels- Case study on four bar mechanism	
Unit-4 - Balancing and Gyroscope	***9 Hour***
Balancing of rotating masses: Static and dynamic balancing of several masses rotating in same and different planes by analytical and graphical methods - Balancing of reciprocating masses by graphical method. Gyroscope: Gyroscopic forces, couple, precessional angular motion, Gyroscopic effects on automobiles, trains, aeroplane and ship	
Unit-5 - Fundamentals of Vibrations	***9 Hour***
Basics of vibrations - Terminology and types of vibrations - Governing equations for free undamped and damped vibrations of single degree of freedom system - logarithmic decrement. Forced vibration: Types of - of forced vibration single degree of freedom system under harmonic excitation.	

Learning Resources	1. *Rattan S.S., "Theory of Machines ", McGraw Hill Education, 4th edition, 2015* 2. *Thomas Bevan, Theory of Machines, 3rd Edition – P* 3. *Education Limited – 2005 – 3rd Edition*	4. *Robert L. Norton, Kinematics and Dynamics of Machinery, 2nd Edition, McGraw Hill, 2013.* 5. *Rao SS, 'Mechanical Vibrations, 5th Edition, Prentice Hall*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*20%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*25%*	-	*30%*	-
Level 5	*Evaluate*	-	-	*10%*	-	-	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. N. Babu, CVRDE, DRDO, Avadi, babu.n.cvrde@gov.in*	1. *Dr. Shankar Krishnapillai, IIT Madras, skris@iitm.ac.in*	1. *KR. Arun Prasad, SRM IST*
2. *Mr. Parameswaran, Nokia, Chennai, parameswaran.s@nokia.com*	2. *Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	

Course Code	21MEC203L	Course Name	MACHINE DYNAMICS 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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*demonstrate the basic concepts of kinematics involved in various machine elements*
CLR-2:	*demonstrate the basic concepts of dynamics involved in various machine elements*
CLR-3:	*demonstrate the free vibration of linear and torsional spring, mass and damper systems*
CLR-4:	*demonstrate the forced vibration of beams and shafts subjected to rotating unbalancing forces*
CLR-5:	*demonstrate the working principles of vibration measuring instruments*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*demonstrate the concepts of kinematics of machine elements*	*3*	*2*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*demonstrate the concepts of dynamics of machine elements*	*3*	*2*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	*analyze the free vibration of Single degree of freedom systems*	*3*	*2*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	*analyze the forced vibration of Single degree of freedom systems*	*3*	*2*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	*analyze the experimental vibration response using digital signal analysis techniques*	*3*	*2*	-	-	*1*	-	-	-	-	-	-	-	-	-	-

Unit-1 - Kinematic Analysis of Machine Elements	***6 Hour***
Cam and Follower - Epicyclic gear train -	
Unit-2 - Dynamic Analysis of Machine Elements	***6 Hour***
Gyroscope -Dynamic balancing of rotating and reciprocating masses- Demonstration of Governors	
Unit-3 - Free Vibration Analysis	***6 Hour***
Free vibration of helical springs - Torsional vibration of single rotor system - Free vibration of equivalent spring, mass and damper system	
Unit-4 - Forced Vibration Analysis	***6 Hour***
Transverse vibration of beam - whirling of shaft- Transmissibility ratio in vibrating systems	
Unit-5 - Experimental Vibration Analysis	***6 Hour***
Measurement of vibration response using strain gauge, accelerometer and Impact hammer- single plane and two plane balancing using Balancing machines	

Learning Resources	1. *Rao SS, 'Mechanical Vibrations, 5th Edition, Prentice Hall* 2. *Thomas Bevan, Theory of Machines, 3rd Edition – Pearsons Education Limited – 2005 – 3rd Edition*	3. *Robert L. Norton, Kinematics and Dynamics of Machinery, 2nd Edition, McGraw Hill, 2013.* 4. *Sujatha C., Vibration and Acoustics - Measurement and Signal Analysis, Tata McGraw Hill Education Pvt. Ltd., 2010*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*						*Final Examination (0% weightage)*	
		CLA-1 Average of first cycle experiments (30%)		*CLA-2 Average of second cycle experiments (30%)*		*Practical Examination (40%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	-	*15%*	-	*15%*	-	*15%*	-	-
Level 2	*Understand*	-	*25%*	-	*20%*	-	*25%*	-	-
Level 3	*Apply*	-	*30%*	-	*25%*	-	*30%*	-	-
Level 4	*Analyze*	-	*30%*	-	*25%*	-	*30%*	-	-
Level 5	*Evaluate*	-	-	-	*10%*	-	-	-	-
Level 6	*Create*	-	-	-	*5%*	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*		-	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. N. Babu, CVRDE, DRDO, Avadi,babu.n.cvrde@gov.in*	1. *Dr. Shankar Krishnapillai, IITMadras, skris@iitm.ac.in*	1. *Mr. KR. Arun Prasad, SRM IST*
2. *Mr. Parameswaran, Nokia, Chennaiparameswaran.s@nokia.com*	2. *Dr. Raju Abraham, NIOT, Chennai,abraham@niot.res.in*	

Course Code	21MEC204L	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	*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:	*identify the flow measuring devices*
CLR-2:	*apply the principles of Bernoulli's equation*
CLR-3:	*analyze the various energy losses in pipes*
CLR-4:	*assess the working of pumps/ Turbines*
CLR-5:	*measure forces around streamline body/bluff body in wind/ water tunnel*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*demonstrate the coefficient of discharge in flow measurement devices*	*3*	-	-	-	-	-	-	-	*3*	-	-	-	-	-	-
CO-2:	*identify Bernoulli's equation for measuring different heads*	*3*	-	-	-	-	-	-	-	*3*	-	-	-	-	-	-
CO-3:	*determine and analyze the various energy losses in pipes*	*3*	-	-	-	-	-	-	-	*3*	-	-	-	-	-	-
CO-4:	*interpret the different types of pumps/turbines based on its performance*	*3*	-	-	-	-	-	-	-	*3*	-	-	-	-	-	-
CO-5:	*perform forces measurement around streamline body/bluff body in wind/ water tunnel*	*3*	-	-	-	-	-	-	-	*3*	-	-	-	-	-	-

Unit-1 - Flow Measuring Devices	***6 Hour***
Determine the coefficient of discharge of Orifice meter/ Venturimeter, Flow measurement using Pitot tube	
Unit-2 - Bernoulli's Principle	***6 Hour***
Determine total heads of fluids at given points in the pipe/ Bernoulli's theorem, forced vortex and find the depth of the forced vortex curve	
Unit-3 - Energy Losses in Pipes	***6 Hour***
Study of major Energy loss in a pipe, Study of Minor losses due to pipe fittings and bends	
Unit-4 - Pumps and Turbines	***6 Hour***
Performance test on Submersible pump/ Reciprocating Pump/ Jet pump/ Gear Pump, Performance test on Pelton turbine/ Kaplan turbine/ Francis turbine	
Unit-5 - Wind and Water Tunnels	***6 Hour***
Velocity and pressure measurement using pitot tube, hot wire Anemometry and pressure sensor, model mounting technique, Force calculations	

Learning Resources	
	1. *Robert W. Fox, Alan T. McDonald, Philip J. Pritchard, Introduction to Fluid Mechanics, 8thed., Wiley,2013*
	2. *Frank M. White, Fluid Mechanics,7th ed., McGraw-Hill,2018*
	3. *P.N.Modi,S.M.Seth,Hydraulics&FluidMechanicsIncludingHydraulicsMachines,20thed.,StandardBookHouse ,2018*
	4. *KL Kumar., Engineering Fluid Mechanics,10th ed.,S Chand&Co.,2015 Laboratory Manual*

Learning Assessment									
	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*						*Final Examination (0% weightage)*	
		CLA-1 Average of first cycle experiments (30%)		*CLA-2 Average of second cycle experiments (30%)*		*Practical Examination (40%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	-	*30%*	-	*30%*	-	*30%*	-	-
Level 2	*Understand*	-	*30%*	-	*30%*	-	*30%*	-	-
Level 3	*Apply*	-	*40%*	-	*40%*	-	*40%*	-	-
Level 4	*Analyze*	-	-	-	-	-	-	-	-
Level 5	*Evaluate*	-	-	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-	-	-
	Total	*100%*		*100%*		*100%*		-	

Course Designers		
Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Er. N. Palani, Scientist D/SAMEER – Chennai.*	1. *Dr. Dhiman Chatterjee, IIT Madras, Chennai, dhiman@iitm.ac.in*	1. *Dr. Pankaj Kumar, SRMIST*
2. *Er.D. Harihara Selvan,Technical Leader, GE Power,Noida - 201301*	2. *Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	2. *Dr. Santosh Kumar singh, SRMIST*

Course Code	21MEC205L	Course Name	MECHANICAL MODELING AND ASSEMBLY	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							0	0	4	2

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:	*implement the basics of standards and conventions, limits, fits and tolerances pertaining to mechanical modeling and assembly of components*
CLR-2:	*develop the assembly and detailed drawing of mechanical joints and couplings*
CLR-3:	*develop the assembly and detailed drawing of Bearings and Engine components*
CLR-4:	*prepare the assembly drawing and detailed of Work holding and Lifting device*
CLR-5:	*create the assembly and detailed drawing of Machine components and Fixture*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*apply various standards and conventional representation of machine components and choose appropriate fits*	*3*	-	-	-	-	-	-	-	-	*2*	-	-	-	-	-
CO-2:	*develop the assembly drawing of mechanical joints and couplings*	*2*	-	-	-	*3*	-	-	-	-	*3*	-	-	-	-	-
CO-3:	*develop the assembly drawing of Bearings and Engine components*	*2*	-	-	-	*3*	-	-	-	-	*3*	-	-	-	-	-
CO-4:	*develop the assembly drawing of Work holding and Lifting device*	*2*	-	-	-	*3*	-	-	-	-	*3*	-	-	-	-	-
CO-5:	*develop the assembly drawing of Machine components and Fixture*	*2*	-	-	-	*3*	-	-	-	-	*3*	-	-	-	-	-

Unit-1 - Standards, Conventions, Symbols, Fits and Tolerances	***12 Hour***
IS/ISO codes, Conventional representation of machine elements-springs-gear drives, Abbreviations, welding symbols, riveted joints, keys, fasteners and Bill of materials, Limits, Tolerances, Computing fundamental deviation Fits-classification-system of fits-hole basis system-shaft basis system, geometric characteristic symbols, geometric tolerances.	
Unit-2 - Joints and Couplings	***12Hour***
Modeling, Assembly and Detailed drawing of Joints and Coupling.	
Unit-3 - Bearings and Engine Components	***12 Hour***
Modeling, Assembly and Detailed drawing of Bearings and engine components.	
Unit-4 - Work Holding and Lifting Device	***12 Hour***
Modeling, Assembly and Detailed drawing of work holding, lifting, hoisting, cranes, jacks and chucks.	
Unit-5 - Machine Components and Fixture	***12 Hour***
Modeling, Assembly and Detailed drawing of machine components and fixtures.	

Learning Resources		
	1. *N. D. Bhatt, Machine Drawing, Charotar Publishing House Pvt Ltd, 2016.*	4. *SP 46: 1988 Engineering Drawing Practice for School & Colleges. Bureau of Indian Standards*
	2. *N. Sidheswar, P. Kanniah and V.V.S. Sastry, Machine Drawing, Tata McGraw Hill, 2010.*	5. *K. R. Gopalakrishna, Machine Drawing, 20th Ed., Subhas Stores, Bangalore, 2007.*
	3. *K. L. Narayana, P. Kannaiah, K. Venkata Reddy – 'Machine Drawing' – New Age International publishers – 2019 – 6 Edition*	6. *Design Data: Data Book of Engineers by PSG College of Technology - Kalaikathir Achchagam, 2020*

Learning Assessment									
	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*						*Final Examination (0% weightage)*	
		CLA-1 Average of first cycle experiments (30%)		*CLA-2 Average of second cycle experiments (30%)*		*Practical Examination (40%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	-	*20%*	-	*20%*	-	*20%*	-	-
Level 2	*Understand*	-	*40%*	-	*40%*	-	*40%*	-	-
Level 3	*Apply*	-	*40%*	-	*40%*	-	*40%*	-	-
Level 4	*Analyze*	-	-	-	-	-	-	-	-
Level 5	*Evaluate*	-	-	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-	-	-
	Total	*100%*		*100%*		*100%*		-	

Course Designers		
Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. Dr. N. Babu, CVRDE, DRDO, Avadi, babu.n.cvrde@gov.in	*1. Dr. Shankar Krishnapillai, IIT Madras, skris@iitm.ac.in*	*1. Dr. V. Magesh, SRM IST*
2. Mr. Parameswaran, Nokia, Chennai, parameswaran.s@nokia.com	*2. Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	*2. Mr. D. Raja, SRM IST*

Course Code	21MEC301T	Course Name	THERMAL SYSTEMS ENGINEERING	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:	*understand the sequence of operation of air standard cycles*
CLR-2:	*identify the fundamentals of Fuels and performance of IC Engines*
CLR-3:	*familiar with thermal performance of boiler and heat exchanger*
CLR-4:	*identify the working of different types of compressors*
CLR-5:	*understand the cooling performance of refrigeration and its applications*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*analyze the basic operations required for cyclic energy release and method to calculate the efficiency*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*examine the fuel properties and performance of IC engines*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	*investigate the thermal performance of boiler and heat exchanger*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	*investigate the thermal performance of compressor*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	*investigate the cooling performance of refrigeration systems*	*3*	-	-	-	-	-	*1*	-	-	-	-	-	-	-	-

Unit-1 - Air Standard Cycles	***12 Hour***
Air standard cycles – Otto, Diesel, Dual and Brayton-- Air standard efficiency - Mean effective pressure - Comparison between cycles - Concept of reheat and regeneration for Brayton cycle.	
Unit-2 - Fuel Combustion and IC Engines	***12 Hour***
Fuels – types and properties -- air fuel ratio - volumetric and gravimetric analysis - Analysis of exhaust and flue gas – Calorimetry. IC engines - classification, Working of two stroke and four stroke engines – Measurement of engine operating parameters, Engine performance and Heat balance sheet.	
Unit-3 - Boilers and Heat Exchangers	***12 Hour***
Boiler –classification- Mountings and accessories – High pressure boilers – requirements – Working of Lamont , Loeffler, Benson and Velox boiler, fluidized bed boiler, Waste heat recovery boiler, sub critical and super critical boilers – Boiler performance- Equivalent evaporation- Factor of evaporation – Boiler efficiency, Function, types and working of condensers, Economiser, Air preheater, super heater	
Unit-4 - Air Compressor	***12 Hour***
Air compressor - classification, working of reciprocating air compressor with and without clearance - Equation for work on single stage compressor - Volumetric efficiency and Free air delivered - Multistage compression with intercooler, Positive rotary compressors - working- Comparison between reciprocating and rotary compressor.	
Unit-5 - Refrigeration and its Applications	***12 Hour***
Vapor compression refrigeration system and its working principle – Refrigerants – Eco-friendly refrigerants, Analysis of vapor compression refrigeration cycle- theoretical and actual cycles - Sub-cooling and superheating - Vapor absorption refrigeration systems –Li-Br, NH3-water, Adsorption cooling system ,Steam jet refrigeration system, HVAC system in automobiles, Thermal processing of dairy and ice plants, thermal comfort in buildings, thermoelectric refrigeration, Summer, winter and year round air-conditioning system.	

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, 11th ed., Laxmi Publications, 2023* 5. *Yunus A Cengel, Michael A Boles, Thermodynamics: An Engineering Approach,9th ed., Tata McGraw Hill, 2018*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	*-*	*15%*	*-*	*15%*	*-*
Level 2	*Understand*	*25%*	*-*	*25%*	*-*	*25%*	*-*
Level 3	*Apply*	*30%*	*-*	*30%*	*-*	*30%*	*-*
Level 4	*Analyze*	*30%*	*-*	*30%*	*-*	*30%*	*-*
Level 5	*Evaluate*	*-*	*-*	*-*	*-*	*-*	*-*
Level 6	*Create*	*-*	*-*	*-*	*-*	*-*	*-*
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *PC M Velan Indian Navy*	1. *Dr. Arun Vijay, Anna university Tirunelveli*	1. *Mr N. Vijay Krishna, SRMIST*
2. *Mr. R. Karthick GM Operations*	2. *Dr. Rajasekaran, University college of engineering, Villupuram*	2. *Dr. R. Senthil Kumar, SRMIST*
		3. *Dr. V. Praveena. SRMIST*

Course Code	21MEC301P	Course Name	DESIGN OF MECHANICAL SYSTEMS	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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*know the fundamentals of mechanical design*
CLR-2:	*be familiar with the concepts to design joints and couplings*
CLR-3:	*know the concepts to design IC engine components*
CLR-4:	*be familiar with the concepts to design gears*
CLR-5:	*know the concepts to design gear box*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*apply failure theories in designing the components*	*3*	-	*3*	-	-	-		-	*2*	-	-	-	-	-	-
CO-2:	*design joints and couplings*	*3*	-	*3*	-	-	-		-	*2*	-	-	-	-	-	-
CO-3:	*design IC engine components*	*3*	-	*3*	-	-	-		-	*2*	-	-	-	-	-	-
CO-4:	*design gears with strength and wear*	*3*	-	*3*	-	-	-		-	*2*	-	-	-	-	-	-
CO-5:	*select the number of teeth on each gear and prepare layout of gear box*	*3*	-	*3*	-	-	-		-	*2*	-	-	-	-	-	-

Unit-1 - Fundamentals of Mechanical Design	***9 Hour***
Introduction to the design process - factors influencing machine design, selection of materials based on mechanical properties -Theories of failure - Design for variable loads: endurance limit, Goodman and Soderberg criteria.	
Unit-2 - Design of Joints, Couplings and Shafts	***9 Hour***
Design of joints - Cotter, Knuckle and Bolted joints, Design of couplings - Rigid and flexible couplings-design of shafts	
Unit-3 - Design of IC Engine Components	***9 Hour***
Design of Cylinder, Piston with pin and rings, Connecting Rod and Crank Shaft.	
Unit-4 - Design of Gears	***9 Hour***
Design of spur, helical, bevel and worm gears from strength and wear considerations.	
Unit-5 - Design of Gear Box	***9 Hour***
Design of multi speed gear box - Requirements of gear box, determination of variable speed range, graphical representation of speeds, structure diagram, ray diagram, selection of optimum ray diagram, estimation of numbers of teeth on gears, layout of gear box.	

Learning Resources	1. *Joseph Shigley, Richard G. Budynas and J. Keith Nisbett "Mechanical Engineering Design", McGraw-Hill International Editions 10th Edition, 2015.* 2. *Robert. C. Juvinall, Kurt. M. Marshek, "Fundamentals of Machine Component Design", John Wiley &sons, 6th Edition, 2017.* 3. *Paul H Black and O. E. Adams, P., "Machine Design", 3rd edition, Mc Graw Hill Book Company, Inc., New York, USA, 2007.*	4. *Bhandari V B, "Design of Machine Elements", 4th Edition, Tata McGraw-Hill Book Co, 2016* 5. *Mehtha. N. K, "Machine Tool Design and Numerical Control", Tata Mc- Graw Hill, Third Edition, 2012* 6. *Design Data: Data Book of Engineers, PSG College Technology, Kalaikathir Achchagam, Coimbatore, 2015* 7. *Gitin M Maitra, "Handbook of Gear Design", Tata Mcgraw-Hill, 2010*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*						*Final Examination (0% weightage)*	
		Formative CLA-1 Average of unit test (20%)		*Project Based Learning CLA-2 (60%)*		*Report and Viva Voce (20%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	-	*15%*	-	*15%*	-	-
Level 2	*Understand*	*25%*	-	-	*25%*	-	*25%*	-	-
Level 3	*Apply*	*30%*	-	-	*30%*	-	*30%*	-	-
Level 4	*Analyze*	*30%*	-	-	*30%*	-	*30%*	-	-
Level 5	*Evaluate*	-	-	-		-	-	-	-
Level 6	*Create*	-	-	-		-	-	-	-
	Total	*100 %*		*100 %*		*100%*		-	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. N. Babu, CVRDE, DRDO, Avadi, babu.n.cvrde@gov.in*	1. *Dr. Shankar Krishnapillai, IIT Madras, skris@iitm.ac.in*	1. *Dr. M. Kamaraj, SRM IST*
2. *Mr. Parameswaran, Nokia, Chennai, parameswaran.s@nokia.com*	2. *Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	2. *Mr. D. Raja, SRM IST*

Course Code	21MEC302T	Course Name	SENSORS AND CONTROL SYSTEMS	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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*be familiar with the sensors and transducers, which are commonly used in automation systems*
CLR-2:	*apply the knowledge advanced sensors technology commonly used in automation systems*
CLR-3:	*be familiar with the working of various drives, valves and actuators for Industrial Automation*
CLR-4:	*apply the knowledge about the controller used in industrial automation signal conditioning and data acquisition techniques*
CLR-5:	*be familiar with the knowledge of sensor in industrial automation*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*acquaint with the sensors and transducers, which are commonly used in automation systems*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*acquaint with the advanced sensors technology commonly used in automation systems*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	*explain the working of various drives, valves and actuators for Industrial Automation*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	*provide the knowledge about the controller, PLC programming and control, signal conditioning and data acquisition techniques*	-	-	-	-	*3*	-	-	-	-	-	-	-	*3*	-	-
CO-5:	*apply the knowledge of sensor in industrial automation*	-	-	-	-	*3*	-	-	-	-	-	-	-	-	*3*	-

Unit-1 - Sensors and Transducers ***9 Hour***

Introduction to sensors and transducers, classification and Static and dynamic characteristics, errors- Principle and working of Resistive, capacitive, inductive transducer- Resonant transducer, Photo electric sensor, Fibre optic transducers, piezoelectric sensor, Ultrasonic sensors- Photo detector-Vision systems

Unit-2 - Advanced Sensor Technology ***9 Hour***

Measurement of Motion, Force, Torque and flow Displacement and speed measurement for translational and rotation systems using potentiometers, LVDT and RVDT, Position Encoder Sensors -Force and Torque measurements using strain gauges and piezoelectric pickups. Flow measurements using Flow meter. Sensor for Identification Bar-Code Identification Systems -Electromagnetic Identification -Optical Character Recognition –Smart sensor/Intelligent sensor Sensors for Faults Diagnosis Sensors Detecting Faults in Dynamic Machine Parts using Surface Acoustic Waves-Sensors for Vibration Measurement of a Structure Microelectromechanical systems (MEMS)

Unit-3 – Drives Valves and Actuators for Industrial Automation ***9 Hour***

Definition, types and selection of Actuators; linear; rotary; Logical and Continuous Actuators, Pneumatic actuator- Electro-Pneumatic actuator; cylinder, rotary actuators, Mechanical actuating system: Hydraulic actuator - Control valves; Construction, Characteristics and Types, Selection criteria. Electrical actuating systems: Solid-state switches, Solenoids, Electric Motors- Principle of operation and its application: D.C motors - AC motors - Single phase & 3 Phase Induction Motor; Synchronous Motor; Stepper motors - Piezoelectric Actuator- Linear Electrical Actuators- Micro Actuators

Unit-4 - Controllers and Signal Processing ***9 Hour***

Programmable Logic Controllers – Architecture – Input / Output Processing – Logic Ladder Programming – Functional Block Programming using Timers and Counters – Applications. A/D converters, D/A converters Multiplexer and Proportional, Integral, Derivative and PID controller- Introduction to Micro controller- Open loop and closed loop control system. Basic signal conditioning – bridges, amplifiers, filters, monitoring and indicating systems and data acquisition systems.

Unit-5 – Application of Sensors and Case Studies in Automation	***9 Hour***
The Roles of Sensors in Industrial Automation- Components of Automation- applications of sensing systems in Automation: Assembly line automation- Testing, Inspection and Quality control, System health Monitoring- Significance of sensors for industry 4.0: Roles, capabilities, and applications	

Learning Resources		
	1. *Ernest O. Doebelin, Dhanesh N. Manik, Doebelin's Measurement Systems: 7th Edition (SIE), Tata McGraw- Hill, 2019.* 2. *Katsuhiko Ogata, Modern Control Engineering, 5th Edition, Prentice Hall of India Pvt. Ltd, 2010.* 3. *Patranabis D, Instrumentation and Control, PHI Learning Pvt. Ltd, 2011*	4. *Anthony Esposito, "Fluid Power with applications", Pearson Education Inc, 2015.* 5. *Soloman S. Sensors and control systems in manufacturing. McGraw-Hill Education; 2010.* 6. *Jacob Fraden, "Handbook of Modern Sensors Physics, Designs, and Applications", 5th Edition, Springer International Publishing, 2016.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*20%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*25%*	-	*30%*	-
Level 5	*Evaluate*	-	-	*10%*	-	-	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr. Venkadesan Velu Founder & CEO @ LogFuze Inc.*	1. *Dr. A.S.S. Balan Assistant Professor, Department of Mechanical Engineering, NITK Surathkal, Mangalore, India*	1. *Dr. M. Prakash, SRMIST*
2. *Dr. Kulasekharan N Simulation Discipline Leader, Valeo India Pvt. Ltd.*	2. *Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	2. *. Dr. Ambigai, SRMIST*

Course Code	21MEC301L	Course Name	THERMAL POWER SYSTEMS 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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*understand the valve and port timing diagram, fuel properties*
CLR-2:	*understand the performance of IC engines*
CLR-3:	*understand the heat balance concept and emission testing*
CLR-4:	*get familiar with the working of boiler, steam turbine and air compressor*
CLR-5:	*understand the performance calculation of the blower and solar flat plate collectors*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*demonstrate the valve and port timing diagram, Analyze the properties of lubricants and fuels*	*3*	-	-	-	-	-	*3*	-	*3*	-	-	-	*1*	-	-
CO-2:	*test the performance of IC engines*	*3*	-	-	-	-	-	*3*	-	*3*	-	-	-	*1*	-	-
CO-3:	*detect the losses in heat balance test and emissions from the IC engine*	*3*	-	-	-	-	-	*3*	-	*3*	-	-	-	*3*	-	-
CO-4:	*analyze the performance of the boiler, steam turbine and air compressor*	*3*	-	-	*1*	-	-	*3*	-	*3*	-	-	-	*3*	-	-
CO-5:	*evaluate the performance of the blower and solar flat plate collectors*	*3*	-	-	-	-	-	*3*	-	*3*	-	-	-	*1*	-	-

Unit-1 - Basics of IC Engine and Fuel Properties	***6 Hour***
Components of Internal combustion engine, Valve timing and port timing diagram of IC Engines, Determination of viscosity, flash point, fire point, cloud and pour point	
Unit-2 - Performance Test on IC Engines	***6 Hour***
Performance test on single cylinder petrol engine with electrical dynamometer, diesel engine with Rope brake/ Eddy current/hydraulic dynamometer, Optimum cooling water flow rate in four stroke engine, Morse Test	
Unit-3 - Heat Balance Test on IC Engine	***6 Hour***
Heat balance test on four stroke diesel engine with and without calorimeter, Retardation test on low speed diesel engine, Determination of brake specific emission s, Emission standards.	
Unit-4 - Power Generation	***6 Hour***
Performance of steam power plant, solar flat plate collectors	
Unit-5 - Compressors and Blowers	***6 Hour***
Performance test on two stage reciprocating air compressor and blower	

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 (CLA)*						*Final Examination (0% weightage)*	
		CLA-1 Average of first cycle experiments (30%)		*CLA-2 Average of second cycle experiments (30%)*		*Practical Examination (40%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	-	*20%*	-	*20%*	-	*20%*	-	-
Level 2	*Understand*	-	*40%*	-	*40%*	-	*40%*	-	-
Level 3	*Apply*	-	*40%*	-	*40%*	-	*40%*	-	-
Level 4	*Analyze*	-	-	-	-	-	-	-	-
Level 5	*Evaluate*	-	-	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100%*		-	

Course Designers		
Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr.R.M.Raghunathan, Assistant Vice President, Tamil Nadu Petroproducts Limited, Manali, Chennai- 600068 mlrmr@hotmail.com*	1. *Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	1. *Dr.G.Balaji, SRMIST*
2. *Er.M.Sakthivel, Dy.Chief Engineer, NLC Limited, Neyveli – 607801, Tamil Nadu sakthivel.m@nlcindia.in*	2. *Dr.G.Arun Vijay, Anna University, Nagercoil, arunvijay.gs@gmail.com*	2. *Mr.G.Manikandaraja, SRMIST*

Course Code	21MEC302L	Course Name	AUTOMATION AND CONTROL SYSTEMS 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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*design pneumatic circuits for low-cost automation*
CLR-2:	*design hydraulic circuits for industrial automation*
CLR-3:	*develop electro pneumatic circuits, control of motors for various applications*
CLR-4:	*acquire sensors outputs using virtual instrumentation for various applications*
CLR-5:	*operate robot for pick and place robot and sorting and impart concepts of IOT for real time application*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*develop pneumatic circuits for low-cost automation*	-	-	*3*	-	-	-	-	-	*1*	-	-	-	-	-	-
CO-2:	*develop hydraulic circuits for industrial automation*	-	-	*3*	-	-	-	-	-	*1*	-	-	-	-	-	-
CO-3:	*construct electro pneumatic circuits, control of motors for various applications*	-	-	*2*	-	-	-	-	-	*2*	-	-	-	*1*	-	-
CO-4:	*acquire and analyse sensor outputs using virtual instrumentation for various applications*	-	-	*2-*	-	*1*	-	-	-	*2*	-	-	-	-	-	-
CO-5:	*manipulate robot for pick and place, sorting and impart concepts of IOT for real time applications*	-	-	*2*	-	*2-*	-	-	-		-	-		-	*2*	-

Unit-1 - Pneumatic Circuits	***6 Hour***
Double Acting Cylinder - Continuous, Speed Control, Sequencing, Cascading of Cylinders Circuit	
Unit-2 - Hydraulic Circuits	***6 Hour***
Double Acting cylinders - Logic Functions. Automatic material handling system integrating sensors	
Unit-3 - Electro Pneumatic Circuits and Control of Actuators	***6 Hour***
Electro Pneumatic - Synchronization, sequencing Circuit. AC Servo Motor - open and closed loop control system. PID Controller- manual gain tuning of DC motor	
Unit-4 - Virtual Instrumentation	***6 Hour***
Process Control - Temperature, Pressure, Force, Accelerometer.	
Unit-5 - Robot and Iot for Real Time Applications	***6 Hour***
Robot - Pick and Place operation Obstacle Avoidance, Vision based Palletizing operation. IoT kit - Temperature, vibration Measurement and analysis during machining.	

Learning Resources	
	1. *Laboratory Manual* 2. *Anthony Esposito, "Fluid Power with applications", Pearson* 3. *Education Inc, 2015.* 4. *FESTO manual, "Fundamentals of Pneumatics", Vol I, II and III. JojiParambath "Industrial Hydraulic Systems: Theory and Practice", Universal Publishers, USA, 2016* 5. *Sanjay Gupta, Joseph John Virtual Instrumentation Using Lab VIEW Tata MaGraw-Hill (2005) D Patranabis, Sensors and Transducers,* 6. *S. Misra, C. Roy, and A. Mukherjee, 2020. Introduction to Industrial Internet of Things and Industry 4.0. CRC Press.*

Learning Assessment									
	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*						*Final Examination (0% weightage)*	
		CLA-1 Average of first cycle experiments (30%)		*CLA-2 Average of second cycle experiments (30%)*		*Practical Examination (40%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	-	*15%*	-	*15%*	-	*15%*	-	-
Level 2	*Understand*	-	*25%*	-	*20%*	-	*25%*	-	-
Level 3	*Apply*	-	*30%*	-	*35%*	-	*30%*	-	-
Level 4	*Analyze*	-	*30%*	-	*30%*	-	*30%*	-	-
Level 5	*Evaluate*	-	-	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100%*		-	

Course Designers		
Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. N Saravanan, Principal Engineer, Smart Implements & Machinery and Sustainability, Mahindra Research Valley.*	1. *Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	1. *Dr. R.Ambigai, SRMIST*
2. *Dr.Kulasekharan N Simulation Discipline Leader, Valeo India Pvt. Ltd.*	2. *Dr.S.Saravanaperumal, Assistant Professor, Department of Mechanical Engineering, Thiagarajar College of Engg., Madurai.*	2. *Mr.V.Manoj Kumar, SRMIST*

Course Code	21MEC301J	Course Name	HEAT AND MASS TRANSFER	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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*apply the basic laws to solve problems in steady and unsteady state conduction systems*
CLR-2:	*apply the numerical techniques to solve one dimensional heat conduction problems*
CLR-3:	*apply the convection principles in simple geometries and to design heat exchangers*
CLR-4:	*apply the laws of radiation in black and grey surfaces*
CLR-5:	*apply the laws of heat transfer for phase change and mass transfer*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*solve the steady and unsteady state heat conduction problems in simple and composite systems*	*3*	-	-	*3*	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*solve the one-dimensional heat conduction problems using numerical methods*	*3*	-	-	*3*	-	-	-	-	-	-	-	-	-	-	-
CO-3:	*compute the heat transfer coefficient under free and forced convection in various geometries and simple design of heat exchangers*	*3*	-	-	*3*	-	-	-	-	-	-	-	-	-	-	-
CO-4:	*examine the surface and gas radiation for black and grey bodies*	*3*	-	-	*3*	-	-	-	-	-	-	-	-	-	-	-
CO-5:	*compute the heat and mass transfer coefficient for phase change process and mass transfer*	*3*	-	-	*3*	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Conduction ***15 Hour***

Modes of heat transfer, General conduction equation- boundary and initial conditions, One Dimensional Steady State Heat Conduction — plane and Composite Systems, Conduction with Internal Heat Generation, Extended Surfaces, Unsteady Heat Conduction – Lumped system analysis – Semi Infinite and Infinite Solids –Use of Heisler's charts Experiment on Heat transfer through composite lagged pipe, Experiment on natural and forced convection heat transfer – from PIN-FIN Apparatus.

Unit-2 - Numerical Methods in Heat Transfer ***15 Hour***

Taylor series expansion, Finite difference equations (FDE) of 1st, and 2nd order derivatives, Truncation errors, order of accuracy, Application of FDM in Steady and unsteady one dimensional heat conduction equation Practice on one dimensional steady and unsteady state heat conduction in finned systems.

Unit-3 - Convection and Heat Exchangers ***15 Hour***

Free and Forced convection – Non dimensional numbers, Boundary layer concept, Free Convection – Flow over vertical plate, horizontal plate, cylinders and spheres, Forced convection- Internal flow, External flow Flow over flat plates, Heat Exchanger Types - Overall Heat Transfer Coefficient – Fouling Factors. LMTD and NTU methods Experiment on natural convection heat transfer - vertical tube, Experiment on forced convection heat transfer - horizontal tube, Experiment on Parallel and Counter flow Heat Exchanger and shell and tube heat exchanger, Experiment on performance test on vapour compression refrigeration test rig and air conditioning test rig

Unit-4 - Radiation ***15 Hour***

Radiation laws, Black and Gray body Radiation, Shape Factor. Electrical Analogy. Radiation Shields, Gas radiation Experiment on radiation using emissivity apparatus and Stefan Boltzmann apparatus

Unit-5 - Phase Change Heat and Mass Transfer ***15 Hour***

Nusselt's theory of condensation- Regimes of Pool boiling and Flow boiling, correlations in boiling and condensation., Fick's law of diffusion, Steady state diffusion through plane membrane, Equimolar counter diffusion, Isothermal evaporation of water vapour into air, Convective mass transfer. Experiment on dropwise and filmwise condensation

Learning Resources	1. *Sachdeva, R.C., Fundamentals of Heat and Mass Transfer, 2nd Edition, New Age International (P) Ltd., New Delhi,2017.* 2. *Nag, P.K., Heat Transfer and Mass Transfer, Tata McGraw Hill, 3rd Edition, New Delhi, 2011.* 3. *Ozisik. M. N, "Heat Transfer", McGraw-Hill Book Co., 2003.* 4. *Holman. J. P "Heat and Mass Transfer" Tata McGraw-Hill, 2008.* 5. *Yunus A. Çengel, Afshin J. Ghajar "Heat and Mass Transfer", Tata McGraw Hill Education, 2017.*	6. *Theo dore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, David P. DeWitt, "Fundamentals of Heat and Mass Transfer", John Wiley and Sons, 2016. DATA BOOKS* 7. *Ko thandaraman. C. P, Subramanyan, S, "Heat and Mass Transfer Data Book", New Age International, 7th edition, 2012.* 8. *K.K.Ramalingam "Steam Tables", SciTech Publications, 2015*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (45%)		*Life-Long Learning CLA-2 (15%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	-	*20%*	*20%*	-
Level 2	*Understand*	*20%*	-	-	*20%*	*20%*	-
Level 3	*Apply*	*30%*	-	-	*30%*	*30%*	-
Level 4	*Analyze*	*30%*	-	-	*30%*	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr.PCM. Velan, Indian Navy*	1. *Dr.Shaligram Tiwari, Professor, IIT Madras*	1. *Dr. D. Premnath, SRMIST*
2. *Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	2. *Dr. G Kumaresan, Professor, Anna university, Chennai*	2. *Dr.P. Chandrasekaran, SRMIST*

Course Code	21MEC302J	Course Name	FINITE ELEMENT METHODS	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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*find the approximate solution of boundary value problems*
CLR-2:	*develop basic finite element concepts and solution procedure for one dimensional problem*
CLR-3:	*find the finite element solution for two dimensional problems*
CLR-4:	*formulate and Solve Eigen value problems in Mechanical Engineering*
CLR-5:	*formulate and solve problems in heat transfer and Fluid dynamics using finite element method*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*find the approximate solution of boundary value problems*	-	*3*	-	*3*	*2*	-	-	-	-	-	-	-	-	-	-
CO-2:	*develop basic finite element concepts and solution procedure for one dimensional problem*	-	*3*	-	*3*	*2*	-	-	-	-	-	-	-	-	-	-
CO-3:	*find the finite element solution for two dimensional problems*	-	*3*	-	*3*	*2*	-	-	-	-	-	-	-	-	-	-
CO-4:	*formulate and Solve Eigen value problems in Mechanical Engineering*	-	*3*	-	*3*	*2*	-	-	-	-	-	-	-	-	-	-
CO-5:	*formulate and solve problems in heat transfer and Fluid dynamics using finite element method*	-	*3*	-	*3*	*2*	-	-	-	-	-	-	-	-	-	-

Unit-1 - Solution of Ordinary Differential Equations ***15 Hour***

Overview of Engineering systems: Continuous and discrete systems – Solution of governing equations by Variational principles and weighted residual techniques for one-dimensional differential equations. Finite element formulations by Rayleigh-Ritz and Galerkin's methods. Spring element-stiffness matrix, assembly procedure of global stiffness matrix, load vector- solution methods for linear algebraic equations. Gauss elimination method.

Practice:

Solution of differential equations by variational and weighted residual methods

Solution of differential equations by finite element method

Unit-2 - One Dimensional Structural Analysis ***15 Hour***

Development of bar element-Governing equation - Minimum potential energy concept-higher order bar elements- application to trusses- Beam elements- natural coordinates- formulation of element stiffness matrix and load vectors

Practice:

Solution of bar/truss/beam problems

Derivation of stiffness matrix and load vectors for higher order elements

Unit-3 - Finite Element Analysis of Two Dimensional Problems ***15 Hour***

Theory of two dimension elasticity-plane stress and strain conditions- derivation of shape function and element matrices of constant strain and linear strain triangle elements-Four node quadrilateral elements-isoparametric formulation-Lagrange and serendipity family elements-Higher order elements-Gauss quadrature for numerical integration-axi-symmetric problems

Practice: 1.Static analysis of plate with plane stress/strain conditions using triangular and quadrilateral elements

Unit-4 - Structural Dynamics	***15 Hour***
Hamilton's Principle- lumped and consistent mass matrices for bar, beam and triangular elements-formulation of Eigen value problems in solid mechanics-natural frequency and normal modes for axial vibration of bar and transverse vibrations of beams-forced vibration response-Numerical time integration (Finite Difference Method, Runge-Kutta method) *Practice:* *Determination of natural frequencies and mode shape of axial vibration of bar* *Determination of natural frequencies and mode shape of transverse vibration of beams*	
Unit-5 - Heat and Fluid Flow Problems	***15 Hour***
Basics of Heat transfer-Governing equations and boundary conditions-Derivation of conductivity, convection and capacitance matrices and thermal load vectors for one dimensional element- steady state and transient heat conduction in one dimension-One dimensional potential fluid flow problems- Introduction to finite element software packages *Practice:* *steady state heat transfer problem* *transient heat transfer problem* *Demo on Finite Element software with advanced modules such as solidification, machining, forming, additive manufacturing processes*	

Learning Resources	1. *Hutton, D.V., "Fundamentals of Finite Element Analysis", McGraw Hill, International Edition, 2004.* 2. *Belegundu, Ashok D.; Chandrupatla, Tirupathi R, "Introduction to Finite Elements in Engineering", Pearson 2012* 3. *J.N Reddy, An introduction to the Finite Element Method, 2005, Mcgraw Hill*	4. *S.S. Rao, The Finite Element method in Engineering, Elsevier Science &Technology Books, 6th edition, 2018.* 5. *K.J. Bathe, Finite Element Procedures, Prentice Hall, Pearson Education, Inc, 2nd edition, 2014* 6. *Cook R.D., Malkus, D.S., Plesha, M.E., Witt, R.J., "Concepts and Applications of Finite Element Analysis", 4th Edition, John Wiley & Sons, 2001*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (45%)		*Life-Long Learning CLA-2 (15%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*10%*	-	-	*5%*	*10%*	-
Level 2	*Understand*	*10%*	-	-	*5%*	*10%*	-
Level 3	*Apply*	*40%*	-	-	*40%*	*40%*	-
Level 4	*Analyze*	*40%*	-	-	*40%*	*40%*	-
Level 5	*Evaluate*	-	-	-	*10%*	-	-
Level 6	*Create*	-	-	-		-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. N. Babu, CVRDE, DRDO, Avadi, babu.n.cvrde@gov.in*	1. *Dr. Shankar Krishnapillai, IIT Madras, skris@iitm.ac.in*	1. *Dr.P. Nandakumar, SRMIST*
2. *Mr. Parameswaran, Nokia, Chennai, parameswaran.s@nokia.com*	2. *Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	

Course Code	21MEC303T	Course Name	INDUSTRY 4.0	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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*explore the need of industry 4.0, IOT architecture and its protocols*
CLR-2:	*interpret the big data usage and the cyber threads on Industry 4.0*
CLR-3:	*reason out the use of cloud computing and data analytics in Industry 4.0*
CLR-4:	*familiar the concepts of digital manufacturing*
CLR-5:	*learn the real time usage of IOT, cloud computing, data analytics in Industry 4.0*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*realize the need of industry 4.0 and interpret the architecture of IOT and its protocols*	*3*	-	*2*	-	*1*	-	-	-	-	-	-	-	*2*	-	-
CO-2:	*understand the use of Big Data and cyber threads on Industry 4.0*	*1*	*2*	*3*	-	-	-	-	-	-	-	-	-	*2*	-	-
CO-3:	*recognize the uses of cloud computing and data analytics*	*1*	*3*	-	-	*2*	-	-	-	-	-	-	-	-	*2*	-
CO-4:	*familiar with the techniques used in Digital manufacturing system*	*1*	-	*2*	-	-	-	-	-	-	-	-	-	*2*	-	-
CO-5:	*acquire knowledge on the use of IOT, cloud computing and Industry 4.0 technologies*	*1*	-	-	-	-	*3*	*2*	-	-	-	-	-	-	*2*	-

Unit-1 - IoT in Industrial Revolution ***9 Hour***

Introduction to Industry 4.0 - Digitalization and the networked economy - Basics of Internet of Things (IOT) and Network protocol - IOT Architecture and its standards - Industry Internet of Things (IIOT) - Need of sustainability assessment of Industries – Lean Production and Smart factory - Introduction to sensors and actuators – Next generation sensors.

Unit-2 - Bigdata and Cyber Security In Industry 4.0 ***9 Hour***

Cyber Physical Systems (CPS) – Features - Role of AI in Industry 4.0 - Need of Big Data in IIOT - Big Data analytics – Data Science in IIOT and Data centred network - Data management using Hadoop - Cyber security in Industry 4.0 - Components - Threats and Awareness - Security issues within Industry 4.0 network.

Unit-3 - Cloud Computing for IoT ***9 Hour***

Introduction to Cloud computing - Cloud computing service options - Cloud deployment models - Cloud virtualization - Types of Hypervisors - Fog computing architecture in IIOT - Cloud 9marketplace and Cloud providers - IOT Gateway, IOT Edge, and its programming

Unit-4 - Digital Manufacturing ***9 Hour***

Introduction to Digital manufacturing - Architecture of Digital manufacturing - Digital Twin technology for smart manufacturing system – Road map to success in Digital Manufacturing -Identification of current situation in Industry – Perform Self-study – attain future goal with in Digital Manufacturing and Design (DMD).model – Intelligent Machining - concept, elements and benefits.

Unit-5 - Applications and Case Studies ***9 Hour***

Application: Assembly sectors in Factories, Inventory and Quality control in Industries, Industrial security and Safety Management and Health care sectors. Case Study: Processing and packing industries and Automobile manufacturing sectors.

Learning Resources	1. *Sudip Misra, Chandana Roy, Anandarup Mukherjee, "Introduction to Industrial Internet of Things and Industry 4.0", CRC press, ISBN 9781032146751.* 2. *Hamilton Ortiz J, editor. Industry 4.0 - Current Status and Future Trends. 2020 Mar 25; Available from: http://dx.doi.org/10.5772/intechopen.86000.* 3. *Cheng FT, editor. Industry 4.1: Intelligent Manufacturing with Zero Defects. John Wiley & Sons; 2021.*	4. *Bernabe JB, Skarmeta A. introducing the challenges in cybersecurity and privacy: The european research landscape. InChallenges in Cybersecurity and Privacy-the European Research Landscape 2022. River Publishers.* 5. *Buyya R, Srirama SN, editors. Fog and edge computing: principles and paradigms. John Wiley & Sons; 2019.* 6. *Kurfess TR, Saldana C, Saleeby K, Dezfouli MP. A review of modern communication technologies for digital manufacturing processes in industry 4.0. Journal of Manufacturing Science and Engineering. 2021.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*25%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*30%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*30%*	-	*30%*	-
Level 5	*Evaluate*	-	-		-	-	-
Level 6	*Create*	-	-		-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. Muthumanikam, Jt. Director, CVRD, Avadi, Chennai*	1. *Dr, A. Suresh Babu, Associate Professor, Manufacturing, Anna University, Chennai*	1. *Dr. T. Rajasekeran, SRMIST*
2. *Mr. S. Bhargav, General Manager, operations, Rane Brakes Lining LTD, chennai.*	2. *Dr.V. Srinivasan, Associate Professor, Annamalai University, Chidamabaram*	2. *Dr. A. Arul Jeya Kumar, SRMIST*

ACADEMIC CURRICULA

UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES

(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021

Volume – 17A
(Syllabi for Mechanical Engineering Programme Courses)

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, Chengalpattu District 603203, Tamil Nadu, India

ACADEMIC CURRICULA

Professional Elective Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

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

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

Course Code	21MEE101T	Course Name	COMPUTER AIDED DESIGN - COMPUTER AIDED MANUFACTURING	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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*be familiar with the concepts of modeling in 2D and 3D*
CLR-2:	*be familiar with the Mathematical Representation of curves and surfaces*
CLR-3:	*be familiar with the concepts of Computer Graphics, Standards and RPT*
CLR-4:	*be familiar with the basics of CNC machines and manufacturing systems*
CLR-5:	*be familiar with the concepts of CAM applications in planning and control*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*familiarize the concepts of modeling in 2D and 3D*	-	*3*	-	-	*1*	-	-	-	-	-	-	-	-	*1*	-
CO-2:	*apply the concepts of Mathematical Representation of curves and surfaces*	-	*3*	-	-	*1*	-	-	-	-	-	-	-	-	*1*	-
CO-3:	*pursue the concepts of Computer Graphics, Standards and RPT*	-	*1*	-	-	*3*	-	-	-	-	-	-	-	-	*2*	-
CO-4:	*familiarize the basics of CNC machines and manufacturing systems*	-	*2*	*2*	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	*acquire knowledge of the concepts of CAM applications in planning and control*	-	*1*	-	-	*2*	-	-	-	-	-	-	-	-	*2*	-

Unit-1 - Introduction to CAD	***9 Hour***
Fundamentals of Computer-aided design, Product Life Cycle, Sequential and concurrent engineering, Coordinate Systems, 2D transformations, 3D transformations, Wireframe modeling, Surface modeling, Solid modeling - Constructive Solid Geometry and Boundary Representation, Feature Entities and Parametric Modeling	
Unit-2 - Representation of Curves and Surfaces	***9 Hour***
Mathematical representation of lines, circles, parabolas, ellipses, Hermite curves, Bezier curves, and B-spline curves. Parametric representation of the plane surface, Ruled surface, Surface of revolution, and Tabulated cylinder	
Unit-3- Graphic Concepts, Standards, and Rapid Prototyping	***9 Hour***
Hidden line removal - Visibility Techniques, Priority and Area -oriented Algorithm, Hidden surface removal algorithms, Hidden Solid removal algorithms. Cohen Sutherland Clipping Algorithm, Shading & Coloring and its types, Introduction to Data exchange standards and its types. Feature technology, Feature data models, Feature recognition, Design by feature. Integration of CAD/CAM – Reverse Engineering – Rapid Prototyping	
Unit-4 - CNC Machines, Group Technology, and FMS	***9 Hour***
Fundamentals of CNC machines, Classification, Developments, CNC principles of operation and features, Machining Centers and their types, Simple CNC Part Programming of Turning and Milling Operations - Tutorials. Introduction of CAM package. Introduction to Group technology and its types, Part families, coding and classification, Production flow analysis with the case study, Machine cell design with the numerical case study. Introduction to FMS, types, applications, and benefits, FMS: components, Layout Configurations and implementation	
Unit-5 - Production Planning and Control System	***9 Hour***
Computer Aided Assembly Planning, Computer Aided Process Planning (CAPP), Computer Aided Inspection, Materials Requirement Planning & Management Resource planning with the case study, Capacity Planning and Data collection systems, Shop floor control and monitoring systems, Inventory control and Case study JIT approach and Case study, Lean Manufacturing, Agile manufacturing, Introduction to virtual and distributed manufacturing	

Learning Resources	1. *Ibrahim Zeid, "Mastering CAD /CAM (Sie)", Tata McGraw-Hill, New Delhi, 2010* 2. *P.N. Rao, "CAD/CAM Principles and Application",3rd Edition, Tata McGraw-Hill, New Delhi, 2012* 3. *Kunwoo Lee, Principles of CAD/CAM/CAE systems, Addison Wesley, 1999*	4. *Mikell P. Groover, "Automation, Production systems and computer integrated manufacturing", Prentice Hallof India Private Ltd., New Delhi, 2008* 5. *Dr. Davidson Jebaseelan, Professor, VIT Chennai 5. Mikell P. Groover, Emory W. Zimmers Jr., "CAD/CAM: Computer Aided Design and Manufacturing", Prentice Hall of India Private Ltd., New Delhi, 2008*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*25%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*30%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*30%*	-	*30%*	-
Level 5	*Evaluate*	-	-		-	-	-
Level 6	*Create*	-	-		-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr. Vignesh Shanmugam, Manager, Hyundai Motors India Ltd*	1. *Dr. Davidson Jebaseelan, Professor, VIT Chennai*	1. *Mr. S. Balamurugan, SRMIST*
2. *Mr.Parameshwaran, Manager, Production, Nokia Solution & Networks, Orgadam, Chennai*	2. *Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	2. *Mr. V. Veeranaath, SRMIST*

Course Code	21MEE102T	Course Name	COMPOSITE MATERIALS AND CHARACTERIZATION	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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*understand the overview, constituents, classifications, and advanced applications of composites*
CLR-2:	*apply the design concept in composite materials*
CLR-3:	*understand the manufacturing techniques of various composite materials*
CLR-4:	*understand the importance of developing eco-friendly and sustainable materials*
CLR-5:	*learn the methods testing and characterization of composite materials*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*compile the constituents, classifications, and advanced applications of composites and composites mechanics*	*3*	*2*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*2*	*-*	*-*
CO-2:	*implement mechanics for designing composite materials*	*1*	*2*	*3*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*3*	*-*
CO-3:	*perform the manufacturing techniques of various composite materials*	*2*	*-*	*3*	*-*	*-*	*-*	*1*	*-*	*-*	*-*	*-*	*-*	*2*	*-*	*-*
CO-4:	*apply the concept of sustainability for designing composites*	*2*	*1*	*-*	*-*	*-*	*-*	*3*	*-*	*-*	*-*	*-*	*-*	*3*	*-*	*-*
CO-5:	*perform different characterization tools for quality inspection of composites*	*3*	*1*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*2*	*-*

Unit-1 - Overview of Composites ***9 Hour***

Introduction to composites – Definitions, Classification, Constituent materials for composite materials, Matrix materials – types and properties Reinforced materials– types and properties Fibers for advanced composites, Metal matrix, Polymer matrix, Ceramic matrix, Hybrid composites, Sandwich structures, Functionally graded materials, Characteristics of composite materials Mechanical behaviour of composite materials, Current and potential advantages of fibre-reinforced composite materials, Applications of composite materials - Military aircraft, Civil aircraft - Automotive applications, Commercial applications.

Unit-2 - Design of Composites ***9 Hour***

Rule of mixture – Voigt model – Reuss model – Upper & Lower bound moduli – Simple problems, Introduction to solid mechanics - lamina and laminates, Interlamellar stresses – Unidirectional and angle lamina and laminates, Engineering constants of lamina and laminates, Effective modulus in stress-strain relationship, Symmetry in stress-strain relationship, Orthotropic and isotropic engineering constants, Effective moduli of continuous fibre reinforced lamina with simple problems, Failure predictions in lamina and laminates.

Unit-3 - Composite Manufacturing ***9 Hour***

Glass fibre production, Carbon fibre production, Polymer matrix composites – Process parameters -Temperature-Pressure-Cure cycles, Hand lay-up, Bag Moulding, Compression moulding, Filament winding, Pultrusion, Resin transfer moulding, Tube rolling, Additive manufacturing of PMCs, Metal matrix composites – Stir casting, Infiltration, Diffusion bonding, Powder metallurgy, Spray forming, Chemical vapour deposition, In-situ composites, Ceramic matrix composites - Solid state route, Sol-gel route.

Unit-4 - Nano-, Bio- and Green Composites ***9 Hour***

Definition of nanocomposites, Classification based on topology, Constituents of nanocomposites, Core-Shell nanocomposites, Ceramic/Metal nanocomposite Systems, Nanocomposites based on polymer matrix, Carbon-carbon, Carbon-metal nanocomposites, Application of nanocomposites in Coating, Electrical & Electronics, Fuel cell, Food packaging, Energy storage, Solar cells. Definition of bio-composites – Biocompatibility, Applications as bioimplants, Green composites – Eco-friendly and Sustainability, Recyclable/Bio-degradable polymer matrix, Natural fiber reinforced composites; Plant fibres – Types, Properties, Advantages and Disadvantages of green composites.

Unit-5 - Characterization of Composites	***9 Hour***
Quality Inspection method, Defects detection, Fibre test, Neat resin matrix test, Tensile test, Compression test, In-plane shear test, Interlaminar shear test, Flexural test, Interlaminar fracture, Fibre/Matrix interface tests, Fatigue and impact tests, Environmental effects, Biodegradability, Fracture behaviour and damage tolerance, Fractographic analyses, Thermal, magnetic and electrical properties characterization, Water absorption tests, Flammability tests.	

Learning Resources	1. *P.K. Mallick, Fibre Reinforced Composites: Materials, Manufacturing and Design, Crc Press, 2007.* 2. *J.C. Halpin, PRIMER ON COMPOSITE MATERIALS, ANALYSIS, Routledge, 2017.* 3. *B.D. Agarwal & L.J. Broutman, Analysis and Performance of Fibre Composites, Wiley, 2017.* 4. *Daniel Gay, Composite Materials - Design and Applications, CRC Press, 2022.*	5. *R.P.L. Nijssen, Composite Materials an Introduction, A Vkcn publication, 1st Edition, 2019.* 6. *Autar K Kaw, Mechanics of Composite Materials, Crc Press, 2006.* 7. *Balasubramaniam, Composite Materials, John Wiley & Sons, Indian Ed., 2013.* 8. *K.K. Chawla, Composite Materials: Science and Engineering, Springer, 2019.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*30%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*30%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*20%*	-	*35%*	-	*30%*	-
Level 4	*Analyze*	*20%*	-	*30%*	-	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. Tanmay Bhattacharyya, Chief, Khopoli Project Composites, Tata Steel, Khopoli, Maharashtra*	1. *Prof. Kamal Krishna Kar, Department of Mechanical Eng, IIT Kanpur*	1. *Dr. Shubhabrata Datta, SRMIST*
2. *Dr. P. Thanikaivelan, Chief Scientist, CSIR-Central Leather Research Institute, Chennai*	2. *Dr. Debdulal Das, HoD, Metallurgy & Materials Eng, IIEST, Shibpur, Howrah 711103*	2. *Dr. Sumit Pramanik, SRMIST*

Course Code	21MEE103T	Course Name	AUTOMATION IN MANUFACTURING 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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*apply the principle of automation and various equipment and systems that are used in the industry*
CLR-2:	*recognize the use of automated systems in Manufacturing & Monitoring*
CLR-3:	*detailed study of flexible manufacturing systems*
CLR-4:	*categorize the Material handling and Data capture technologies used in the automated systems*
CLR-5:	*categorize the Material handling and Data capture technologies used in the automated systems*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*study the principle of automation and systems that are used in the industry*	-	*3*	-	-	*2*	-	-	-	-	-	-	-	*2*	-	-
CO-2:	*discuss the idea of Manufacturing & Monitoring systems utilize for automation*	-	*3*	-	-	-	-	-	-	-	-	-	-	*3*	-	-
CO-3:	*summarize the concepts and the importance of FMS in the automated systems*	-	-	*3*	-	*2*	-	-	-	-	-	-	-	*1*	-	-
CO-4:	*interpret the importance of the various Automatic material handling devices and automatic identification Methods*	-	-	*3*	-	*2*	-	-	-	-	-	-	-	*2*	-	-
CO-5:	*illustrate modern concepts for Automation in Manufacturing Systems*	-	-	*3*	-	*3*	-	-	-	-	-	-	-	-	*2*	-

Unit-1 - Introduction to Automation ***9 Hour***

Automation in Production Systems- Computerized Manufacturing Support Systems, Automation Principles and Strategies, Basic elements of an Automated Systems, Advanced automation functions, Level - Process Industries and Discrete Manufacturing Industries, Importance of automation in the manufacturing industry and its Applications – Design of an automated system - Building blocks of an automated system, working principle and examples - Fabrication or selection of various components of an automated system, Sensors used in an automated system , construction and principle of operation.

Unit-2 - Automated Manufacturing and Monitoring System ***9 Hour***

Introduction to Manufacturing Systems – Components – Classification - Single Station Manufacturing Cells - Cellular Manufacturing – Manual assembly lines - Transfer Lines - Automated Assembly Systems - Production Monitoring System-Introduction – types - process control & strategies - Linear & Circular Interpolation Program Simulation & Execution- Milling in Sinumeric Controller – Inspection – types - Automated Inspection - Quantitative Analysis of Inspection - case-studies.

Unit-3 - Flexible Manufacturing System ***9 Hour***

Introduction to FMS, Objective, need, Components and types of FMS, Applications, Benefits and limitations, planning and implementation issues, Quantitative Analysis of Flexible Manufacturing Systems, Simple example of FMS planning for Automobile plant, Different FMS software's, General structure and Requirements for FMS Software, Functional descriptions and operational overview advantages, FMS application in machining, sheet metal fabrication

Unit-4 - Industrial Robotics and Material Handling System ***9 Hour***

Introduction, Robot Anatomy and Related Attributes, Robot Control Systems, End Effectors, Sensors in Robotics, Industrial Robot Applications, Robot Programming overview, Engineering Analysis of Industrial Robots. Automated Storage Systems – types - Automated Storage/Retrieval Systems (AS/RS), Material transport system – types - Automated guided vehicles (AGVs), Automatic Identification Methods - Barcode Technology, Radio Frequency Identification (RFID), Magnetic Stripes, Optical character recognition (OCR) - case-studies.

Unit-5 - Intelligent Manufacturing Systems	***9 Hour***
Artificial Intelligence based systems, role of artificial intelligence in Industry Automation, Benefits, Applications, Evolution of process automation, Robotic Process Automation (RPA) - Challenges, benefits of RPA – RPA in supply chain, Industry 4.0 – building blocks - IoT in Manufacturing - Smart Manufacturing – Concepts, applications, benefits & challenges, Product Lifecycle Management (PLM), Case studies.	

Learning Resources	1. *Mikell P. Groover, "Automation Production systems and Computer Integrated manufacturing", Fourth edition, prentice hall of India, New Delhi, 2016.* 2. *Boltan, W., Mechatronics: electronic control systems in mechanical and electrical engineering, Longman, Singapore, 1999.* 3. *HMT Ltd. Mechatronics, Tata McGraw-Hill, New Delhi, 1988.* 4. *G. Boothroyd – "Assembly Automation and Product Design", Second Edition, Taylor & Francis, First Indian Edition – 2010* 5. *David J. Parrish, "Flexible Manufacturing", Butterworth-Heinemann, Newton, MA, USA, 1990.*	6. *Regtien, P. P. L., Sensors for mechatronics, Elesevier, USA, 2012.* 7. *Tonshoff, H.K. and I. Inasaki, Sensors in manufacturing,Wiley-VCH, 2001.* 8. *Gaonkar, R. S., Microprocessor architecture, programming,and applications with the 8085, Penram International Publishing (India), Delhi, 2000.* 9. *Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)", 1st Edition, VPT, 2014.* 10. *Russel,S., and Norvig,P., (2015), Artificial Intelligence: A Modern Approach, 3rd Edition, Prentice Hall*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*30%*	-	*30%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*30%*	-	*30%*	-
Level 5	*Evaluate*	-	-		-	-	-
Level 6	*Create*	-	-		-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr.Srinivasan Palanisamy, Principal Engineer - E&E , Mahindra & Mahindra Ltd.*	1. *Dr. N. Arunachalam, Associate Professor, IITM*	1. *Dr.S.Oliver Nesa Raj, SRMIST*
2. *Dr. N Saravanan, Mahindra Research Valley.*	2. *Dr. S. Kumaresh Babu, Professor, NIT Trichy*	2. *Dr.R. Murugasen, SRMIST*

Course Code	21MEE104T	Course Name	ENERGY ENGINEERING AND MANAGEMENT	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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*understand the impact of energy on environment*
CLR-2:	*understand the energy conservation and acts*
CLR-3:	*familiar with the concepts of energy saving in the thermal systems*
CLR-4:	*understand the energy management and auditing in industries*
CLR-5:	*get familiar with the energy economics ratios of the energy systems*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*recognize the impact of energy on environment*	-	-	-	-	-	-	*3*	-	-	-	-	-	*1*	-	-
CO-2:	*explain the energy conservations and acts*	-	-	-	-	-	-	*3*	-	-	-	-	-	*1*	-	-
CO-3:	*analyze the energy saving of the various thermal systems*	-	-	-	-	-	-	*3*	-	-	-	-	-	*3*	-	-
CO-4:	*implement of energy management and auditing in industries*	-	-	-	*1*	-	-	*3*	-	-	-	-	-	*3*	-	-
CO-5:	*assess the economics of the energy systems*	-	-	-	-	-	-	*3*	-	-	-	-	-	*1*	-	-

Unit-1 - Energy and Environment — ***9 Hour***

Introduction to Energy and Environment, Global and national energy scenario, World energy reserves, Effect of Greenhouse gases, Global warming, Renewable and non-renewable energy sources, Environmental aspects and utilization, Energy prices, World energy polices, United Nations framework convention on climate change (UNFCC), Kyoto Protocol, conference of parties (COP), clean development mechanism (CDM), prototype carbon funds, carbon credits and trading, benefits to developing countries, Sustainable development goals, MNRE, Funding schemes and policies.

Unit-2 - Energy and Environment — ***9 Hour***

Introduction, Energy conservation schemes, Energy Conservation Act 2001, Industrial energy conservation methods, Energy surveying for industries., Energy index and cost, Energy conservation in engineering and process industries, Energy conservation in Buildings, Concept of Green building

Unit-3 - Energy Savings in Thermal Systems — ***9 Hour***

Fuels and consumption, Energy savings in Boiler, Fuel economy measures in furnaces, Waste heat recovery systems, Cogeneration Systems, Energy saving in HVAC, Refrigeration, Insulated pipes and Energy Storage systems

Unit-4 - Energy Management and Auditing — ***9 Hour***

Energy management principles, Energy resource management, Elements of Monitoring and Targeting System, Energy management information system, Energy measurement in energy management, Energy Audit-Types, Methodology, Benchmarking and Energy Performance, Energy instrumentation, Matching energy usage to requirement, Maximizing system efficiency. Fuel and energy substitution, Demand side management, Simple case study of energy auditing in process industries

Unit-5 - Energy Economics — ***9 Hour***

Costing techniques in energy engineering, Cost factors, Break even analysis, Investment - appraisal and criteria, Financial analysis-Simple payback, Return on investment, Net present value, Internal rate of return, Cash flows, Risk and sensitivity analysis; Financing options, Energy performance contracts and role of energy service companies. Advances and recent trends in solar PV

Learning Resources	1. *Murphy.W.R and McKay G, "Energy Management", Butterworths, London, 2007.* 2. *Reay.D.A, "Industrial Energy Conservation", Pergamon Press, 2003.* 3. *Steve Doty, Wayne C. Turner, "Energy Management Handbook", Fairmont Press, 7th edition, 2009.* 4. *Barney L. Capehart, Wayne C. Turner, William J. Kennedy, "Guide to Energy Management", The Faimont Press, 6th edition, 2008.*	5. *Hamies, "Energy Auditing and Conservation; Methods", Measurements, Management and Case study", Hemisphere, 2003.* 6. *UmeshRathore, "Energy Management", S.K.Kataria& Sons, 2015.* 7. *Suresh Kumar Soni and Manoj Nair, "Energy Conservation and Management", SatyaPrakashan, 2017.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*25%*	-	*25%*	-	*25%*	-
Level 2	*Understand*	*25%*	-	*25%*	-	*25%*	-
Level 3	*Apply*	*25%*	-	*25%*	-	*25%*	-
Level 4	*Analyze*	*25%*	-	*25%*	-	*25%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr.R.M.Raghunathan,Assistant Vice President, Tamil Nadu Petroproducts Limited,Manali, Chennai- 600068 mlrmr@hotmail.com*	1. *Dr.P.V.Manivannan, Associate Professor, Department of Mechanical Engineering, Indian Institute of Technology Madras, Chennai-600036 pvm@iitm.ac.in*	1. *Dr.G.Balaji SRMIST*
2. *Er.M.Sakthivel, Dy.Chief Engineer, NLC Limited, Neyveli – 607801, Tamil Nadu sakthivel.m@nlcindia.in*	2. *Dr. K. R. Balasubramanian Associate Professor Department of Mechanical Engineering National Institute of Technology Tiruchirappalli - 620 015, Tamil Nadu India krbala@nitt.edu*	2. *Mr.S.Panneerselvam, SRMIST*

Course Code	21MEE105T	Course Name	SOLAR ENERGY 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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*acquire knowledge of the basics of solar radiation and its measurement*
CLR-2:	*explain the working of types of solar collectors*
CLR-3:	*design the solar thermal systems for various application*
CLR-4:	*explain the solar thermal energy storage and its application in solar cooling systems*
CLR-5:	*acquire knowledge of the solar photovoltaic technology*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*apply the knowledge of solar radiation terminology on solar radiation measurement*	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-2:	*analyse the performance of solar collector systems*	-	-	-	-	-	-	3	-	-	-	-	-	3	-	-
CO-3:	*analyse and design the solar thermal energy systems*	-	2	-	-	-	-	3	-	-	-	-	-	3	-	-
CO-4:	*evaluate the performance solar thermal energy storage for solar cooling systems*	-	-	-	-	-	-	3	-	-	-	-	-	3	-	-
CO-5:	*analyse the solar photovoltaic energy conversion systems*	-	-	-	-	-	-	3	-	-	-	-	-	3	-	-

Unit-1 - Fundamentals of Solar Radiation and its Measurements	***9 Hour***
The sun and the earth, electromagnetic spectrum- Laws of thermal radiation- Solar radiation: beam and diffuse radiations- Sun and earth geometry- Solar angles- Sunrise, sunset and day length- Solar radiation on tilted surfaces - Measurement of solar radiation: pyranometer, pyrheliometer, sunshine recorder, Along with practical case studies of solar radiation measurement using pyranometer- Analysis of the solar radiation data	
Unit-2 - Solar Collectors	***9 Hour***
Classification of solar collectors - flat plate, evacuated tube – Relative merits and demerits - Solar concentrators - receiver geometries, concentration ratio, Compound parabolic concentrators - parabolic concentrators: trough systems, dish systems- Solar central receiver system- Compound parabolic concentrators, Fresnel lens concentrator- Real time case studies in Parabolic Concentrator cooking plant	
Unit-3 - Design of Solar Thermal Systems	***9 Hour***
Design of solar flat plate collector, solar active systems using f- chart method, solar cooker, air heater, and dryer- Solar desalination - types, and operation - Solar Pond- types and applications, Solar thermal power plants, solar furnace – Review of parabolic concentrator receivers - design	
Unit-4 - Solar Thermal Energy Storage and Solar Cooling	***9 Hour***
Need for solar thermal energy storage - Sensible and latent heat storage, advantages, and disadvantages - Stratified thermal energy storage - PCM based solar thermal energy storage - Selection of latent heat storage materials - Solar cooling systems and its advantages, solar assisted - vapour compression refrigeration - vapour absorption cooling systems, thermoelectric cooling systems- Ministry of New and Renewable Energy (MNRE), National renewable energy laboratory (NREL) annual reports on recent advancement techniques and funding details	
Unit-5 - Solar Photovoltaic Energy Conversion	***9 Hour***
Photovoltaic effect, advantages and disadvantages of solar photovoltaic technology and classification, Semiconductors, p-n junction, photo generation of charge carriers - I-V characteristics of solar cell - Losses in solar cells and solar module - Maximum power point tracking in solar photovoltaic system - Photovoltaic modules in series and parallel - Concentrated photovoltaic cells, multi junction solar cells, Temperature dependent performance parameters - Grid connected and standalone photovoltaic system- Case studies from PV power plant	

Learning Resources	1. *Duffie. J. A & Beckman. W.A, "Solar Engineering of Thermal Processes", 3ro Edition, John Wiley & Sons, Inc.,2006* 2. *Sukhatme, Suhas P. Sukhatme, "Solar energy: Principles of thermal collection and storage", Tata McGraw Hill publishing Co. Ltd, 8th Edition, 2011.* 3. *Green MA. Solar cells: operating principles, technology, and system applications. Englewood Cliffs, NJ, Prentice-Hall, Inc., 2009.* 4. *Garg. H.P, Prakash. J, "Solar energy fundamentals and applications", Tata McGraw Hill publishing Co. Ltd, 2006.*	5. *Yogi Goswami, Frank Kreith, Jan F. Kreider, "Principle of solar engineering", Taylor and Francis, 2nd Edition, 2000.* 6. *Chetan Singh Solanki, "Solar Photovoltaic technology and systems: A manual for Technicians, Trainers and Engineers", PHI Learning private limited, 2013.* 7. *G. N. Tiwari and M. K. Ghosal, "Renewable Energy Applications", Narosa Publications, 2004.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*30%*	-	*30%*	-	*30%*	-
Level 3	*Apply*	*30%*	-	*30%*	-	*30%*	-
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	-
Level 5	*Evaluate*	-	-		-	-	-
Level 6	*Create*	-	-		-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr. Babu P, Head of Innovation at Thermax Limited, Chennai, Tamil Nadu, India*	1. *Dr. G. Kumaresan, Professor, Anna university, Chennai*	1. *Mr. M. Sivashankar, SRMIST*
2. *Mr. Daniel Gnanaselvam , Chief Executive Officer at Brighter Green Universal Engineering, Bengaluru, Karnataka, India*	2. *Dr. Chitti Babu, Professor, IIITDM, Kancheepuram*	2. *Dr. R. Senthil, SRMIST*

Course Code	21MEE201T	Course Name	FOUNDATION SKILLS IN INTEGRATED PRODUCT DEVELOPMENT	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	Mechanical Engineering	Data Book / Codes / Standards		Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	apply fundamentals of Product Development
CLR-2:	incorporate the requirement Engineering and System Design of any product
CLR-3:	develop the Conceptual design
CLR-4:	organize the documentation details of the product
CLR-5:	implement the maintenance, PLM and IPR for the Business Dynamics

Course Outcomes (CO):	At the end of this course, learners will be able to:	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	apply the concepts of product development	-	-	3	1	-	-	-	-	-	-	-	-	2	-	-
CO-2:	incorporate the Requirement engineering, System Design with QFD	-	-	3	1	-	-	-	-	-	-	-	-	2	-	-
CO-3:	implement the conceptual design to develop the prototype	-	-	3	1	-	-	-	-	-	-	-	-	2	-	-
CO-4:	develop the Product verification process and its documentation	-	-	3	1	-	-	-	-	-	-	-	-	2	-	-
CO-5:	implement the Business Dynamics	-	-	3	1	-	-	-	-	-	-	-	-	2	-	-

Unit-1 - Fundamentals of Product Development ***9 Hour***

Types of various trends affecting product decision - Social Trends (Demographic, Behavioral, Psychographic), Technical Trends (Technology, Applications, Tools, Methods), Economical Trends (Market, Economy, GDP, Income Levels, Spending Pattern, target cost, TCO), Environmental Trends (Environmental Regulations and Compliance), Political/Policy Trends (Regulations, Political Scenario, IP Trends and Company Policies); PESTLE Analysis. Overview of Products and Services (Consumer product, Industrial product, Specialty products etc); Types of Product Development (NPD/ Re-Engineering (Enhancements, Cost Improvements)/ Reverse Engineering/ Design Porting & Homologation); Overview of Product Development methodologies (Over the Wall/ Waterfall/ V-Model/ Stage-Gate Process/ Spiral/Systems Engineering/ Agile); Product Life Cycle (S- Curve, Reverse Bathtub Curve); Product Development Planning and Management (Budgeting, Risk, Resources and Design Collaboration, Scheduling, Change Management, Product Cost Management

Unit-2 - Requirements and System Design ***9 Hour***

Types of Requirements (Functional, Performance, Physical, Regulatory, Economical, Behavioral, Technical, Stakeholder, Environmental, Industry specific, Internal-Company Specific); Requirement Engineering (Gathering (VOC), Analysis (QFD), Design Specification); Traceability Matrix and Analysis; Requirement Management .System Design & Modeling: Introduction to System Modeling; System Optimization; System Specification; Sub-System Design; Interface Design.

Unit-3 - Design and Testing ***9 Hour***

Industrial Design and User Interface Design; Introduction to Concept generation Techniques; Concept Screening & Evaluation - Concept Design, S/W Architecture, Hardware Schematics and simulation. Component Design and Verification; High Level Design/Low Level Design of S/W Programs, S/W Testing; Hardware Schematic, Component design, Layout and Hardware Testing. Prototyping: Types of Prototypes (Mockups, Engineering Assessment Prototype, Alpha, Beta, Gama); Introduction to Rapid Prototyping and Rapid Manufacturing

Unit-4 - System Integration, Testing, Certification and Documentation	***9 Hour***
Manufacturing/Purchase and Assembly of Systems; Integration of Mechanical, Embedded and S/W systems; Introduction to Product verification processes and stages – Industry specific (DFMEA, FEA, CFD); Introduction to Product validation processes and stages - Industry specific (Sub-system Testing/ Integration Testing/ Functional Testing/ Performance Testing / Compliance Testing); Product Testing standards and Certification – Industry specific; Product Documentation (Compliance Documentation, Catalogue, Brochures, user manual, maintenance Manual, Spares Parts List, Warranty, Disposal Guide, IETMS, Web Tools).	
Unit-5 - Sustenance Engineering, End-of-Life (EoL) Support and Business Dynamics	***9 Hour***
Maintenance and Repair; Enhancements. Product EoL: Obsolescence Management; Configuration Management; EoL Disposal Engineering Services Industry – overview; Product development in Industry versus Academia. The IPD Essentials: Introduction to vertical specific product development processes; Product development Trade-offs; Intellectual Property Rights and Confidentiality; Security and configuration management	

Learning Resources	1. *Foundation Skills in Integrated Product Development (FSIPD),Ist Edition,2013, Published by NASSCOM.* 2. *Ulrich, Karl T. and Eppinger, Steven D (2004) Product Design and Development, 5th Edition, McGraw-Hill, 2012*	3. *Kevin N. Otto, "product design – techniques in reverse engineering and new product development", PEARSON, New Delhi, 2011.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*60%*	-	*60%*	-	*60%*	-
Level 4	*Analyze*	-	-	-	-	-	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. N. Babu, CVRDE, DRDO, Avadi, babu.n.cvrde@gov.in*	1. *Dr. Shankar Krishnapillai, IITMadras, skris@iitm.ac.in*	1. *Dr.E.Vijayaragavan, SRM IST*
2. *Mr. Parameswaran, Nokia, Chennai, parameswaran.s@nokia.com*	2. *Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	2. *Mr.N.Arun, SRM IST*

Course Code	21MEE202T	Course Name	MECHANICAL VIBRATIONS	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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*formulate the Governing differential equation for single DOF and Multi DOF problems*
CLR-2:	*solve the Governing differential equation for single DOF and Multi DOF problems*
CLR-3:	*identify the numerical method to solve vibration problems and solution procedure for multi DOF problems*
CLR-4:	*formulate the stiffness and mass matrices for various types of vibration problems*
CLR-5:	*monitor the condition of mechanical systems using vibration measurement techniques*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*analyze the free and forced vibration problems of single DOF systems*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	*3*	-
CO-2:	*analyze the free vibration problems of two and multi DOF systems*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	*3*	-
CO-3:	*determine the natural frequency and mode shape of multiple DOF system using numerical methods*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	*3*	-
CO-4:	*determine the natural frequencies and mode shape using continuous system principle*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	*3*	-
CO-5:	*identify the vibration measuring devices and apply condition monitoring techniques*	*3*	*2*	-	-	-	-	-	-	-	-	-	-	-	*3*	-

Unit-1 - Single DOF Systems	***9 Hour***
Free Vibration: Equation of motion for free undamped and damped vibration - Logarithmic decrement. Forced vibration of system subject to harmonic force - unbalance due to rotating and reciprocating mass - Base excitation - Vibration isolation and transmissibility; Whirling of shaft:	
Unit-2 - Two and Multiple DOF Systems	***9 Hour***
Equation of motion for free undamped systems-Newton's method- Lagrangian energy method- Coordinate coupling-natural frequencies and normal modes-tuned vibration absorber-Torsional vibration for single rotor, two rotor and three rotor systems, Geared systems	
Unit-3 – Multiple DOF System	***9 Hour***
Influence coefficients-Stiffness and flexibility influence coefficients- formulation of Eigenvalue problem, natural frequencies and normal modes- orthogonal Properties of Eigen vectors - Dunkerlay's method - Rayleigh's Method - Holzer's method for coupled and uncoupled systems -Matrix iteration method-Forced vibration response using Finite Difference method and Runge-Kutta method	
Unit-4 - Continuous Systems	***9 Hour***
Longitudinal vibration in rod - Transverse vibration in string- Torsional vibration in shaft-Lateral vibration in Beams-Vibrations in membrane	
Unit-5 - Vibration Measurement	***9 Hour***
Transducers- Vibration pick-ups; Piezo-electric sensors, Frequency Measurement-Vibration Exciters-Experimental modal analysis; Condition monitoring Techniques-spectrum analysis; Single plane and two plane Balancing of machines	

Learning Resources	1. *Rao.S.S, "Mechanical Vibrations", Global Edition, Pearson Education Inc. 2018.* 2. *Thomson.W.T, "Theory of Vibration and its Applications", 5th Edition, Prentice Hall, New Delhi, 2001.*	3. *Meirovitch, L., "Fundamentals of Vibrations", Mc Graw – Hill Book Co., New York, 2001.* 4. *Rao.J.S and Gupta.K, "Introductory course on theory and practice of mechanical vibrations", 2nd Edition,New Age International, New Delhi, 2014.* 5. *S. Graham Kelly, "Mechanical Vibrations: Theory and Applications", Cengage Learning, 2012*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	*-*	*10%*	*-*	*15%*	*-*
Level 2	*Understand*	*25%*	*-*	*30%*	*-*	*25%*	*-*
Level 3	*Apply*	*30%*	*-*	*30%*	*-*	*30%*	*-*
Level 4	*Analyze*	*30%*	*-*	*30%*	*-*	*30%*	*-*
Level 5	*Evaluate*	*-*	*-*	*-*	*-*	*-*	*-*
Level 6	*Create*	*-*	*-*	*-*	*-*	*-*	*-*
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. N. Babu, CVRDE, DRDO, Avadi, babu.n.cvrde@gov.in*	1. *Dr. Shankar Krishnapillai, IITMadras, skris@iitm.ac.in*	1. *Dr. P.V. Jeyakarthikeyan, SRMIST*
2. *Mr. Parameswaran, Nokia, Chennai, parameswaran.s@nokia.com*	2. *Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	2. *Mr. KR. Arun Prasad, SRMIST*

Course Code	21MEE203T	Course Name	INDUSTRIAL TRIBOLOGY	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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*be familiar with surfaces and types of friction*
CLR-2:	*identify the various wear mechanisms and their consequences on system*
CLR-3:	*formulate and analyze the thin film developed using lubricants, types of lubricants and methods of lubrication*
CLR-4:	*be familiar with surface engineering and its applications*
CLR-5:	*be familiar with surface coating and its application*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*analyze the various engineering surface and friction generation*	*1*	*3*	-	-	-	-	*2*	-	-	-	-	-	*2*	-	-
CO-2:	*develop the knowledge of wear and its consequences on industrial systems*	*1*	*3*	-	-	-	-	*2*	-	-	-	-	-	*2*	-	-
CO-3:	*develop the knowledge of lubricants, types, and methods of lubrication on industrial systems*	*1*	*3*	-	-	-	-	*2*	-	-	-	-	-	*3*	-	-
CO-4:	*analyze various surface conditions and provide new ideas of surface protection techniques*	*1*	*3*	-	-	-	-	*2*	-	-	-	-	-	-	*2*	-
CO-5:	*apply the knowledge of various surface coating methods and its consequences on industrial systems*	*1*	*3*	-	-	-	-	*2*	-	-	-	-	-	-	*2*	-

Unit-1 - Surfaces and Friction ***9 Hour***

Introduction to the concept of tribology, Nature of engineering surfaces, Surface topography: Surface profilometer, measurement of surface topography; importance of roughness parameters, Friction and its Laws, Types of friction, Sources of sliding and rolling friction, Friction characteristics of metals and non-metals, Friction due to ploughing, Friction due to adhesion, stick-slip motion, contact between surfaces, Hertzian contact theory, Junction growth theory, Relationship between adhesion, friction and interfacial fracture, Surface tension, surface energy, capillary effect

Unit-2 - Wear ***9 Hour***

Introduction and background of Wear, Types of Wear: Adhesive wear, Abrasive wear, surface fatigue, corrosive wear, erosive wear and fretting wear, wear on polymer, metal and ceramic, measurement of wear, methods to reduce the wear

Unit-3 - Lubricants and Lubrication ***9 Hour***

Lubricants and its types, Lubricant properties, Introduction to Viscosity and its importance in lubrication, Stribeck curve and its significance, Lubrication Regimes and its application, Importance of film thickness and lambda ratio, Reynold equation, Bio-lubricant: Development and applications, Nano-lubricant: Development and applications

Unit-4 - Surface Engineering ***9 Hour***

Introduction of surface engineering, methods of surface engineering, Surface engineering through removal of materials: grinding, buffing, lapping, etching, surface texturing, Surface engineering through material addition: Hardening, Electrodeposition, Surface engineering through energy beams: Laser cladding, Ion beam, Surface engineering through spray techniques: Thermal and plasma spray, cold spray, HVOF, HVAF, Application of surface engineering in industrial systems

Unit-5 - Surface Coating ***9 Hour***

Introduction of surface coating, Methods of thin film coating: PVD, CVD, Electroplating, Spin coater, spray coating, Surface Coating by Wetting, diffusion coating, measurement of coating thickness, characterizations of surface coatings, Applications of surface coating in industrial systems

Learning Resources	1. *Hirani H, Fundamentals of Engineering Tribology with Applications, 1st edition, Cambridge University Press, 2016* 2. *Katiyar JK, Sahu RK. And Gupta TCSM, Sustainable Lubrication, 1st Edition, CRC Press USA, 2022.* 3. *Dwivedi DK, Surface Engineering: Enhancing Life of Tribological Components, 1st Edition, Springer Nature, 2018*	4. *Hutchings.I.M and Shipway P, "Tribology, Friction and Wear of Engineering Material, Elsevier Butterworth –Heinemann, UK, 2017.* 5. *Bharat Bhushan, "Introduction to tribology", Wiley Publication, 2013.* 6. *Katiyar JK, Ramkumar P, Rao TVVLN, and Devim JP, Tribology of Materials and Applications, 1st Edition, Springer Nature, 2020*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	*-*	*15%*	*-*	*15%*	*-*
Level 2	*Understand*	*20%*	*-*	*25%*	*-*	*25%*	*-*
Level 3	*Apply*	*40%*	*-*	*40%*	*-*	*40%*	*-*
Level 4	*Analyze*	*20%*	*-*	*20%*	*-*	*20%*	*-*
Level 5	*Evaluate*	*-*	*-*		*-*	*-*	*-*
Level 6	*Create*	*-*	*-*		*-*	*-*	*-*
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. N. Babu, CVRDE, DRDO, Avadi, babu.n.cvrde@gov.in*	1. *Dr. Shankar Krishnapillai, IITMadras, skris@iitm.ac.in*	1. *Jitendra Kumar Katiyar, SRMIST*
2. *Mr. Parameswaran, Nokia, Chennai, parameswaran.s@nokia.com*	2. *Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	

Course Code	21MEE204T	Course Name	DESIGN FOR MANUFACTURING AND ASSEMBLY	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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*study how a design can be made suitable for various manufacturing and assembly process requirements*
CLR-2:	*application of this study to various manufacturing processes*
CLR-3:	*study about the various assembly methods and processes*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*identify the needs of the customer and convert them into technical specifications for the products*	*2*	*1*	-	-	-	-	-	-	-	-	-	-	-	*2*	-
CO-2:	*design various manufacturing processes*	*2*	-	*1*	-	-	-	-	-	-	-	-	-	-	*3*	-
CO-3:	*apply the principles of design for manufacture in assembly process*	*2*	-	*1*	-	-	-	-	-	-	-	-	-	-	*3*	-

Unit-1 - DFMA: Introduction	***9 Hour***
Introduction to DFMA: History of DFMA, Steps for applying DFMA during product design, Advantages of applying DFMA during product design, Reasons for not implementing DFMA, Significance of design, Systematic working plan, The engineering problem to be solved, The basic design, Factors influencing choice of materials, The factors influencing manufacturing, Process Capability, Tolerances relevant to manufacturing, Assembly- Material condition, Tolerance stack- effects on assembly- Examples, Methods of eliminating tolerance stack- Examples	
Unit-2 - Design for Manufacturing Process	***9 Hour***
Influence of loading, Materials, Production methods on form design, Casting Considerations- Requirements and rules for casting, Form design of pressure die castings, Redesign of components for casting, Design for cleaning, Design for polishing and plating , Design for plated surface, Thermal sprayed coating., Welding Considerations-Welding Processes, Requirements and rules for welding, Redesign of components for welding, Metal Extrusion, Metal stamping , Fine blanked parts, Rolled formed sections.	
Unit-3 - Form Design for Forging and Machining	***9 Hour***
Forging Considerations, Hammer forging, Drop forging, Requirements and rules for forging, Redesign of components for forging, Choice between casting, forging and welding. Machining Considerations , Requirements and rules for Machining Considerations-Reduction of machined areas, Redesign of components for Machining, Simplification by separation-Simplification by Amalgamation, Case studies- forging and Machining	
Unit-4 - Design for Assembly Processes	***9 Hour***
DFA Introduction, Distinction between assembly methods and processes, Factors Determining assembly methods and processes, Product Design factors independent of methods and processes, Design factors dependent on Assembly methods, Design factors dependent on Assembly processes, Factors Influencing Production rate to Facility Ratio, Gripping.	
Unit-5 - Design for Assembly Methods	***9 Hour***
Approaches to design for assembly Introduction, Approaches based on design principles and rules, Example DFA method using Design Principles, DFA Systems employing Quantitative evaluation procedures, IPA Stuttgart Method, DFA Methods employing a Knowledge based approach, Boothroyd and Dewhurst DFA method Objectives of the method, Software design for assembly	

Learning Resources	1. *Harry Peck., Design for Manufacture, Pittman Publications, 1983.* 2. *Robert Matousek, Engineering Design-A Systematic Approach, Blackie &sons Ltd., 1963.* 3. *Measuring Process Capability: Techniques and Calculations for Quality and Manufacturing Engineers McGraw-Hill Education 1997*	4. *Alan Redford and chal, Design for Assembly-Principles and Procedures, McGraw Hill International Europe, London, 1994* 5. *Geoffrey Boothroyd, Peter Dewhurst and Winston Knight (2010) Product Design for Manufacture and Assembly, Second Edition, CRC press, Taylor & Francis, Florida, USA*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*25%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*30%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*30%*	-	*30%*	-
Level 5	*Evaluate*	-	-		-	-	-
Level 6	*Create*	-	-		-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. N. Babu, CVRDE, DRDO, Avadi, babu.n.cvrde@gov.in*	1. *Dr. Shankar Krishnapillai, IITMadras, skris@iitm.ac.in*	1. *Dr.P.Susai Manickam, SRMIST*
2. *Mr. Parameswaran, Nokia, Chennai, parameswaran.s@nokia.com*	2. *Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	

Course Code	21MEE205T	Course Name	ELECTRIC VEHICLE TECHNOLOGY	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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*impart Knowledge about the various components in an EV*
CLR-2:	*learn about the various parameters that influence the performance of vehicles*
CLR-3:	*gain knowledge on various energy storage system for EVs*
CLR-4:	*have an insight on government policies and standards pertaining to EV*
CLR-5:	*develop a road map to sustainable future – Road map*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*define the concept of topology and vehicle integration*	*2*	-	-	-	-	-	*2*	-	-	-	-	-	*2*	-	-
CO-2:	*analyze the performance characteristics of Electric vehicle*	*2*	-	-	-	-	-	*2*	-	-	-	-	-	*3*	-	-
CO-3:	*apply the Energy requirement based on GVW and to identify the Battery Sizing*	*2*	-	-	-	-	-	*2*	-	-	-	-	-	*3*	-	-
CO-4:	*apply EV regulations, standards and testing*	*2*	-	-	-	-	-	*2*	*3*	-	-	-	-	*3*	-	-
CO-5:	*incorporate homologation requirements*	*2*	-	-	-	-	-	*2*	*3*	-	-	-	-	*2*	-	-

Unit-1 - Introduction	***9 Hour***
History and development of electric Vehicles- Need of EV-types of EV - Components of an EV, chassis design considerations of a conventional vehicle and electric vehicle, EV Power train – Components, Steering systems, Regenerative braking and Suspension systems	
Unit-2 - Vehicle Mechanics	***9 Hour***
Basic terminology in vehicle dynamics-Rolling resistance, tractive effort, aerodynamic drag, hill climbing force, Vehicle Acceleration – Performance parameters, power requirement-Force -velocity characteristics, wheel balancing, wheel alignment	
Unit-3 - Energy Sources	***9 Hour***
Batteries-principle-construction-working, Battery Characteristics, Open Circuit Voltage (OCV), Battery efficiency, Battery Rating Energy requirement based on gross vehicle weight (GVW) rating, Investigation on Pros and Cons of Lead-Acid, Lithium-Ion, Nickel Metal Hydride (NiMH) batteries for E-mobility, Fuel cells – Construction and working, Solar cells, Fundamentals and controls of Battery Management System (BMS)	
Unit-4 - Regulations, Standards and Testing	***9 Hour***
Introduction of Regulatory framework from policy decisions, understanding of testing agencies and test facilities in India, Scheme for Faster Adoption and manufacturing of electric and hybrid vehicles (FAME), IS Standards, ARAI standards, ISO / IEC Standards for Motors design, Testing, Bharat DC-001 or Bharat AC-001 standards	
Unit-5 - Homologation	***9 Hour***
Fundamentals, FAME requirements, Power, Torque, Gradient & Energy consumptions, Comprehensive Vehicle homologation protocols, Retro fitment EV Homologation procedures, Standards and testing related to EV Homologation as per AIS 131, Introduction to EMI/EMC Testing as per AIS 004, ISO26262 of power electronics, Case studies	

Learning Resources	1. *James Larminie and John Lowry "Electric Vehicle Technology Explained" Second Edition Wiley Publication – 2012* 2. *Rajesh Rajamani "Vehicle dynamics and control" Springer - 2006* 3. *Advances in Battery Technologies for Electric Vehicles, 1st Edition, Editors: Bruno ScrosatiJurgenGarche Werner Tillmetz, Hardcover ISBN: 9781782423775, e-Book ISBN: 9781782423980, Imprint: Woodhead Publishing, Published Date: 21st May 2015.*	4. *Linden's Handbook of Batteries, Fifth Edition 5th Edition, by Kirby W. Beard (Author), ISBN-13: 978-1260115925, ISBN-10: 1260115925.* 5. *https://corporate.cyrilamarchandblogs.com/2019/03/electric-vehicles-disrupting-the-automotive-ecosystem-part-1/* 6. *Electric rod vehicles – ICS 43 [https//iso.org/ics/43.120/]*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*20%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*25%*	-	*30%*	-
Level 5	*Evaluate*	-	-	*10%*	-	-	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. N. Babu, CVRDE, DRDO, Avadi, babu.n.cvrde@gov.in*	1. *Dr. Shankar Krishnapillai, IITMadras, skris@iitm.ac.in*	1. *Dr. P. Nandakumar, SRMIST*
2. *Mr. Parameswaran, Nokia, Chennai, parameswaran.s@nokia.com*	2. *Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	2. *Dr. E. Vijayaragavan, SRMIST*

Course Code	21MEE206T	Course Name	BIOMECHANICS	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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*understand concept of anatomical structure of the human body*
CLR-2:	*understand the mechanics of joints in human body*
CLR-3:	*understand the mechanics of soft tissues- skeletal muscle*
CLR-4:	*analyse the concept mechanical testing in biomechanics*
CLR-5:	*analyse ergonomics in biomechanics problems*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*express the anatomical structures and movement of human body*	*3*	-	-	-	-	-	-	-	-	-	-	*2*	*2*	-	-
CO-2:	*define the reference positions, planes, and axes associated with the human body*	*3*	-	-	-	-	-	-	-	-	-	-	*2*	*2*	-	-
CO-3:	*define the Musculoskeletal tissue mechanisms*	*3*	-	-	-	-	-	-	-	-	-	-	*2*	*2*	-	-
CO-4:	*apply various testing methods of body components*	*3*	-	-	-	-	-	-	-	-	-	-	*2*	*2*	-	-
CO-5:	*apply biomechanics in ergonomics to real-time problems*	*1*	-	-	-	-		*2*	-	-	-	-	*2*	*3*	-	-

Unit-1 - Introduction	***9 Hour***
Biomechanics: definition and perspective- kinetics and kinematics- Quantitative and qualitative problems- Structure and movements of human body	
Unit-2 - Anatomical Standards and Plane Reference	***9 Hour***
Anatomical terms and terminology, reference position and reference planes and axes. Joint Torques - Levers - Bone behavior under various loads- the properties of Maxwell& Voight Models of bone -Location of Center of Gravity of human body- Gait analysis. Properties of Bone,	
Unit-3 - Musculoskeletal Tissue Mechanism	***9 Hour***
Musculoskeletal Soft Tissue Mechanics- Structure of Soft Tissue Cartilage, Tendon and Ligament, Muscle. Mechanical properties of tendons and ligaments- muscles- study of stress and strain, stress - strain curve for tendons and ligaments- Joint Architecture- Synovial joint and loads in joints- Behavioral properties of the Musculotendinous unit - Factors affecting muscular - Force generation- Mechanical characteristics of muscle force –velocity–length and time relationships	
Unit-4 - Mechanical Testing of Body Components	***9 Hour***
Experimental testing in Biomechanics - testing instruments- challenges in testing, repeatability, reproducibility, reliability of results - Pit falls of biomechanical testing- Computational methods in biomechanics- Loading and results in computational studies - Measuring Tools for body angles, kinematic quantities video and film- Other movement-monitoring systems- Stride and Temporal Parameters, Motion Measurement, Ground Reaction Measurement Dynamic Electromyography (EMG)	
Unit-5 - Ergonomics Design	***9 Hour***
Biomechanics in Ergonomics design with case studies on design of ladder - stair climbing and walking on ramps- Orthotics and prosthetics devices- introduction of Dental Biomechanics and Sports Biomechanics	

Learning Resources	1. Susan .J. Hall, —Basic biomechanics", Tata Mcgraw Hill, Sixth edition, 2011 2. D. J. Schneck and J. D. Bronzino, —Biomechanics- Principles and Applications", CRC Press, Second Edition, 2000	3. Y. C. Fung, Biomechanics - Circulation Springer Verlang, 2nd Edition, 1997.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. N. Babu, CVRDE, DRDO, Avadi, babu.n.cvrde@gov.in	1. Dr. Amit Roy Chowdhury, amit@aero.iiests.ac.in, IISER Shibpur	1. Dr. S. Karuppudaiyan, SRM IST
2. Mr. Parameswaran, Nokia, Chennai, parameswaran.s@nokia.com	2. Dr. Shankar Krishnapillai, IITMadras, skris@iitm.ac.in	2. Dr. Sandipan Roy, SRM IST

Course Code	21MEE207T	Course Name	OPERATIONS RESEARCH	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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*discuss the necessity, scope, applications of operations research in industries*
CLR-2:	*outline various resource management techniques and their applications in industries*
CLR-3:	*construct real life problems into modeling and solving for decision making*
CLR-4:	*apply cost effective techniques for cost and time reduction of the projects with reduced resources*
CLR-5:	*recommend suitable decisions under competitive and uncertain environments*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*create the linear programming model and apply various techniques to optimize the objective function within the given constraints*	-	*1*	*3*	-	*1*	-	-	-	-	-	-	-	-	*3*	-
CO-2:	*solve transportation and assignment models for cost effective solutions*	-	*1*	-	-	*1*	-	-	-	-	-	*3*	-	-	*3*	-
CO-3:	*identify suitable job sequencing for reducing idle time of resources, and to identify ideal time of replacement of individual, group items for saving investment*	-	*1*	-	-	*1*	-	-	-	-	-	*3*	-	-	*3*	-
CO-4:	*evaluate decision variables of queuing and inventory models for ensuring prompt service with limited resources*	-	*1*	-	-	*1*	-	-	-	-	-	*3*	-	-	*3*	-
CO-5:	*construct the project network for cost and time effective project completion with limited resources, and to apply various techniques to determine best strategies under competitive and uncertain environments*	-	*1*	-	-	*1*	-	-	-	-	-	*3*	-	-	*3*	-

Unit-1 - Linear Programming Model	***9 Hour***
Necessity of OR in industry – Concept and formulation of LP models for the real life and industrial problems – Graphical method – Simplex method – Big M method. Solving tutorial problems using software.	
Unit-2 - Transportation and Assignment Models	***9 Hour***
Transportation model – basic feasible solution using Least Cost, VAM – Optimality test using U-V method-Assignment model – Minimization and Maximization problems Solving tutorial problems using software.	
Unit-3 - Sequencing and Replacement Models	***9 Hour***
Sequencing model – Processing of 'n' jobs on 2 & 3 machines. Replacement models – items that deteriorate with time – items that fail completely – individual and group replacement policy. Solving tutorial problems using software.	
Unit-4 - Queuing and Inventory Models	***9 Hour***
Queuing theory - Poisson arrival and exponential service times – single server with limited, unlimited number of arrivals allowed. Inventory models – Purchase and Manufacturing deterministic models without shortages allowed Solving tutorial problems using software.	
Unit-5 - Project Network Model and Game Theory	***9 Hour***
PERT & CPM techniques – Project completion time – CPM cost model. Game theory- 2 persons zero sum games. Pure and mixed strategies. Method of dominance – Matrix oddment method for n x n matrix - Solving tutorial problems using software.	

Learning Resources	1. *Hamdy A Taha, Operations Research : An Introduction, 10th edition, Prentice Hall of India, New Delhi, 2017* 2. *Gupta, P.K. and Hira, D.S, Operations Research, 3rd Edition, S.Chand and Company Ltd., New Delhi, 2015* 3. *Panneerselvam R, Operations Research, Prentice Hall of India, 2nd edition, New Delhi, 2016*	4. *Duraivelu K and Balasubramanian M, Operations Research, 2nd Edition, DeaR Publications, 2022* 5. *Sundaresan V, Ganapathy Subramanian and Ganesan K, Operations Research, 4th Edition, A.R.Publicattions, 2006.* 6. *Software for solving tutorial problems : TORA Software:www.mediafire.com/file/t48w3vjo6os9pxp/ToraSystem7th.zip/file*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	*Remember*	*20%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*25%*	-	*30%*	-
Level 5	*Evaluate*	-	-	*10%*	-	-	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Mr. A. Muguntharajan, Vice President, OBTim Consulting Services, Bangalore*	1. *Dr. M. Raj Mohan, Professor, Dept of Industrial Engineering, CEG campus, Anna University, Chennai*	1. *Dr. K. Duraivelu, SRMIST*
2. *Dr. D. Arivudainambi, Secretary, Operations Research Society of India,*	2. *Dr. Usha Mohan, Professor, Dept of Management Studies, IIT-Madras, Chennai*	2. *Mr. S. Sundar, SRMIST*

Course Code	21MEE208T	Course Name	SOFT COMPUTING TECHNIQUES AND APPLICATIONS IN MECHANICAL ENGINEERING	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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*be familiar with basic concept of soft computing techniques*
CLR-2:	*apply the fuzzy logic applications in Robotics and composites*
CLR-3:	*well-acquainted with the Genetic algorithm and its hybrid applications*
CLR-4:	*apply the different types of ANN and its applications in CFD*
CLR-5:	*practice on various techniques used in Computational analysis*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*discuss the basics of soft computing techniques*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*analyze the Fuzzy logic applications*	*3*	-	-	*3*	-	-	-	-	-	-	-	-	-	*2*	-
CO-3:	*illustrate the different models of Genetic algorithm with applications*	*2*	-	-	*3*	-	-	-	-	-	-	-	-	-		-
CO-4:	*analyze the different models of ANN with its applications*	*3*	-	-	*3*	-	-	-	-	-	-	-	-	-	*2*	-
CO-5:	*illustrate the different computational analysis using software's*	*2*	-	-	-	*3*	-	-	-	-	-	-	-	-	*3*	-

Unit-1 - Introduction to Soft Computing — ***9 Hour***

Evolution of Computing: Soft Computing Constituents, Conventional AI to Computational Intelligence- Various Soft Computing Techniques and Their Description- Machine Learning Basics, Confusion Matrix, precision, recall and F1 score- Understanding AUC - ROC Curve-Solving simple application problems. Single and Multi-objective optimization techniques

Unit-2 - Fuzzy Logic Applications — ***9 Hour***

Introduction to Fuzzy logic, Fuzzy sets, Membership functions, Fuzzy rules, Fuzzy logic architecture- Applications of Fuzzy logic in Machining, Robotics and Composites - Adaptive Neuro-Fuzzy Inference Systems (ANFIS) with applications. Classification and Regression Trees--Evolutionary computation- Case studies related to Mechanical Applications

Unit-3 - Genetic Algorithm Applications — ***9 Hour***

Introduction, Population, Fitness function, Crossover, Mutation, Reproduction-Solving single-objective optimization problems using GAs- Heuristic Algorithms-Simulated annealing, A Search and Best First search-Weighted Principal Component Analysis-Applications of GA in Machine Learning-Particle swarm optimization (PSO) Algorithm- Case studies*

Unit-4 - ANN and its Applications — ***9 Hour***

Motivation and properties of Biological Neural Networks, Feed Forward Neural Networks, Recurrent Neural Networks-Perceptron's classification- Activation Functions- Back Propagation Networks- Image classification using CNN, YOLO Algorithm, Pooling layer and Feature extraction- Artificial Neural Networks in CFD-Applications of CNN in Robot vision-Case studies

Unit-5 - Software Based Computational Analysis — ***9 Hour***

Using software programming-Practice on Linear Regression Single and Multiple Variables and Polynomial Regression. Practice on Gradient Descent Algorithm and Logistic Regression. Computational analysis on K Means Clustering, Support Vector Machine, Naive Bayes Classifier and Random Forest Decision Tree Algorithm.

Learning Resources	1. *Mangey Ram, J. Paulo Davim, Soft Computing Techniques and Applications in Mechanical Engineering, IGI Global, USA, DOI: 10.4018/978-1-5225-3035-0,2022.ISBN13: 9781522530350* 2. *Pratihar D.K., Soft Computing, Narosa Publishers, and ISBN: 978-81-8487-495-2, 2018.* 3. *Goldberg D.E., Genetic algorithms in search optimization and machining, Pearson Education, 13th Edition, and ISBN-13:978-0201157673, 1989.* 4. *Haykin Simon., Neural networks a comprehensive foundation, Pearson Education, 2nd Edition, ISBN-13: 978-0138958633, 1997.* 5. *Klir George, and Yuan Bo., Fuzzy sets and fuzzy logic theory and applications, PHI. ISBN-13:978-0131011717, 1995.*	6. *Jun Sun, Choi-Hong Lai, Xiao-Jun Wu, Particle swarm optimization: Classical and quantum perspectives, CRC Press, ISBN 9780367381936, 2019.* 7. *Kaushik Kumar, Supriyo Roy,J. Paulo Davim, Soft Computing Techniques for Engineering Optimization, ISBN 9780367780210, CRC Press,2021.* 8. *Melanic Mitchell, an Introduction to Genetic Algorithm, MIT Press, 2000.* 9. *Martin.F, Mc Neill and Ellen Thro, Fuzzy Logic: A Practical Approach, A P Professional, May 2014.* 10. *Timothy J. Ross, Fuzzy Logic with Engineering Applications, Wiley, Reference II.2015.* 11. *Rajasekaran,S., Vijayalakshmi Pai,GA., Neural Network, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications, Prentice Hall India.2011.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*30%*	-	*30%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*30%*	-	*30%*	-
Level 5	*Evaluate*	-	-		-	-	-
Level 6	*Create*	-	-		-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr.S.Prabhu Shankar, DXC Technologies, Chennai*	1. *Dr. N.Arunachalam, Associate Professor, IIT Madras*	1. *Prof. S.Prabhu, SRMIST*
2. *Mr. Parameswaran S, Nokia Solutions, Chennai*	2. *Dr. P.Hariharan, Professor,Anna University Chennai*	2. *Mr.V.Manojkumar, SRMIST*

Course Code	21MEE209T	Course Name	PROCESS PLANNING AND COST ESTIMATION	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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*acquire knowledge about Process planning*
CLR-2:	*understand the concepts of Estimation and Costing*
CLR-3:	*learn about different components of Costing*
CLR-4:	*acquire knowledge about various cost involved in Forging, Casting, and welding shops*
CLR-5:	*calculate Machining time for different process*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*design and plan for various process and various manufacturing methodologies*	*1*	*3*	-	*2*	-	-	-	-	-	-	-	-	-	*2*	-
CO-2:	*utilize the knowledge in Estimating the cost of the project / product*	-	*3*	-	-	-	-	-	-	-	-	-	-	-	*3*	-
CO-3:	*estimate cost of the Component*	-	*2*	-	-	-	-	*1*	-	-	-	-	-	-	*3*	-
CO-4:	*estimate cost in different fabrication shops*	*1*	*2*	-	-	-	-	-	-	-	-	-	-	-	*3*	-
CO-5:	*estimate machining time of various metal removal operations*	-	*3*	-	-	-	-	-	-	-	-	-	-	-	*3*	-

Unit-1 - Process Planning	***9 Hour***
Process Planning-Steps involved, Bill of Materials, Uses, Routing, Route Sheet, Process Selection, Process Planning Activities, Machine Selection, Factors Influencing Process and Material Selection Parameters, Documents Required for Process Planning, Steps in Process Planning, Computer Aided Process Planning (CAPP) - Benefits, Approaches -Variant, Generative Method-Practices, and Breakeven Analysis. Case Study in Process Planning	
Unit-2 - Costing and Estimation	***9 Hour***
Cost Estimating, Cost Accounting, Objectives of Cost Estimation, and Components of a Cost Estimate, Cost Estimation Procedure, Classification of Costing, Elements of Cost, Ladder of Costs, allowances in Estimation.	
Unit-3 - Elements of Cost	***9 Hour***
Introduction-Material cost, Labour cost, and Expenses. Determination of direct and indirect cost,-material, Labour Analysis of overhead expenses-Factory expenses - Administrative expenses- selling and distributing expenses. Depreciation-Causes of depreciation- Methods of depreciation, simple problems	
Unit-4- Cost Estimation in Forming, Casting, and Welding Shop	***9 Hour***
Introduction of hand forging shop, Losses in forging, estimation of forging cost, foundry shop, moulding section, core making section, fettling section, casting section. Estimation of casting. Introduction of arc, gas welding, estimation of arc welding, gas welding.	
Unit-5 - Estimation of Machining Time and Cost	***9 Hour***
Estimation of machining time and cost of Lathe operations, Drilling, Milling Shaping operations, Grinding operations.	

Learning Resources	1. Banga.T.R and Sharma.S.C, "Mechanical Estimating and Costing", Khanna publishers, New Delhi, 17th Edition, 2015 2. Adithan.M.S and Pabla, "Estimating and Costing", Konark Publishers Pvt., Ltd, 2013	3. Narang.G.B.S and Kumar.V, "Production and Planning", Khanna Publishers, New Delhi, 2014 4. Peter Scalon, Process planning, Design/ Manufacture Interface, Elsevier Sci. & Tech. 2002

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

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. Raju Abraham, NIOT, Chennai, abraham@niot.res.in	1. Dr. A. Arul Jeya Kumar, SRMIST
2. Dr. Parameswaran S- Nokia Solutions	2. Dr. N. Arunachalam, IIT Madras, chalam@iitm.ac.in	2. Mr. S. Sundar, SRMIST

Course Code	21MEE210T	Course Name	MECHATRONICS SYSTEM DESIGN	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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*be familiar with the basic key elements of mechatronics systems*
CLR-2:	*apply the knowledge on modeling and simulation of physical systems*
CLR-3:	*be familiar with the working and selection of sensors for mechatronics-based applications*
CLR-4:	*be familiar with the working and selection of actuators for mechatronics-based applications*
CLR-5:	*be familiar with the signals and applications of mechatronics systems*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*differentiate the basic key elements of mechatronics systems*	-	-	*3*	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*have cognizance on modeling and simulation of physical systems*	-	-	*3*	-	-	-	-	-	-	-	-	-	-	*2*	-
CO-3:	*differentiate and utilize various sensors to design the mechatronics system*	-	-	*3*	-	-	-	-	-	-	-	-	-	-	*2*	-
CO-4:	*differentiate and utilize actuation systems to be used in mechatronics systems*	-	*2*	*3*	-	-	-	-	-	-	-	-	-	-	*2*	-
CO-5:	*apply the knowledge on designing mechatronics-based system*	-	-	*3*	*1*	-	-	-	-	-	-	-	-	-	*3*	-

Unit-1 - Introduction to Mechatronics System Design	***9 Hour***
Introduction to Mechatronics- Integrated Design Issues, Design Process, Important Features. Mechatronics Key Elements: Information Systems- Mechanical Systems - Electrical Systems - Sensors and Actuators, Real-Time Interfacing. Applications in Mechatronics: Condition Monitoring- On- line and Model-Based monitoring, Opto mechatronics, E-Manufacturing, Mechatronic Systems in industrial automation.	
Unit-2 - Modeling and Simulation of Physical Systems	***9 Hour***
Component modeling: Operator Notation and Transfer Functions, Block Diagrams, Manipulations, and Simulation, Block Diagram Modeling: Direct Method, Transfer Function/ Mechanical Illustration Conversion to Block Diagram Models. Analogy Approach model -Impedance Diagrams, Modified Analogy Approach. Modeling of Physical Systems: Electrical, Mechanical – Translational and rotational Systems	
Unit-3 - Sensors Used in Mechatronics Systems	***9 Hour***
Introduction to Sensors and Transducers, Sensor Classification, Elements of Measurement system, Quality Parameters. Sensors for Motion and Position Measurement: Resistance Transducers, Inductive and Capacitance Transducers. Digital Encoders: Principle, Absolute and Incremental Encoders. Resistive Transducers, Strain Gauges, Tactile Sensors. Vibration and Acceleration Sensors: Piezoelectric Transducers, Active Vibration Control, Magnetostrictive Transducer. Sensors for Flow Measurement: Solid Flow, Liquid Flow, Differential Pressure, Ultrasonic Flow Transducers, Hot Wire anemometers, Electromagnetic Flow Meters. Temperature Sensing Devices: Thermistors, Thermocouple, Radiative Temperature Sensing, Temperature Sensing using Fiber Optics.	
Unit-4 - Actuators Used in Mechatronics Systems	***9 Hour***
Electrical Motors: DC Motors, AC Motors, Stepper Motors: Permanent Magnet Stepper Motor, Modeling Approach, Drive Equations/ Motor Equations and Block Diagram Model, Position System Using Stepper Motor. Piezoelectric Actuators. Control Systems in Fluid Power, Fluid Power Actuators, Fluid Power Design Elements, Fluid Power Energy-Input Devices, Energy Modulation Devices (Valves), Energy-Output Devices, Control Modes of Fluid Power Circuits. Electrical Components in Fluid Power Circuits.	

Unit-5 - Signals, Systems, and Controls, Application Case Studies	***9 Hour***
Introduction to Signals, Systems, and Controls. System Representation: Transfer Function Form, Basic Feedback System and G-Equivalent Form. Measures of System Performance: Stability, Accuracy, Transient Response, and Sensitivity. Application Case Studies: Car park barriers, Pick and place robot, Electronic washing machine, Position Control of a Permanent Magnet DC Gear Motor, Auto-Control System for Greenhouse Temperature, Transducer Calibration System for Automotive applications, Strain Gauge Weighing System.	

Learning Resources	1. *Devdas Shetty and Richard A. Kolk "MECHATRONICS SYSTEM DESIGN" Cengage Learning, SECOND EDITION, 2011.* 2. *Bolton.W, "Mechatronics", Addison Wesley, 4th Edition, New Delhi, 2010.* 3. *Bradley.D.A, Dawson.DBurdN.C.and Loader A.J, "Mechatronics", Chapman and Hall Publications, New York, 1993*	4. *Jacob Fraden, "Handbook of Modern Sensors Physics, Designs, and Applications", Third Edition, Springer-Verlag New York, 2004* 5. *Anthony Esposito, "Fluid Power with applications", Pearson Education Inc, 2015.* 6. *Soloman S. Sensors and control systems in manufacturing. McGraw-Hill Education; 2010.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*25%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*30%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*30%*	-	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. N Saravanan, Principal Engineer, Smart Implements & Machinery and Sustainability, Mahindra Research Valley,*	1. *Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	1. *Dr. R. Murugesan, SRMIST*
2. *Mr. N Parameswaran, Manager-Production Engineering at Nokia Solutions and Networks Pvt Ltd Chengalpattu, Tamil Nadu, India*	2. *Dr. S. Kumaresh Babu, Professor, NIT Trichy*	2. *Dr. M. Prakash, SRMIST*

Course Code	21MEE211T	Course Name	SOFT ROBOTICS	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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*know about the fundamental concepts of Industrial Robotics*
CLR-2:	*demonstrate the Forward Kinematic and Inverse Kinematic solutions for a Multi Degree of Freedom Robots*
CLR-3:	*familiarize with the existing concepts of soft grippers and fabrication techniques*
CLR-4:	*demonstrate a systematic approach in constructing an soft sensing and gripping mechanism*
CLR-5:	*apply the Robot program in real world platform to perform simple task*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*examine critical components of different robot systems, the functionalities and performance of different configurations*	3	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-2:	*evaluate the transformation of end effectors position with the kinematics and dynamics of robots*	-	3	3	-	-	-	-	-	-	-	-	-	-	2	-
CO-3:	*impart the fundamental concepts and material selections of soft robots*	-	3	3	-	-	-	-	-	-	-	-	-	2	-	-
CO-4:	*identify the use of physical principles for robot sensing and gripping*	-	3	3	-	-	-	-	-	-	-	-	-	-	2	-
CO-5:	*construct a industrial and soft robot for various real world applications*	-	3	3	-	-	-	-	-	-	-	-	-	-	3	-

Unit-1 - Introduction to Industrial Robot	***9 Hour***
Introduction to Robotics, Developments in Robotics- Definition and law of robotics, Robot anatomy -Terminology of Robotics, Accuracy and repeatability, dexterity-RCC compliance - Robot Drive Systems-Hydraulic, Pneumatic and Electric system. Mechanical grippers-Slider crank mechanism, Screw type-Rotary actuators, cam type-Magnetic grippers- Vacuum grippers, Robot Sensor, Operator interface, Safety monitoring devices in Robot.	
Unit-2 - Robot Motion Analysis	***9 Hour***
Robot kinematics-Types- 2D, 3D Transformation-inverse kinematics- Simple Problems-Scaling, Rotation, Translation, Homogeneous Transformations, multiple transformations – Simple Problems-Kinematic equations using Homogeneous Transformations - Joints, frame assignment to links and orientation- Simple Problems-Velocities and Static forces in manipulators: Jacobians and singularities, Robot work cell design and its types, Hands on session with Industrial robot.	
Unit-3 - Smart Material and Fabrication	***9 Hour***
Robot -Bio Inspiration and its Types - Role of Smart material– Classification of compliant Material -Shape Memory alloys- Elastomers -Dielectric Elastomers -Fluid Materials -Liquid Metal Embedded Elastomers-Hydrogels- Magnetic Hybrid Material, Fabrication Methods-casting, molding,3D printing.	
Unit-4 - Soft Sensing and Grippers	***9 Hour***
Self-sensing- Physical Principles -Coulomb effect, Johnsen Raheb Effect, Electro adhesion Force, Dielectric Polarization , Highly Sensitive Soft Three axial force sensor, End effector – Types- Biological Gripping-Hooking Grippers- Lock and Key Gripper-Clamp Gripper -Sucker Gripper -Adhesion Gripper -Frictional Gripper - Electro Adhesive Grippers-Tendon Based Gripper.	
Unit-5 - Robot Applications	***9 Hour***
Various applications of Industrial Robot, Material transfer, Machine loading/unloading, Welding Robot, Soft robot Translational Applications-Self-Healing Soft Pneumatic Robot, Artificial Eyelids Closing using Exopatches, Soft Robotic Hand, Portable Continuum Robot, Dynamic analysis of Rotary soft robot arm Implementation of Artificial Intelligence.	

Learning Resources	1. *Deb. S.R, "Robotics Technology and flexible automation", Tata McGraw-Hill Education, 2009.* 2. *Mikell P Groover & Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, Industrial Robotics, "Technology Programming and Applications", McGraw Hill, 2012* 3. *Gareth J. Monkman, "Soft Robotics", Bentham Books, 2022* 4. *Ali Shafti& Ali Shiva, "Soft and Stiffness-controllable Robotics Solutions EUROSPAN GROUP, 2018* 5. *Matthew Borgatti, "Soft Robotics: A DIY Introduction to Squishy, Stretchy, and Flexible Robots", Make Community, 2018*	6. *Klafter.R.D, Chmielewski.T.A and Noggins, "Robot Engineering: An Integrated Approach", Prentice Hall of India Pvt. Ltd., New Delhi, 2010.* 7. *John J. Craig, "Introduction to Robotics Mechanics and Control", Third Edition, Pearson, 2008.* 8. *John C. Lippold, Welding Metallurgy and Weldability, John Wiley & Sons, Inc., publication, 2015.* 9. *Proceedings of the Soft Robotics, Springer Cham,Livorno, Italy,2016* 10. *"Soft Robotics", Journal Publication,Mary Ann Liebert Publisher*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*20%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*25%*	-	*30%*	-
Level 5	*Evaluate*	-	-	*10%*	-	-	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr. N Parameswaran, Manager-Production Engineering at Nokia Solutions and Networks Pvt Ltd Chengalpattu, Tamil Nadu, India*	1. *Dr. S. Kumaresh Babu, Professor, NIT Trichy*	1. *Mr. V. Manoj Kumar, SRMIST*
2. *Dr. N Saravanan, Principal Engineer, Smart Implements & Machinery and Sustainability, Mahindra Research Valley, n.saravanan@mahindra.com*	2. *Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	2. *Dr. R. Ranjith Pillai, SRMIST*

Course Code	21MEE212T	Course Name	HEATING, VENTILATION AND AIR CONDITIONING 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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*acquire knowledge of air-conditioning and thermal comfort*
CLR-2:	*explain the heating and cooling load estimation*
CLR-3:	*acquire knowledge of ventilation systems*
CLR-4:	*explain the working of air-conditioning systems*
CLR-5:	*acquire knowledge of comfort Air-conditioning in different applications*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*apply the knowledge of air-conditioning and thermal comfort*	*3*	-	-	-	-	-	-	-	-	-	-	-	*2*	-	-
CO-2:	*evaluate the heating and cooling load in buildings*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	*3*	-	-
CO-3:	*apply the knowledge of ventilation systems*	*3*	-	-	-	-	-	-	-	-	-	-	-	*3*	-	-
CO-4:	*apply the knowledge of different types of air-conditioning systems and duct design*	*3*	*2*	-	-	-	-	-	-	-	-	-	-	*2*	-	-
CO-5:	*apply the concept of comfort air-conditioning in different applications*	*2*	-	-	-	-	-	*3*	-	-	-	-	-	*3*	-	-

Unit-1 - Introduction to HVAC ***9 Hour***

Brief history of air conditioning and impact of air conditioning-HVAC systems and classifications-heat pumps-modes of heat transfer-sensible and latent heat- refrigerant and brines- comfort air conditioning: thermodynamics of human body, metabolic rate, energy balance and models, thermoregulatory mechanism

Unit-2 - Heat Transfer Through Building Structures and Load Calculations ***9 Hour***

Solar radiation-heat transfer through walls and roofs-empirical methods to calculate heat transfer through walls and roofs using decrement factor and time lag method. Infiltration, stack effect, wind effect-internal heat gains, system heat gain, cooling and heating load estimate.

Unit-3 - Ventilation Systems ***9 Hour***

Introduction- fundamentals of good indoor air quality, need for building ventilation, types of ventilation system, air inlet system-Filters, heating & cooling equipment, fans, duct design, grills, diffusers for distribution of air in the workplace, HVAC interface with fire and gas detection systems - system requirements, devices and their functioning.

Unit-4 - Air-Conditioning Systems ***9 Hour***

Classification of air-conditioning system - window, split, ductable split, ductable package, central plant chill water system - variable refrigerant volume (VRV) system - variable refrigerant flow (VRF) system - air distribution system- duct sizing methods, selection of diffusers and grilles - legends and symbols used in the HVAC industry - hydronic system- water piping, fittings, valves, and selection of pumps - district cooling system.

Unit-5 - Applications of Comfort Air Conditioning Systems ***9 Hour***

Automobile air-conditioning systems - industrial air conditioning: textile industries, semi-conductor industries, pharmaceutics - air-conditioning systems integrated with energy storage technologies - adopting codes and standards for energy efficiency - designing for efficient operations and maintenance – commissioning - design of an air conditioning system for a laboratory- case study I - design of an air conditioning system for an office room- case study II.

Learning Resources	1. James E. Brumbou, "HVAC Fundamentals Volume-3", 3rd Edition, Audel, 2015. 2. Robert Mcdowall, "Fundamentals of HVAC Systems", 3rd Edition, Academic Press, 2007. 3. Samuel C. Sugarman, "Home Heating & Air Conditioning systems ", 3rd Edition, Fairmont Press, 2005.	4. Hazim B. Awbi, " Ventilation Systems: Design and Performance", 3rd Edition, Routledge, 2007. 5. John L Alden, "Design of Industrial Ventilation Systems", 5th Edition, Industrial Press, 2017. 6. ISHRAE, "Industrial Ventilation Applications ", 5th Edition, ISHRAE Hand Book, 2019.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Jayachandran Murugesan, Deputy Manager - Technology & Innovation Thermax Limited, Chennai, Tamil Nadu, India	1. Dr. V. Kumaresan, Associate Professor, Anna University, Chennai, Tamil Nadu.	1. Mr. A. Sathishkumar, SRMIST
2. Mr. Babu P, Head Of Innovation at Thermax Limited, Chennai, Tamil Nadu, India	2. Dr. A. Gurubalan, Assistant Professor, IIT Bombay, Mumbai	2. Mr. J. Thavamani, SRMIST

Course Code	21MEE213T	Course Name	EMERGING TECHNOLOGIES IN AUTOMOTIVE 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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*enrich the students in the basics of Internal Combustion engine*
CLR-2:	*enumerate the knowledge in SI Engine*
CLR-3:	*enumerate the knowledge in CI Engine*
CLR-4:	*enrich knowledge of Pollutant Formation and Control*
CLR-5:	*acquire knowledge of Electrical vehicles*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*acquire knowledge of SI Engines*	-	-	-	-	-	-	*3*	-	-	-	-	-	*3*	-	-
CO-2:	*acquire knowledge of CI Engines*	-	-	-	-	-	-	*3*	-	-	-	-	-	*3*	-	-
CO-3:	*enumerate the formation of pollution due to IC Engine Combustion*	-	-	-	-	-	-	*3*	-	-	-	-	-	*3*	-	-
CO-4:	*recognize the current trends in Internal combustion Engines*	-	-	-	-	-	-	*3*	-	-	-	-	-	*3*	-	-
CO-5:	*identify and renovate future energy needs towards Hybrid Vehicles*	-	-	-	-	-	-	*3*	-	-	-	-	-	*3*	-	-

Unit-1 - Spark Ignition Engines ***9 Hour***

Mixture requirements – Fuel injection systems –Single point, Multipoint & Direct injection - Stages of combustion – Normal and Abnormal combustion – Knock - Factors affecting knock – Combustion chambers. Heat release rate analysis- Alternative fuels- Alcohol, Hydrogen, Biogas-characteristics- engine modification

Unit-2 - Compression-Ignition Engines ***9 Hour***

Diesel Fuel Injection Systems - Stages of combustion – Knocking – Factors affecting knock – Direct and Indirect injection systems – CRDI - Combustion chambers – Fuel Spray behavior – Spray structure and spray penetration –.- Heat release rate analysis- Alternative fuels- Biodiesel, Gaseous fuel, DME, DEE-characteristics- engine modification

Unit-3 - Pollutant Formation and Control ***9 Hour***

Pollutant – Sources – Formation of Carbon Monoxide, Unburnt hydrocarbon, Oxides of Nitrogen, Smoke, and Particulate matter – Methods of controlling Emissions – Catalytic converters, Selective Catalytic Reduction and Particulate Traps –EGR- Methods of measurement – Emission norms and Driving cycles-Onboard Diagnostics..

Unit-4 - Recent Trends in IC Engines ***9 Hour***

Air assisted Combustion-Variable Geometry turbochargers- Variable valve timing- – HCCI- PCCI-RCCI–Low-temperature combustion(LTC) -Dual Fuel Engines– NOx Adsorbers -

Unit-5 - Hybrid Electrical Vehicles ***9 Hour***

Introduction To Electric and Hybrid Electric Vehicles- Types of EVs - Types of power train - Traction drive Power calculations for Electric Vehicles-Energy Storage Systems - Battery- Fuel Cell – Super capacitors - Power train design aspects for EV and HEV,

Learning Resources

1. *Ramalingam. K.K., "Internal Combustion Engine Fundamentals", Scitech Publications, 2002.*
2. *Ganesan, "Internal Combustion Engines", II Edition, TMH, 2002.*
3. *Mathur. R.B. and R.P. Sharma, "Internal Combustion Engines". Dhanpat Rai & Sons 2007.*
4. *Duffy Smith, "Auto Fuel Systems", the Good Heart Willcox Company, Inc., 1987.*
5. *Eric Chowenitz, "Automobile Electronics", SAE Publications, 1995Husain, I. "Electric and Hybrid Vehicles" Boca Raton, CRC Press, 2010.*

Learning Assessment							
	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*25%*	-	*25%*	-	*25%*	-
Level 2	*Understand*	*25%*	-	*25%*	-	*25%*	-
Level 3	*Apply*	*50%*	-	*50%*	-	*50%*	-
Level 4	*Analyze*	-	-	-	-	-	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers		
Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr. Jayachandran Murugesan, Deputy Manager - Technology & Innovation Thermax Limited, Chennai, Tamil Nadu, India*	1. *Dr. D. Ganesh/ CEG Anna University, Chennai*	1. *Dr. V. Mathanraj, SRMIST*
2. *Mr. Babu P, Head Of Innovation at Thermax Limited, Chennai, Tamil Nadu, India*	2. *Dr. G.Kumarasen, CEG, Anna University, Chennai*	2. *Dr. T.Lakshmanan, SRMIST*

Course Code	21MEE214T	Course Name	GAS DYNAMICS AND SPACE PROPULSION	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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*apply the thermodynamics concepts in relation to compressible flows*
CLR-2:	*apply the theory of shock waves*
CLR-3:	*analyze the flow parameters with friction and heat transfer*
CLR-4:	*analyze the theory of various power plants in jet propulsion*
CLR-5:	*apply the basic principles of rocket propulsion*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1 Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*solve the Isentropic relations to variable area duct*	*2*	*1*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*analyze and solve problems related to normal and oblique shock waves*	*1*	*2*	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	*solve for compressible flow characteristics with friction and heat transfer*	*1*	*2*	-	-	-	-	-	-	-	-	-	-	-	*1*	-
CO-4:	*examine the performance of aircraft power plants*	*2*	*2*	-	-	-	-	-	-	-	-	-	-	-	*1*	-
CO-5:	*analyze the various rocket propulsion systems*	*2*	*1*	-	-	-	-	-	-	-	-	-	-	-	*1*	-

Unit-1 - Fundamentals of Compressible Flow — ***9 Hour***

Energy and momentum equations of compressible fluid flows – Stagnation states- – Mach waves and Mach cone – Effect of Mach number on compressibility, Isentropic flow through variable area ducts.

Unit-2 - Normal and Oblique Shocks — ***9 Hour***

Governing equations – Variation of flow parameters across the normal and oblique shocks – Prandtl Meyer relations – Expansion of supersonic flow around corners, Case studies on isentropic flows using CFD

Unit-3 - Flow Through Ducts — ***9 Hour***

Flows through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) – variation of flow properties. Choking. Isothermal flow with friction. Use of Gas tables.

Unit-4 - Aircraft Propulsion — ***9 Hour***

Theory of jet propulsion – Thrust equation – Thrust power and propulsive efficiency – Operation principle, cycle analysis and use of stagnation state performance of turbojet, turbofan and turbo-prop engines, merits and demerits of ramjet and pulsejet engines, Aircraft combustors.

Unit-5 - Rocket Propulsion — ***9 Hour***

Types of rocket engines – Propellants – Ignition and combustion – Theory of rocket propulsion, Nozzle types, Performance study – Applications.

Learning Resources

1. *Yahya.S.M, "Fundamentals of Compressible Flow with Aircraft and Rocket Propulsion", New Age International (P) Ltd, New Delhi, 3rd edition, 2012.*
2. *Radhakrishnan.E, "Gas Dynamics", PHI Learning Pvt. Ltd, 4th edition, 2012.*
3. *Mattingly.J.D, "Elements of Propulsion: Gas turbines and Rockets", McGraw Hill, 2012.*
4. *Balachandran.P, "Fundamentals of compressible fluid dynamics", PHI Learning, 2012*
5. *Robert.D.Zucker, "Oscar Biblarz, Fundamentals of Gas Dynamics",John Wiley and Sons, 2nd edition, 2011.*
6. *Ascher Schapiro, 'The dynamics and thermodynamics of compressible flow",R.R.Kreiger Publishers, Volume 2, 1983.*
7. *Yahya.S.M, "Gas Tables for compressible flow calculations", New Age International (P) Ltd, New Delhi, 6th edition, 2011.*

Learning Assessment							
	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*20%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*25%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*35%*	-	*30%*	-
Level 5	*Evaluate*	-	-		-	-	-
Level 6	*Create*	-	-		-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers		
Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. Dr. Gireesh Yanamashetti, National Aerospace Laboratory, Bangalore	*1. Dr V. Babu, Professor, IIT Madras*	*1. Dr M Gunasekaran, SRMIST*
2. Dr. G. Muthuselvan, National Aerospace Laboratory, Bangalore	*2. Dr Ranjith Mohan, IIT Madras*	*2. Dr Siva Krishna Reddy, SRMIST*

Course Code	21MEE215T	Course Name	COMPUTATIONAL FLUID DYNAMICS: THEORY WITH APPLICATIONS	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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*get familiarity with governing equations of fluid mechanics and their mathematical behavior*
CLR-2:	*understand the intricate details of discretization techniques and stability analysis of difference equations*
CLR-3:	*know various numerical methods to solve equations and solution technique for compressible flows*
CLR-4:	*grasp techniques for coupling continuity and momentum equations for incompressible flows, simple algorithm and its application to Couette flow*
CLR-5:	*be familiar with concepts of turbulence and its modelling*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*derive governing equations to a fluid system and classify governing equations mathematically*	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*implement different discretization techniques to solve simple PDEs, and perform stability analysis*	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	*analyze the solution techniques for algebraic, ordinary differential and partial differential equations and applying to solve compressible flows*	3	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-4:	*evaluate the solution techniques for elliptic equations and apply them to potential flows, incompressible flows and specifically to Couette flow*	2	-	-	-	2	-	-	-	-	-	-	-	-	3	-
CO-5:	*evaluate the concept of turbulence and Reynold's averaging and examine the turbulence modelling approaches*	-	3	-	-	2	-	-	-	-	-	-	-	-	3	-

Unit-1 - Governing Equations ***9 Hour***

Introduction, Various applications of computational fluid dynamics, Models of fluid flow, Continuity equation derivation in all forms, Momentum, Energy and Scalar transport equations derivation, Conservation and Non conservation form of governing equations, Different types of boundary conditions –Dirichlet, Neumann, Cauchy and Robbins boundary conditions with examples, Classification and Mathematical behavior of Partial differential equations – elliptic ,parabolic and hyperbolic equations, well posed problems

Unit-2 - Discretization Techniques ***9 Hour***

Discretization concept and principles, Finite difference approximations of partial derivatives – Forward, Backward and Central difference methods, Discretization of one dimensional un-steady state heat conduction, Explicit and Implicit method, Discretization of one dimensional wave equation, Tutorials on discretization of equations, Stability analysis of different equations, consistency and convergence, Discussion on CFL condition, Short discussion on shock capturing methods: Godunov, TVD, flux-limiter schemes

Unit-3 - Solution Techniques and Numerical Methods for Compressible Flows ***9 Hour***

Direct methods for system of linear equations: Gauss elimination method and Tri-diagonal matrix algorithm, Iterative methods: Gauss-Siedel, Jacobi and relaxation techniques, Solution techniques for ordinary differential equations: Euler, predictor-corrector, Runge-Kutta methods, Linear multi-step methods: Adams-Bashforth method, Short discussion on algebraic multi-grid method, Application of McCormack technique to compressible flows: case study- Supersonic flow through convergent-divergent nozzle: Governing equations, numerical method, boundary conditions, case set-up and results, Tutorials on McCormack method, Coding practice for Jacobi method.

Unit-4 - Solution Techniques for Elliptic and Parabolic Equations	***9 Hour***
Application of relaxation techniques to potential flow equation, Application of Alternating Direction Implicit method to unsteady two-dimensional heat conduction, Techniques for incompressible Navier-Stokes equations: Concept of staggered grid., Pressure correction method, SIMPLE algorithm and boundary conditions, Solution of Couette flow using SIMPLE algorithm	
Unit-5 - Introduction to Turbulence Modelling	***9 Hour***
Concept of Turbulent boundary layer over a flat plate: Laminar sub, logarithmic and outer layers, Concept of turbulence, Reynolds averaging, Time averaged equations for turbulent flow, Boussinesq approximation, Types of turbulence models: Prandtl mixing length, One-equation, Two-equation models, Comparison of different turbulent models, Energy cascade mechanism in turbulent flows, Advanced methods: Large Eddy Simulations, Direct Numerical Simulations, Detached Eddy Simulations	

Learning Resources	1. *Anderson J.D., "Computational Fluid dynamics: The basics with Applications", McGraw Hill Education, July 2017.* 2. *Versteeg H.K., and Malalasekera W., "An introduction to computational fluid dynamics: "The finite volume method", Pearson India Publisher, January 2010* 3. *Muralidhar.K, and Sundararajan.T, "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, Second Edition, 2008.*	4. *Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons, 2011.* 5. *R. Byron Bird, Warren E. Stewart, Edwin N. Lightfoot, "Transport Phenomena", 3rd Edition, John Wiley and Sons, 2013.* 6. *Piyush K. Kundu and Ira M. Cohen, "Fluid Mechanics", 4th Edition, Elsevier, 2010*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*20%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*25%*	-	*30%*	-
Level 5	*Evaluate*	-	-	*10%*	-	-	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. Anil Kumar, Fluidyn Consultancy Private Limited, Bengaluru*	1. *Dr. Arul Prakash, Professor, IIT Madras*	1. *Dr D. Siva Krishna Reddy, SRMIST*
2. *P. S. G. Kumar, Siemens Industry Software (India) Pvt Ltd, Bengaluru*		2. *Dr. P. Sudhakar. SRMIST*

Course Code	21MEE216T	Course Name	MODELING AND ANALYSIS OF THERMAL SYSTEMS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

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:	*identify the techniques used for storing various forms of energy*
CLR-2:	*classify the properties of storage materials and heat transfer fluids*
CLR-3:	*analyze the sensible, latent, and thermochemical energy storage systems*
CLR-4:	*interpret the modeling aspects of thermal systems*
CLR-5:	*categorize the various techniques used for storing thermal energy in heating/cooling] applications and energy savings*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*describe the techniques suitable for energy storage*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*apply the properties of storage materials and heat transfer fluids*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	*examine the sensible, latent and Thermochemical energy storage systems*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	*categorize various modeling techniques used for thermal energy storage systems*	*3*	-	-	-	-	-	*3*	-	-	-	-	-	*3*	-	-
CO-5:	*evaluate various techniques used for storing thermal energy in heating/cooling applications and energy savings*	*3*	-	-	-	-	-	*3*	-	-	-	-	-	*3*	-	-

Unit-1 - Energy Storage	***9 Hour***
Basics of Energy storage and its types, Energy storage by mechanical and chemical medium, High temperature thermal storage systems, Necessity and types of Thermal Energy Storage (TES), Seasonal (Source) TES technologies - aquifer, borehole and cavern, Thermal storage- energy piles, sea water, rock and roof pond.	
Unit-2 - Thermal Energy Storage Systems	***9 Hour***
Thermal energy storage materials - Classification, Thermophysical properties, Selection of sensible thermal energy storage materials and methodologies, Properties of sensible heat storage materials, Sensible cooling and heating load calculations, Passive solar heating storage, Active solar heating storage, Heat transfer fluids and properties, Selection of heat transfer fluid for heating and cooling applications	
Unit-3 - Sensible, Latent Thermal and Thermochemical Energy Storage Systems	***9 Hour***
Sensible and Latent Thermal Energy Storage (STES/ LTES) system and its types, Encapsulation techniques of LTES (PCM) materials, Performance assessment of LTES system in building, Thermochemical energy storage principles and materials, Thermochemical energy storage systems - open adsorption energy storage system and closed adsorption energy storage system, thermochemical energy storage system and thermochemical accumulator energy storage system.	
Unit-4 - Modeling Aspects of Thermal Storage System	***9 Hour***
Mathematical models, Principles, Types, Flow Diagram, Optimal Systems solution of set of nonlinear algebraic equations - successive substitution - Newton Raphson method- examples of thermal systems simulation, Simulation of thermal processes, (Stefan's method, enthalpy porosity method, apparent heat capacity method	
Unit-5 - Modeling of Components in Thermal Storage System	***9 Hour***
Modeling of heat exchangers, Evaporators, Condensers, Absorption and rectification column, Solar collectors, Thermal Energy storage, Case studies for TEST	

Learning Resources	1. *R. Parameshwaran and S. Kalaiselvam, "Thermal Energy Storage Technologies for Sustainability: Systems Design, Assessment and Applications", Academic Press Inc, 23 September 2014.* 2. *Ibrahim Dincer and Marc A. Rosen, "Thermal Energy Storage Systems and Applications", 2nd Edition, John Wiley and Sons Ltd., 2011.* 3. *Luisa F. Cabeza, "Advances in Thermal Energy Storage Systems: Methods and Applications", October 31, 2014* 4. *Charles E. Dorgan, James S. Elleson, "Design Guide for Cool Thermal Storage", ASHRAE, Atlanda, 1993*	5. *R. Velraj "Sensible heat Storage for solar heating and cooling systems" in the book titled "Advances in Solar Heating and Cooling - Pages 399 - 428, Elsevier Publication, 2016* 6. *ASHRAE, "Handbook of Fundamentals", American Society of Heating Refrigeration and Air Conditioning Engineers, New York, 1993.* 7. *Hailong Li, Xuan Zhou "Advanced Energy Storage Technologies and Their Applications" MDPI - Multidisciplinary Digital Publishing Institute, 2018*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*25%*	-	*25%*	-	*25%*	-
Level 4	*Analyze*	*25%*	-	*25%*	-	*25%*	-
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	-	-		-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Raju Abraham, Sc-F, National Institute of Ocean Technology, Chennai, Email: abraham@niot.res.in*	1. *Dr. Avinash Kumar, Assistant Professor, IIITDM, Kancheepuram*	1. *Dr. Pankaj Kumar, SRMIST*
2. *Dr N Saravanan, Mahindra Research Valley Chengalpattu*	2. *Dr. G. Kumaresan, Professor, Anna University, Chennai*	2. *Dr. Santosh Kumar Singh, SRMIST*

Course Code	21MEE217J	Course Name	MICROELECTRONICS THERMAL MANAGEMENT	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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*understand the concepts of semiconductor technology, thermodynamics and heat transfer for electronic cooling applications*
CLR-2:	*understand the different measurement techniques for electronic thermal management*
CLR-3:	*familiarize different thermal management process in printed circuit boards*
CLR-4:	*be familiar with the direct contact cooling techniques for electronic cooling*
CLR-5:	*be familiar with the indirect contact cooling techniques for electronic cooling*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*explain the concepts of semiconductor technology, thermodynamics and heat transfer for electronic cooling applications*	*3*	-	-	-	-	-	-	-	*1*	-	-	-	-	*2*	-
CO-2:	*explain the concepts of different measurement techniques for electronic thermal management*	*3*	-	-	-	-	-	-	-	*1*	-	-	-	-	*2*	-
CO-3:	*illustrate the different thermal management process in printed circuit boards*	*3*	-	-	-	-	-	-	-	*1*	-	-	-	-	*2*	-
CO-4:	*analyze the direct contact cooling techniques for electronic thermal management*	*3*	-	-	-	-	-	-	-	*1*	-	-	-	-	*2*	-
CO-5:	*investigate the indirect contact cooling techniques for the thermal management of electronics*	*3*	-	-	-	-	-	-	-	*1*	-	-	-	-	*2*	-

Unit-1 - Introduction to Electronic Cooling	***9 Hour***
Semiconductor technology-trends, electronic packaging, and materials, heat transfer mechanisms in electronic systems, junction temperature, failure rate and reliability of electronic components, requirements for electronic cooling, modeling and simulation of electronic systems' cooling. *Laboratory experiments on hot-spot identification using thermal imaging camera, influence of fan location in nullifying/minimizing the hot spot in an electrical/electronic circuit.*	
Unit-2 - Electronic Systems Cooling and Measurements	***9 Hour***
Measurements- Velocity, Pressure, Temperature, heat flux, thermal conductivity, flow rate and Acoustical noise, Uncertainty Analysis. *Laboratory experiments on electronic system and its system impedance measurement, experiments on noise measurement.*	
Unit-3 - Printed Circuit Boards	***9 Hour***
Chip Packaging -technology- thermal resistance, chip package attachment, board-cooling methods- thermal analysis, thermal interface materials, equivalent thermal conductivity. *Laboratory experiments on different board-cooling methods.*	
Unit-4 - Direct Contact Cooling	***9 Hour***
Direct contact cooling-active and passive cooling-air cooling-spray cooling-immersion cooling-jet impingement-droplet electrowetting. *Laboratory experiments on orientation effect on printed circuit board cooling under natural and forced convection.*	
Unit-5 - Indirect Contact Cooling	***9 Hour***
Indirect contact cooling-active and passive cooling-heat pipes-vapor chamber- cooling using microchannel -thermoelectric - phase change materials. *Laboratory experiments on thermoelectric cooling with and without heat pipe embedded heat sink.*	

Learning Resources	1. *L. T. Yeh, r. C. Chu, Thermal Management of Microelectronic equipment, ASME press book series on electronic packaging, ASME PRESS, NEW YORK, 2007* 2. *Anantha Chandrakasan, "Thermal and Power Management of Integrated Circuits", Springer Science, Business Media, Inc., 2006* 3. *Ansys® Academic Research Mechanical, Release R 2021, Help System, Coupled Field Analysis Guide, ANSYS, Inc. Drive Canonsburg, PA 15317, July 2021*	4. *Azar, Kaveh, ed. "Thermal Measurements in Electronics Cooling."Taylor& Francis, 1997.* 5. *"MIL – HDBK – 217F Reliability prediction of electronic components", 1997.* 6. *Kothandaraman. C. P, Subramanyan, S, "Heat and Mass Transfer Data Book", New Age International, 7th edition, 2012.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (45%)		*Life-Long Learning CLA-2 (15%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	-	*15%*	*15%*	-
Level 2	*Understand*	*25%*	-	-	*25%*	*25%*	-
Level 3	*Apply*	*30%*	-	-	*30%*	*30%*	-
Level 4	*Analyze*	*30%*	-	-	*30%*	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. Prabhakar Subrahmanyam prasub@gmail.com*	1. *Dr. Raju Abraham, Scientist, NIOT, Chennai*	1. *Prof. B. K. Gnanavel, SRMIST*
2. *Dr. N. Saravanan, Principal Engineer, Smart Implements & Machinery and Sustainability, Mahindra*	2. *Dr. PandiyarasanVeluswamy pandiyarasan@iiitdm.ac.in*	2. *Dr. S. Manikandan, SRM IST*

Course Code	21MEE218T	Course Name	AERODYNAMICS OF ELECTRIC AND SPORTS VEHICLES	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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*acquire knowledge of the basics of aerodynamics*
CLR-2:	*identify the suitable optimization for the cars*
CLR-3:	*explain the various dynamics and controls*
CLR-4:	*acquire knowledge of the electric vehicle aerodynamics*
CLR-5:	*acquire knowledge of the electric sports aerodynamics*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*extrapolate the knowledge of basic aerodynamics*	*2*	-	-	-	-	-	-	-	-	-	-	-	-	*1*	-
CO-2:	*apply the optimization parameters of the vehicles*	*2*	-	-	-	-	-	-	-	-	-	-	-	-	*2*	-
CO-3:	*apply the various dynamics and control to the vehicles*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	*2*	-
CO-4:	*analyze the aerodynamics of the electric vehicles*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	*2*	-
CO-5:	*analyze the aerodynamics of the sports vehicles*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	*2*	-

Unit-1 - History and Aerodynamic Forces ***9 Hour***

Historic development of vehicle aerodynamics, Boundary layer and flow separation, Bernoulli's equation, Flow over bodies and pressure coefficient, Flow phenomenon related to vehicles – External & Internal flow, Aerodynamics of cars, Resistance to vehicle motion – Types of drags, Fuel consumption and performance.

Unit-2 - Airfoils and Shape Optimization ***9 Hour***

Airfoils and types, Finite wing, Front and rear modification, wind shield angle, Boat tailing, Hatch back, Fast back, Square back, Effect of gap and fasteners configuration, wind tunnel measurement techniques, road testing methods

Unit-3 - Vehicle Dynamics and Control ***9 Hour***

Lateral and longitudinal dynamics, Steering control for automated lane keeping, Differential braking systems, Steer by wire systems, Torque distribution – left and right wheels, Active control of torque transfer

Unit-4 - Electric Vehicle Aerodynamics ***9 Hour***

Electric vehicle and types, Components of Electric Vehicle, EV aerodynamic parts – front end – upper body – rear end – under body – wheels, Air curtain, Wheelhouse ventilation, Front spoiler/Splitter package, Underbody vanes, Diffuser extension, Roof and trunk spoiler extension, Consideration of Vehicle Speed and mass, Power requirement to overcome aerodynamic drag.

Unit-5 - Sports Vehicles Aerodynamics ***9 Hour***

Various components – Splitter – Hood vents – NACA ducts – Diffuser – Spoiler, Vehicle dynamics, Role of inverted airfoil shape, Various aerodynamic forces, Pressure distribution, Role of Speed and Mass, Stall, Flow over wheels, Tyer performance, Effect of aerodynamics performance on speed.

Learning Resources

1. *Hucho,W.H. 1987 "Aerodynamics of Road vehicles", Butterworths Co. Ltd.,*
2. *Yi Zhang and Chris Mi, 2018, "Automotive Power Transmission Systems", Wiley.*
3. *Rajesh Rajamani, 2003, "Vehicle Dynamics and Control", Springer.*
4. *Larminie, J. and Lowry, J. 2012, "Electric Vehicle Technology Explained", Second Edition. John Wiley & Sons, Chichester.*
5. *Joseph Katz (2003), "Race Car Aerodynamics: Designing for Speed", Bentley Publishers.*

Learning Assessment							
	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*30%*	-	*30%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*30%*	-	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers		
Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. Dr. Gireesh Yanamashetti, National Aerospace Laboratory, Bangalore	*1. Dr Ranjith Mohan, IIT Madras*	*1. Dr. P. Balakrishnan, SRMIST*
2. Dr. Muthuselvan, National Aerospace Laboratory, Bangalore	*2. Dr.S.Mohammed Ibrahim, IITKanpur*	*2. Dr. M. Gunasekaran, SRMIST*

Course Code	21MEE219T	Course Name	GREEN ENERGY 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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*understand the impact of green energy on environment*
CLR-2:	*understand solar energy system application*
CLR-3:	*familiar with the application aspects of wind and microhydro turbines*
CLR-4:	*understand the green hydrogen energy generations and scope*
CLR-5:	*get familiar with the economics of green energy systems*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*describe the impact of green energy on environment*	-	-	-	-	-	-	*3*	-	-	-	-	-	*3*	-	-
CO-2:	*enumerate the Solar energy conversion systems*	-	*3*	-	*1*	-	-	-	-	-	-	-	-	*3*	-	-
CO-3:	*illustrate the wind and Micro hydro turbines systems*	-	*3*	-	-	-	-	*1*	-	-	-	-	-	*3*	-	-
CO-4:	*familiarity with green hydrogen energy systems*	-	*3*	-	-	-	-	*1*	-	-	-	-	-	*3*	-	-
CO-5:	*discuss the economics of green energy systems*	-	-	-	-	-	-	*3*	-	-	-	-	-	*3*	-	-

Unit-1 - Green Energy and Environment — ***9 Hour***

The concept of green Energy; evolution; nature, scope, importance and types; Green energy sources- green energy carriers-hydrogen, biofuels, etc. Life cycle analysis , Carbon foot print, Carbon sequestration, Carbon disposal, Carbon trading, Climate neutrality, climate change

Unit-2 - Solar Energy Systems — ***9 Hour***

solar collectors and evacuated tube solar collectors, solar water heating systems, design and their applications - space heating and space cooling systems and an economic comparison between solar water heater, electric heater and gas-fired water heater for hot water supply Solar Photo Voltaic -characteristics of solar cells under lighting are analyzed, output parameter, and impact of module and array output, Application of building-integrated photovoltaic system (BIPV) and system design. Field visit : Testing of Solar thermal collectors, solar water heater (flat plate type),Solar box cooker, Solar air heater, and solar concentrator for high temperature applications, Solar PV panel performances

Unit-3 - Energy Wind Energy Technology and Micro Hydropower(MHP) — ***9 Hour***

Environmental impact- Noise and Life cycle Greenhouse gas emissions, Power and Energy of wind- Coefficient of Performance-Aerodynamics, Wind characteristics, Turbine performance, Levelized cost of energy for a wind turbine, Wind farms- offshore , Onshore Introduction to MHP system design, Planning concepts, Evaluation of MHP requirements, Power from water, , System components of Mini and Micro Hydropower, Micro Hydropower plant in India, , Potential Hydropower plant projects identified in India

Unit-4 - Green Hydrogen — ***9 Hour***

Primary Sources of green energy for Hydrogen production - Hydrogen Demand – Characteristics of Hydrogen. Electrochemical water splitting – Electrolyzer or electrolytic cell –Faraday's law – Faradaic efficiency – Energy efficiency of water electrolysis cells- Classification of electrolyzer. Global green hydrogen market- Green hydrogen projects and its applications

Unit-5 - Energy Environment Interaction Energy Economics — ***9 Hour***

Embodied energy, Environmental impact , Tolerance, Impact Assessments, Unit cost of energy , Societal and Environmental cost, Life cycle assessment (LCA), Energy return on Energy invested, Greenhouse gas accounting, Carbon tax

Learning Resources	1. *Eric Jeffs, "Green Energy: Sustainable Electricity Supply with Low Environmental Impact" CRC Press,2009* 2. *Xianguo Li,"Green Energy-Basic Concepts and Fundamentals" Springer Verlog, London Ltd, 2011*	3. *Dincer, C. Zamfirescu, "Sustainable Energy Systems and Applications", Springer, 2012.* 4. *Frank Kreith, Susan Krumdieck, "Principles of Sustainable Energy Systems", 2nd Edition, Taylor & Francis, 2014.* 5. *Bryan Leyland , "Small hydroelectric engineering practice", CRC Press, 2014*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	*-*	*15%*	*-*	*15%*	*-*
Level 2	*Understand*	*25%*	*-*	*20%*	*-*	*25%*	*-*
Level 3	*Apply*	*30%*	*-*	*25%*	*-*	*30%*	*-*
Level 4	*Analyze*	*30%*	*-*	*25%*	*-*	*30%*	*-*
Level 5	*Evaluate*	*-*	*-*	*10%*	*-*	*-*	*-*
Level 6	*Create*	*-*	*-*	*5%*	*-*	*-*	*-*
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr . R. Karthick GM Operations Flexiflo India Pvt Limited alwarpet Chennai,karthik@flexiflo.ae*	1. *Dr.M.Venkataraman Professor Institute for Energy Studies venkat@annauniv.edu*	1. *Dr T.Lakshmanan SRMIST*
2. *Mr R.M RaghunathanAssistant Vice President,TamilNadu Petro Products Limited, Manali Chennai, Email: mlrmr@hotmail,com*	2. *.Dr .R L Krupakaran, Associate Professor, Dept of Mechanical Engineering, Mohan Babu University, Tirupathi krupakarank1305@gmail.com*	2. *Mr. S.Arul Kumar, SRMIST*

Course Code	21MEE301T	Course Name	OPTIMIZATION IN ENGINEERING DESIGN	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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*apply advanced concepts of mathematics to formulate design optimization problems*
CLR-2:	*apply various conventional optimization techniques*
CLR-3:	*familiarize Solving multivariable problems techniques*
CLR-4:	*familiar with Solving problems using unconventional optimization techniques*
CLR-5:	*familiar with Application of optimization to design of machine elements*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*define the optimization principles and its need*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	*1*	-
CO-2:	*apply the concept of conventional optimization techniques*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	*3*	-
CO-3:	*apply the concept of constrained in single variable and multivariable*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	-	*3*	-
CO-4:	*apply the concept unconventional optimization techniques*	*3*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	*3*	-
CO-5:	*apply the methods of optimization in real life situation*	*3*	*3*	*3*	-	-	-	-	-	-	-	-	-	-	*3*	-

Unit-1 - Introduction to Optimization — ***9 Hour***

Introduction, methods, engineering applications of optimization Statement of an optimization problem-classification of optimization problems Single variable optimization Multivariable optimization with no constraints-Multi variable optimization with equality and in equality constraints problems on maximum and minimum values of the function and an inflection point, design of a thin wall tray with minimal material

Unit-2 - Unconstrained Nonlinear Optimization — ***9 Hour***

Region elimination methods: Unrestricted search, Dichotomous Search, Fibonacci method, Golden Section method Random search Univariate Method Gradient search

Unit-3 - Multivariable Unconstrained and Constrained Optimization. — ***9 Hour***

Direct search methods: Random jumping method, Random walk method Tutorials on Random Jumping Method Direct search methods: conjugate gradient method, quasi- Newton methods - Indirect methods – Penalty function method Geometric Programming - Posynomial-Unconstrained Primal Dual Relation Ship And Sufficiency Condition In The Unconstrained Case

Unit-4 - Modern Methods of Optimization — ***9 Hour***

Genetic Algorithm Introduction Basic elements of natural genetics—reproduction, crossover, and mutation The computational procedure involved in optimizing the fitness function in genetic algorithm Tutorials on Genetic Algorithm, Simulated Annealing: Introduction to Ant Colony Optimization particle swarm optimization problems

Unit-5 - Optimum Design of Machine Elements — ***9 Hour***

Optimum design of machine elements Design optimization of springs Objective function for springs Design optimization of shafts and torsionally loaded members Design vectors for torsionally loaded members Design designing the rectangular column

Learning Resources	1. *Rao Singaresu.S, "Engineering Optimization – Theory & Practice", New Age International (P) Limited, New Delhi, 2011.* 2. *Kalyanamoy Deb, "Optimization for Engineering design algorithms and Examples", Prentice Hall of India Pvt. Ltd., 2012.*	3. *Johnson Ray C, "Optimum design of mechanical elements", Wiley, John & Sons, Digitized 2007* 4. *Goldberg .D.E, "Genetic algorithms in search, optimization and machine", Barnen, Addison Wesley,New York, · 2013.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*20%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*25%*	-	*30%*	-
Level 5	*Evaluate*	-	-	*10%*	-	-	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. N. Babu, CVRDE, DRDO, Avadi, babu.n.cvrde@gov.in*	1. *Dr. Shankar Krishnapillai, IITMadras, skris@iitm.ac.in*	1. *Mr. Vamsi Krishna D, SRM IST*
2. *Mr. Parameswaran, Nokia, Chennai, parameswaran.s@nokia.com*	2. *Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	2. *Dr. M. R. Stalin John, SRM IST*

Course Code	21MEE302T	Course Name	DESIGN OF TRANSMISSION 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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*select the flat belt, V-belt, chain and wire ropes*
CLR-2:	*know the concepts of journal bearing, ball bearings, roller bearings*
CLR-3:	*apply the concepts of friction clutches and brakes*
CLR-4:	*be familiar with the concepts of power screws*
CLR-5:	*know the concepts of automotive transmission systems*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*design the belts, chain, and wire ropes*	2	-	3	-	-	-	-	-	-	-	-	-	-	3	-
CO-2:	*design the journal bearing, ball bearings and roller bearings*	2	-	3	-	-	-	-	-	-	-	-	-	-	3	-
CO-3:	*design the clutches and brakes*	2	-	3	-	-	-	-	-	-	-	-	-	-	3	-
CO-4:	*design the power screws for various applications*	2	-	3	-	-	-	-	-	-	-	-	-	-	3	-
CO-5:	*design the automotive transmission systems*	2	-	3	-	-	-	-	-	-	-	-	-	-	3	-

Unit-1 - Flexible Drives	***9 Hour***
Belt drives: types, selection of belt drives-Belt materials and applications-Selection and problems on flat belt drives using fundamental equations-Selection procedure and problems on flat belt drives using manufacturer's data, Selection procedure and problems on V-belt drives using fundamental equations-Selection procedure and problems on V-belt drives using manufacturer's data, Wire ropes: types, construction and Selection of wire ropes-Stresses in wire ropes-Selection procedure for wire ropes-Problems on wire ropes, Power transmission chains: types and applications-Selection procedure on power transmission chains and sprockets-Problems on power transmission chains and sprockets	
Unit-2 - Bearings	***9 Hour***
Hydrodynamic journal bearings-Sommerfeld Number, Raimondi and Boyd graphs-Bearing materials, properties required for bearing materials, System of lubrication-Selection procedure and problems on journal bearing, Roller contact bearings-Types of bearing, Load rating, bearing materials and bearing failure- selection and problems on ball bearings	
Unit-3 - Friction	***9 Hour***
Friction-types, laws of solid and dry friction, limiting angle of friction-single plate clutch- theory and problems, multi plate clutch- theory and problems, cone clutch- theory and problems, centrifugal clutch- theory and problems, Friction in brakes- types-block or shoe brake- theory and problems, band and block brake - theory and problems, internal expanding shoe brake.	
Unit-4 - Power Screws	***9 Hour***
Types of Screw Threads used for Power Screws-Multiple Threads-Torque Required to Raise Load by Square Threaded Screws-Torque Required to Lower Load by Square Threaded Screws-Efficiency of Square Threaded Screws-Maximum Efficiency of Square Threaded Screws-Efficiency vs. Helix Angle-Overhauling and Self-locking Screws-Efficiency of Self Locking Screws-Coefficient of Friction-Acme or Trapezoidal Threads-Stresses in Power Screws-Design of Screw Jack	

Unit-5 - Automotive Transmission Systems	***9 Hour***
Fluid coupling-principle of operation-working and constructional details of fluid coupling-torque capacity-performance characteristics of fluid coupling-reduction of drag force in fluid coupling and types-problems on fluid coupling, Torque converter-principle of operation-constructional details of single phase torque converter-difference between fluid coupling and torque converter-performance characteristics of torque converter, Automatic transmission-block diagram-components-construction and working of hydraulic control system-advantages, limitations and applications	

Learning Resources	1. *Robert. C. Juvinall, Kurt. M. Marshek, "Fundamentals of Machine Component Design", John Wiley & sons, 6th Edition, 2017.* 2. *Joseph Edward Shigley and Charles R. Mischke, "Mechanical Engineering Design", McGraw –Hill International Editions, New York, 10th Edition, 2014.* 3. *Spotts, M.F., Shoup, T.E., Hornberger, L.E., "Design of Machine Elements", Prentice Hall of India Eighth Edition, 2018.*	4. *Crouse, W.H., Anglin, D.L., "Automotive transmission and power train construction", Mc Graw Hill, 2016* 5. *Khurmi R.S, Gupta J.M., "A text book of machine design", S.Chand &Company Ltd, 25th revised edition, 2020.* 6. *P.S.G Tech..,"Design Data Book", Kalaikathir Achchagam, 2012.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*25%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*30%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*30%*	-	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. N. Babu, CVRDE, DRDO, Avadi, babu.n.cvrde@gov.in*	1. *Dr. Shankar Krishnapillai, IITMadras, skris@iitm.ac.in*	1. *Mr.V.Raghavendra Rao, SRM IST*
2. *Mr. Parameswaran, Nokia, Chennai*	2. *Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	2. *Mr.D.Raja, SRM IST*

Course Code	21MEE303T	Course Name	MICRO AND NANO MACHINING	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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*understand the mechanical micro machining process*
CLR-2:	*illustrate the Thermal micro machining process*
CLR-3:	*learn the Nano polishing and Nano technology concepts*
CLR-4:	*comprehend the concepts of MEMS*
CLR-5:	*be acquainted with Metrology of Micro and Nano machined components*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*compile the basic micro machining processes*	*3*	-	-	*1*	-	-	-	-	-	-	-	-	-	*2*	-
CO-2:	*demonstrate the various thermal energy based micro machining processes*	*3*	-	-	*1*	-	-	-	-	-	-	-	-	-	*2*	-
CO-3:	*express the nano technology concepts*	*3*	-	-	*1*	-	-	-	-	-	-	-	-	-	*2*	-
CO-4:	*acquire knowledge on MEMS*	-	-	-	*1*	*3*	-	-	-	-	-	-	-	-	*2*	-
CO-5:	*demonstrate metrology and characterization of micro machined components*	-	-	-	*3*	*1*	-	-	-	-	-	-	-	-	*2*	-

Unit-1 - Introduction ***9 Hour***

Introduction of micro machining process, Mechanical Micro machining; micro turning, micro milling, Ultra Sonic micro machining, Chemical and Electro Chemical Micro Machining, Bio Machining.

Unit-2 - Thermal Micro Machining ***9 Hour***

Introduction of Beam Energy based micro machining; Electron Beam, Laser Beam, Electric Discharge, Ion Beam, Focused Ion Beam and Plasma Beam Micro Machining. Hybrid Micro Machining Processes, Electro Chemical Spark Micro Machining (ECSMM).

Unit-3 - Nano Polishing ***9 Hour***

Nano Polishing of Abrasive Flow finishing; Magnetic Abrasive Finishing, Magneto Rheological Finishing, Magneto Rheological Abrasive Flow Finishing, Magnetic Float Polishing. Elastic Emission Machining, Chemo-Mechanical Polishing

Unit-4 - MEMS ***9 Hour***

Micro- Electro- Mechanical Systems, Lithography, Doping, Ion Implantation, Silicon Oxidation, Crystallography, Etching, Physical vapor deposition, Chemical Vapor deposition, Biotechnology integration, Optical MEMS

Unit-5 - Metrology , Characterization and Applications ***9 Hour***

Metrology of micro machined components, challenges in measuring Micro machined components, CMM, Interferometry, Laser interferometry, SEM, TEM, EBSD , Fabrication of Microelectronic Devices, Dimensional Metrology for Micro/Mesoscale Manufacturing, Generalized applications

Learning Resources	1. *Jain V.K., Introduction to Micro machining, Narosa Publishing House.* 2. *Jain V. K., Micro Manufacturing Processes, CRC press, Taylor & Francis Group.* 3. *Norio Taniguchi, Nano Technology, Oxford University Press, New York.* 4. *Bharat Bhushan, Handbook of nanotechnology, springer, Germany.* 5. *Jain V. K., Advanced Machining Processes, Allied Publishers, Delhi.*	6. *Megeoug J.A., Micromachining of Engineering Materials, CRC Press.* 7. *Tai–Ran Hsu – 'Mems & Microsystems Design and Manufacturing' – John Wiley & Sons – 2008 – 2nd Edition* 8. *Microfacbrication & Nanomanufacturing, Mark J. Jackson, CRC press* 9. *A review on micro-milling: recent advances and future trends, The International Journal of Advanced Manufacturing Technology volume 112, pages655–684 (2021)*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*20%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*25%*	-	*30%*	-
Level 5	*Evaluate*	-	-	*10%*	-	-	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr. Thayumanavan.E, Operation Planning Engineer, FORD Chennai.*	1. *Dr. Karthic Narayanan R, IIITDM Kancheepuram*	1. *Dr. Deepan Bharathi Kannan T, SRMIST*
2. *Mr. Sundar. L, Senior Manager, Drive Train Engineering, Ashok Leyland, Chennai*	2. *Dr. Eswaramoorthy, IIITDM Kurnool*	2. *Mr. Manoj Samson, SRMIST*

Course Code	21MEE304T	Course Name	MACHINE VISION	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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*be familiar with the sensors and Image acquisition system*
CLR-2:	*be familiar with the basics of image processing in Frequency domain*
CLR-3:	*be familiar with the image enhancement and feature extraction*
CLR-4:	*know the digital image correlation algorithms*
CLR-5:	*practice the image classification tasks using image processing software*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*establish the basic functions of machine vision system along with knowing fundamentals of planar sensor*	-	*3*	-	-	-	-	-	-	-	-	*3*	*3*	-	-	-
CO-2:	*learn the image fundamentals and mathematical transforms necessary for image processing*	-	*3*	-	-	*3*	-	-	-	-	-	-	-	-	-	-
CO-3:	*extract the features from the images after segmentation*	-	*3*	-	*2*	-	-	-	-	-	-	-	-	-	-	-
CO-4:	*explore the object recognition and image correlations*		*2*	-	*3*	-	-	-	-	-	-	-	-	-	*2*	-
CO-5:	*list the techniques involved in machine learning, deep learning used in image processing*	-	*3*	-	-	*2*	-	-	-	-	-	-	-	-	*2*	-

Unit-1 - Introduction to Machine Vision and Fundamentals of Image Acquisition	***9 Hour***
Review of existing machine vision systems-Binary, gray vision system- industrial applications-basic functions of machine vision system- Elements of visual perception, structure of eye-Image acquisition and digitization, sensing, Illumination and its types, point sensor, line and plane sensor- CCD and CMOS Cameras, Representing Digital Images, Spatial and Intensity Resolution, Problems on quantization and sampling, Practice on reading image and exercise on spatial resolution and sampling	
Unit-2 - Low Level Vision and Image Enhancement	***9 Hour***
Relationship between pixels: connectivity, distance measures- mean, median Filtering, - Smoothing of binary images-Histogram equalization- frequency domain - Basic steps in frequency domain filtering- Low pass filtering, Ideal low pass filter ,Butterworth low pass filter ,Image sharpening, Butterworth filters -Generation of spatial masks from frequency domain specification, Practice on image filtering	
Unit-3 - Image Segmentation and Feature Extraction	***9 Hour***
Thresholding, Edge detection, gradient operators, Laplacian operator, HOG and SIFT -region based segmentation, boundary descriptors ,Chain code, Fourier descriptors, Region descriptors, Texture analysis, Practice Problems based on feature extraction	
Unit-4 - Object Recognition and Image Correlations	***9 Hour***
Object recognition, Approaches to Object Recognition, structural methods, matching shape numbers, string matching- Digital image correlation- Algorithms, Strain measurement in tensile testing- Fracture behavior-3D Vision- Motion analysis	
Unit-5 - Deep Learning and Artificial Intelligence in Image Processing	***9 Hour***
Image Features - Artificial Neural Network for Pattern Classification –CNN- Introduction to Deep Learning -Applications of Deep Nets: Image segmentation, Object recognition, Transformation invariant recognition. Visual Tracking with Deep trained nets; Bayesian Belief Networks for Semi-supervised learning. Recurrent NN	

Learning Resources	1. *Anil K. Jain, "Fundamentals of Digital Image Processing", Prentice Hall of India, New Delhi, 2007.* 2. *Rafel.C.Gonzalez and Richard E.Woods, "Digital Image Processing", Addison Wesley, New York, 3rd editon, 2016.* 3. *Milan Sonka, Vaclav Hlavac , Roger Boyle , "Image Processing, Analysis, and Machine Vision", Cengage Learning, 2015* 4. *William K. Pratt, "Digital Image Processing", John Wiley, New York, 2007.* 5. *Jürgen Beyerer, Fernando Puente León, Christian Frese, " Machine Vision, Automated Visual Inspection: Theory, Practice and Applications", 2016, Springer Berlin Heidelberg*	6. *Fabio Solari, Manuela Chessa and Silvio P. Sabatini, Machine Vision: Applications and Systems, InTech (2012)* 7. *Tercero, J. S., Enano, N. V., "Learning Image Processing with OpenCV: Exploit the Amazing Features of OpenCV to Create Powerful Image Processing Applications Through Easy-to-follow Examples". United Kingdom: Packt Publishing, 2015* 8. *Singh, Himanshu. Practical Machine Learning and Image Processing: For Facial Recognition, Object Detection, and Pattern Recognition Using Python. Germany, Apress, 2019.* 9. *Deep Learning for Computer Vision: Image Classification, Object Detection, and Face Recognition in Python. N.p., Machine Learning Mastery, 2019.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*20%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*25%*	-	*30%*	-
Level 5	*Evaluate*	-	-	*10%*	-	-	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Dr. S. A. Krishnan, IGCAR, Kalpakkam*	1. *Dr. N. Arunachalam, Associate Professor, IIT Madras*	1. *Dr.A.Vijaya, SRMIST*
2. *Mr. Narasimhan Sridhar, Tesa Technologies*	2. *Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	2. *Dr. R. Senthil Nathan, SRMIST*

Course Code	21MEE305T	Course Name	QUALITY MANAGEMENT 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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*know about the quality improvement of goods and services*
CLR-2:	*utilize the tools of quality management*
CLR-3:	*impart knowledge on system reliability and system maintenance*
CLR-4:	*familiarize the differences between common and special causes of variations and their influence to technological processes outcomes*
CLR-5:	*practice the benefits of teamwork to get better results*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*impart the quality aspects based on customer feedbacks*	-	-	-	-	-	-	-	-	-	-	*3*	*3*	-	-	-
CO-2:	*utilize the quality management tools*	-	*3*	-	-	*3*	*2*	-	-	-	-	-	-	-	*1*	-
CO-3:	*design systems with a focus on enhancing reliability and availability*	-	*3*	*3*	-	-	-	-	-	-	-	-	-	-	*2*	-
CO-4:	*benchmark the quality management principles and standards*	*3*	-	*2*	-	-	*2*	-	-	-	-	-	-	-	*1*	-
CO-5:	*work in team to achieve quality awards*	-	-	-	-	-	*3*	-	-	*3*	-	-	*3*	*3*	-	-

Unit-1 - Introduction to Quality, Customer Focus and Cost of Quality ***9 Hour***

Evolution of Quality - Definition of Quality - Dimensions of Quality - Quality policy - Quality objectives - McKinsey 7s model - Contributions of Deming, Juran and Crosby - Customer requirements, Meeting customer needs and expectations, Customer satisfaction and Understanding customer behavior, Customer value evaluation, Case studies, Kaizen – Problem solving- Cost of quality, Categories of cost of Quality, Models of cost of quality

Unit-2 - Quality Control Tools and SQC ***9 Hour***

Quality control tools – Check sheet, Histogram, Pareto chart, Cause & Effect diagram, Scatter diagram, Control chart. Statistical Quality Control - Acceptable Sampling, Sampling methods, Probability based sampling, Acceptance sampling plans, Control Charts – X bar, R, p np -simple problems- Process Capability, Six Sigma Techniques – case studies

Unit-3 - Reliability and Maintainability ***9 Hour***

System reliability- Series, Parallel and mixed configuration, Problems, Weibull distribution and application. Mean time to repair, Mean time between failures, Predictive maintenance, Reliability Centered Maintenance, Reliability improvement – Redundancy - Unit and stand by redundancy – Maintainability and availability – System downtime – Reliability and Maintainability trade off –Simple problems

Unit-4 - Quality Management System and Benchmarking ***9 Hour***

Quality Management Principles, ISO 9001, ISO 9000:2000, ISO 14000, Quality Audits, ISO Registration, Requirements, Benefits of ISO registration, Examples of ISO Standard Application – Benchmarking - Definition Reasons, Types, Process, Advantages and Limitations. Taguchi techniques – introduction, loss function, parameter and tolerance design, signal to noise ratio.

Unit-5 - Employee Involvement, Team Building and Quality Awards ***9 Hour***

Importance of Employee Involvement, Empowerment, Motivation & Theories of Motivation, Recognition and Reward, Suggestion System, Teams in Organizations - Quality Awards - Malcolm Baldrige National Quality Award, Deming Prize-categories-criteria-committee, Rajiv Gandhi National Quality Award. Concepts of Quality circle

Learning Resources	1. *Best Quality management systems by written by James O. Westgard, PHD and Sten Westgard* 2. *A Textbook of Reliability and Maintenance Engineering, Charles Ebeling, UBSPD, 2017.* 3. *E. Balagurusamy, Reliability Engineering, UBSPD, 2017.* 4. *ItayAbuhav ISO 9001: 2015 A complete guide to Quality Management Systems, 2021*	5. *Sachin Grover, Ramesh C Grover, Implementing integrated management system for quality, environment, occupational health & safety and energy: ISO 9001:2015/ISO14001:2015/ISO45001:2018/ISO50001:2018, 2021.* 6. *Amitava Mitra, "Fundamentals of Quality Control and Improvement", Wiley, 5th Edition, 2021.* 7. *Douglas C. Montgomery Introduction to statistical quality control, 8th Edition, 2019, Wiley* 8. *Dale H. Besterfield, Carol Besterfield, Glen H. Besterfield, Mary Besterfield, Hemant Urdhwareshe, Rashmi Urdhwareshe. Total Quality Management (TQM) 5e, 2018, Pearson*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*25%*	-	*20%*	-	*25%*	-
Level 3	*Apply*	*30%*	-	*25%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*25%*	-	*30%*	-
Level 5	*Evaluate*	-	-	*10%*	-	-	-
Level 6	*Create*	-	-	*5%*	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. Paneerselvam Ramaswamy, Principal Director, MSME, TDC, Agra*	1. *Dr. N. Arunachalam, Associate Professor, IIT Madras*	1. *Dr. I. Infanta Mary Priya, SRMIST*
2. *Dr. Mallikarjun Koripadu, Director BOM Consulting, Labcorp Drug Development, Bengaluru*	2. *Dr. S. Kumaresh Babu, Professor, NIT Trichy*	2. *Dr. E. Vijayaraghavan, SRMIST*

Course Code	21MEE306T	Course Name	ENERGY CONVERSION 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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*understand the functions of thermal power plant*
CLR-2:	*familiarize with the Diesel, Gas and MHD power plants*
CLR-3:	*familiarize with the nuclear plants*
CLR-4:	*understand the renewable energy conversion system*
CLR-5:	*familiarize with the power plant economics and emission control techniques*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*apply the concept of thermal power generation*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*apply the concept of power generation in conventional power plants and MHD power generation*	*3*	-	-	-	-	-	-	-	-	-	-	-	*1*	-	-
CO-3:	*examine the fundamentals of nuclear power plants*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	*apply the concepts of power generation from renewable energy sources*	*3*	-	-	-	-	-	*3*	-	-	-	-	-	*3*	-	-
CO-5:	*apply the concepts of plant economy and emission control techniques*	*3*	-	-	-	-	-	*3*	-	-	-	*3*	-	*3*	-	-

Unit-1 - Thermal Power Generation	***9 Hour***
Introduction- Plant types, Captive and central plant, Site selection, Plant layout and working, Coal and ash handling, Fuel burning – Furnace, draught system	
Unit-2 - Diesel, Gas Turbine and MHD Power Plants	***9 Hour***
Diesel power plant- site selection, Main components of the Diesel power plant, working principle of Diesel power plant engine. Gas turbine power plant-Open cycle, closed cycle, Gas turbines with intercooling and reheating, Combined cycle power plant, Cogeneration- Classification, Factors influencing cogeneration, technical parameters for cogeneration, Merits and Demerits, Applications in industry, Caste study. Waste hea recovery system, MHD power plant- working principle, Classification, MHD systems, parameters governing power output.	
Unit-3 - Nuclear Power Plant	***9 Hour***
Introduction- Site selection, fission and fusion reaction- chain reaction, fertile and fissile materials, layout of nuclear power plant-reactor components and working principle, types of reactors: Boiling water reactor, pressurized water reactor, sodium-cooled reactor, gas-cooled reactor, fast breeder reactor- Third Generation Reactors – Fourth Generation Reactor Design and Concepts Relative merits and demerits, nuclear fuels-Enriched uranium-Enrichment techniques, slow neutron breeder reactor, advanced reactor design, waste disposal-solid, liquid and gaseous waste, safety measures.	
Unit-4 - Renewable Energy Conversion Systems	***9 Hour***
Introduction- Site selection, wind turbine plants-Types, design and development, OTEC - Ocean Thermal Energy Conversion for Open and closed Systems, solar, solar photovoltaic, concentrated collector plant, tower concept, pumped storage plant, Fuel Cell - Types of Fuel Cells - Polymer electrolyte membrane fuel cells - Solid oxide fuel cells, Biomass - Sources of biomass - Pyrolysis, combustion and Gasification: Fluidized Bed Gasifier, Fermentation and digestion process: Floating Digester Biogas Plants, hybrid plant-types.	
Unit-5 - Power plant Economics, Emissions and Control	***9 Hour***
Introduction- Capital, fixed, operating, variable cost, Factors-load, demand factor, Tariff methods, cost of power generation. Emissions from Power plants-Air pollution, water pollution, control measures for Pollutants, Pollution standards, greenhouse effects and global warming.	

Learning Resources	1. El Wakil MM "Power plant Technology" McGraw Hill Inc 2017. 2. G.R. Nagpal and R. C. Sharma "Power Plant Engineering" Khanna Publishers, 16th Edition, 1995. 3. Ramalingam K K "Power plant engineering", Scitech publications Pvt Ltd, 2015. 4. Arora S C and Domkundwar S "Power plant Engineering",DhanapatRai& sons, New Delhi, 2016	5. Rai G D " Non-Conventional Energy sources, "Khanna publishers, 5thEdition, New Delhi, 2014 6. Nag P K " Power plant Engineering" Tata McGraw-Hill, New Delhi, 4th Edition, 2017.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	40%	-	40%	-	40%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Jayachandran Murugesan, Deputy Manager - Technology & Innovation Thermax Limited, Chennai, Tamil Nadu, India	1. Dr. A. Gurubalan, Assistant Professor, IIT Bombay, Mumbai	1. Mr.S. Malarmannan, SRM IST
2. Mr. Babu P, Head Of Innovation at Thermax Limited, Chennai, Tamil Nadu, India	2. Dr. G Kumaresan, Professor, Anna University, Chennai	2. Dr. K. Sureshkumar, SRMIST
		3. Mr. J. Joji Johnson, SRM IST

Course Code	21MEE307T	Course Name	SUSTAINABLE AND RENEWABLE ENERGY 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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*be familiar with the Sustainable energy sources*
CLR-2:	*familiarize with the solar energy harvesting systems*
CLR-3:	*understand the wind energy conversion systems*
CLR-4:	*be familiar with the concepts of ocean and geothermal energy systems*
CLR-5:	*be familiar with the Sustainability Practices*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*extrapolate knowledge on the Sustainable energy systems*	-	-	-	-	-	-	*2*	-	-	-	-	-	*3*	-	-
CO-2:	*extrapolate knowledge on the solar energy harvesting systems*	-	-	-	-	-	-	*3*	-	-	-	-	-	*3*	-	-
CO-3:	*analyze the wind energy conversion systems*	*3*	-	-	-	-	-	*2*	-	-	-	-	-	*3*	-	-
CO-4:	*explain the ocean and geothermal energy systems*	*3*	-	-	-	-	-	*2*	-	-	-	-	-	*3*	-	-
CO-5:	*extrapolate knowledge on the Sustainability Practices*	-	-	-	-	-	-	*3*	-	-	-	-	-	*3*	-	-

Unit-1 - Introduction to Sustainable Energy Systems	***9 Hour***
Sustainability principles, context for sustainable energy, sustainability considerations, challenges in sustainability, energy efficiency, environmental impact of energy systems, solar radiation balance, climate change	
Unit-2 - Solar Energy	***9 Hour***
Solar radiation and its measurements- types of solar thermal collectors, solar thermal applications -water heaters- solar stills - solar pond- solar refrigeration and air conditioning-solar dryer-solar cookers - solar furnaces- solar thermal power generation. Solar photovoltaic systems- working principle- components - applications	
Unit-3 - Wind Energy	***9 Hour***
Wind energy, -principles -components of wind energy conversion system- wind data, site selection and energy estimation. Types -Horizontal axis- vertical axis. Aerofoil theory-aerodynamic forces acting on the blade, performance of wind turbines, hybrid energy systems (solar and wind), environmental issues of wind energy, offshore wind plants	
Unit-4 - Ocean and Geothermal Energy	***9 Hour***
Wave characteristics and wave energy conversion systems, Tidal energy and its types. Estimation of energy and power in single basin tidal systems. Ocean thermal energy conversion open & closed system. Exploration of geothermal energy- Geothermal power plants-Challenges, availability, geographical distribution.	
Unit-5 - Sustainability Practices	***9 Hour***
Energy Conservation, Energy Storage - thermal & electrical, Carbon-di-oxide technologies- refrigeration and carbon capture technologies, Hybrid Renewable Energy Systems, Distributed Energy Systems, Duck curve	

Learning Resources	1. https://beeindia.gov.in/sites/default/files/1Ch1.pdf Dincer, C. Zamfirescu, "Sustainable Energy Systems and Applications", Springer, 2012. 2. Frank Kreith, Susan Krumdieck, "Principles of Sustainable Energy Systems", 2nd Edition, Taylor & Francis, 2014. 3. Godfrey Boyle, "Renewable energy", 2nd Edition, Oxford University Press, 2010 4. G.D Rai, "Non-Conventional Energy Sources", Khanna Publishers, 5th Edition, New Delhi, 2011.	5. Twidell.J.W and Weir.A.D, "Renewable Energy Resources", 1st Edition, UK, E.&F.N. Spon Ltd, 2006. 6. B.H Khan, "Non-conventional Energy Resources", 2nd Edition, New Delhi, Tata McGraw Hill, 2009. 7. iwari.G.N, Ghosal.M.K, "Fundamentals of renewable energy sources",1stEdition, UK, Alpha Science International Ltd, 2007

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	25%	-	25%	-
Level 2	Understand	30%	-	30%	-	30%	-
Level 3	Apply	30%	-	25%	-	25%	-
Level 4	Analyze		-	20%	-	20%	-
Level 5	Evaluate	-	-		-	-	-
Level 6	Create	-	-		-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr R.M Raghunathan Assistant Vice President, TamilNadu Petro Products Limited, Manali, Chennai, mlrmr@hotmail,com	1. Dr.M.Venkataramanan Professor, Institute for Energy Studies, Anna University, Chennai	1. S. Arul Kumar, SRMIST.
2. Mr .R.Karthick, GM Operations ,Flexiflo India Pvt Limited , Alwarpet, Chennai, Email: karthik@flexiflo.ae	2. Dr .R L Krupakaran,Associate, Professor, Dept of Mechanical Engineering, Mohan Babu University, Tirupathi	2. Dr.S. Manikandan, SRMIST

Course Code	21MEE308T	Course Name	SUSTAINABLE WASTE MANAGEMENT	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	*Mechanical Engineering*	Data Book / Codes / Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*make an awareness of solid waste management*
CLR-2:	*represent the various techniques of waste management and its recycling*
CLR-3:	*provide idea of nature of logistics and supply chain management and its associated techniques*
CLR-4:	*identify the methods for waste management of industrial, agricultural & clinical wastes*
CLR-5:	*provide awareness of economic & social issues of waste management and its effects*

Course Outcomes (CO):	*At the end of this course, learners will be able to:*	Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	*describe basic sustainable waste management and its effect on environment*	*3*	-	-	-	-	-	*2*	-	-	-	-	-	*3*	-	-
CO-2:	*explain solid waste management technologies, recovery & recycle of waste*	*3*	-	-	-	-	-	-	-	-	-	-	-	*3*	-	-
CO-3:	*discuss the nature of logistics and supply chain management and its strategies*	*3*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	*explain the waste management processes in the field of industrial, agricultural and clinical wastes*	*2*	-	-	-	-	-	*3*	-	-	-	-	-	*2*	-	-
CO-5:	*discuss the social and economic impacts on the waste management*	-	-	-	-	-	-	*3*	*2*	-	-	-	-	-	-	-

Unit-1 - Waste Management	***9 Hour***
Waste Management in India – Hierarchy of Sustainable Waste Management – Current Waste Handling Practices in India: Composting or Mechanical, Biological Treatment, Reuse Derived Fuel, Waste–To–Energy Combustion– Improper Waste Disposal – Method to Reduce Food Waste (SUSTAINABLE)	
Unit-2 - Solid Waste Management (SWM) Technology	***9 Hour***
Classification– Waste Management – Waste Operational Units: Equipment and Facilities, Collection and Transportation, Treatment: Mechanical and Biological – Mixed SWM: Biodegradable, Packaging, Vehicles, Scrap, Electrical and Electronic Equipment, Construction and Demolition Wastes – Recycling Process (Policies)	
Unit-3 - Logistics and Supply Chain in Waste Management	***9 Hour***
Logistics and Supply Chain, Suitability in Freight Transport, Warehouses, Product Design with Cleaner Production — Nuclear Waste – Agricultural Waste Management, Biogas – Clinical Wastes: Disinfection, Electron Beam for Sterilization — Electronics, Vehicle, Battery, SPV Waste Disposal, Recycling – Site Visit	
Unit-4 - Industrial Waste Management	***9 Hour***
Solid, Water and Air Pollution by Industrial Activities – Waste and its Sustainable Disposal in Industry: Sugarcane, Metal, Textile, Cement, Plastics, Electronics - Waste Management for Industrial Estates, Infrastructure Development	
Unit-5 - Economic and Social Concerns	***9 Hour***
Environmental Pollution in Indian Cities: Health Issues – Waste Management Cost and Revenue – Socio-Economic Concerns - Performance of Existing System –Indian Government Policies and its Efforts, Waste Management Organizations – Case Studies	

Learning Resources	1. *Mary K Theodore, Louis Theodore, Introduction to Environmental Management, CRC Press., 2010*	2. *David B Grant, Alexander Trautrims and Chee Yew Wong., Sustainable Logistics and Supply Chain Management, Second edition, Kogan Page, 2013*

Learning Assessment							
	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*30%*	-	*30%*	-	*30%*	-
Level 4	*Analyze*	*30%*	-	*30%*	-	*30%*	-
Level 5	*Evaluate*	-	-	-	-	-	-
Level 6	*Create*	-	-	-	-	-	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers		
Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr R.M Raghunathan Assistant Vice President, TamilNadu Petro Products Limited, Manali, Chennai, mlrmr@hotmail,com*	1. *Dr.M.Venkata Ramanan Professor, Institute for Energy Studies, Anna University, Chennai venkat@annauniv.edu*	1. *Mr. S. Ponsankar, SRMIST*
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