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 – 17B
(Syllabi for Mechanical Engineering w/s Artificial Intelligence and Machine Learning 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

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	21MEE351J	Course Name	IOT SYSTEMS DESIGN	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	0	2	3

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

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1:	*recognize concepts of IoT*
CLR-2:	*develop applications using IoT hardware*
CLR-3:	*identify IoT protocols*
CLR-4:	*select appropriate sensing elements for IoT*
CLR-5:	*further develop IoT 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:	*define the IoT concept and apply in the field of mechanical engineering*	-	-	2	1			-	-	-	-	-	-	-	-	-
CO-2:	*explore IoT architecture for mechanical applications*	-	-	2	1	-	-	-	-	-	-	-	-	-	-	-
CO-3:	*implement sensing elements for smart systems*	-	-	2	1	-	-	-	-	-	-	-	-	-	1	-
CO-4:	*classify various Protocols in Networks*	-	-	2	1	1	-	-	-	-	-	-	-	-	-	-
CO-5:	*find coherence of IoT applications in various fields*	-	-	2	2	-	-	-	-	-	-	-	-	1	-	-

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

Definition and Characteristics of IoT, Genesis of IoT, IoT - Digitization, Impact, Convergence, Challenges, and Communication Models - APIs, IoT Network Architecture and Design: Drivers Behind New Architectures – Scale, Security, constrained Devices and Networks, Data, Legacy Device Support, Comparing IoT Architectures, M2M IoT standardized Architecture, IoT OSA Layer - Simplified IoT Architecture - Core IoT Functional Stack – Layer 1 to 3. Practice: 8051 Microcontroller trainer kit – Traffic light Control system, Alarm System, Counter based LED

Unit-2 - IoT Hardware — ***9 Hour***

Introduction to Hardware used for IoT, Comparison of Microprocessors and Microcontrollers, Peripheral Interface Controller (PIC)- pin diagram, architecture, -,Advanced Risc Machine (ARM) - Architecture. IoT platforms design methodology, IoT physical devices and Endpoints, Open Source Microcontroller – pin diagram , Programming, Open Source Microprocessor - Hardware Layout, Operating system Programming. Practice Exercise : ARM Trainer kit –External Interrupt for Temperature Sensor using Onchip ADC, Line Following Robot

Unit-3 - Manufacturing Information Sensing System — ***9 Hour***

Real-Time and Multisource Manufacturing Information Sensing System, Sensor and Multiple sensor management system, RFID reader, Temperature and humidity sensor, Displacement sensor, Acoustic Emission, Acceleration sensor, Piezo electric Sensor, Smart water and electricity meters. Reconfigurable Manufacturing Systems (RMS), Manufacturing Grid (M- Grid), Cloud Manufacturing. Case studies on IoT Sensors and Smart system in Industries - Smart Assembly Station, Smart Trolley, Production Scheduling System. Practice Exercise : open source based on microcontroller - RFID, Automatic gas leakage indication system IoT protocols and Network Layer

Unit-4 - IoT Protocols and Network Layer — ***9 Hour***

IoT protocols: Bluetooth, Zigbee, 6 LoWPAN Zigbee, Routing Protocol, Cognitive RPL (CORPL), Lossy Network, Channel Aware Routing Protocol (CARP), Dynamic Host Configuration Protocol (DHCP), Internet Control Message Protocol (ICMP), MAC Layer, Network layer- IPv4, IPv6. IoT Transportation layer, Transmission Control Protocol (TCP), User Datagram Protocol (UDP), Datagram Congestion Control Protocol (DCCP), Stream Control Transmission Protocol (SCTP), IoT service layer, IoT Security layer, MAC 802.15 and its applications. Practice on IoT Protocol simulation system, security system

Unit-5 - IoT Applications	***9 Hour***
Architecture for connected factory- Converged Plantwide Ethernet (CPwE) design, Architecture. Real-Time Location System (RTLS), Industrial automation control- EtherNet / IP, PROFINET, Media Redundancy Protocols (MRP), Industrial safety using Industrial Demilitarized Zone (DMZ), Edge Computing. Case study on IoT devices - Oil and Gas Industry, power utility Industry, supply chain management, Biomechanics, autonomous vehicle. Practice: Open source Microprocessor – Vision based lane tracking system, Barcode Reader, Automatic Valve control of fuel valve.	

Learning Resources	1. *David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols and Use Cases for the Internet Things", First Edition, Pearson Education (Cisco Press Indian Reprint). (ISBN: 978 – 9386873743).* 2. *Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on Approach)", First Edition, VPT, 2014 (ISBN: 978 – 8173719547).* 3. *Jonathan Follet, Designing for Emerging Technologies – UX for Genomics, Robotics and the Internet of things technologies, O' Reilly, 2014.* 4. *Adrian McEwen, Hakim Cassimally, "Designing the Internet of things", John Wiley and sons, Ltd, First Edition, 2014.* 5. *Srinivasa K. G, "Internet of Things", CENGAGE Leaning India, 2017.*	6. *Francis DaCosta, "Rethinking the Internet of Things – A Scalable Approach to Connecting Everything", A Press, 2013.* 7. *Raj kamal, Internet of Things: Architecture and Design Principles", First Edition, McGraw Hill Education, 2017. (ISBN: 978 – 9352605224).* 8. *Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The evolving world of M2M communications", ISBN: 978- 1-118-47347-4, Willy Publications* 9. *Bolton W., "Mechatronics", Fourth edition, Pearson publishers, 2010.* 10. *Clarence W de Silva, "Sensors and Actuators – Engineering system instrumentation", second edition, CRC press, Taylor and Francis group, 2016.*

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%*	-	-	*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 Saravanan, Principal Engineer, Smart Implements & Machinery and Sustainability, Mahindra Research Valley, Chengalpattu, Tamil Nadu*	1. *Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	1. *Dr. R. Ambigai, SRMIST*
2. *Mr. N Parameswaran, Manager-Production Engineering at Nokia Solutions and Networks Pvt Ltd Chengalpattu, Tamil Nadu, India*		2. *Mr. V. Manoj Kumar, SRMIST*

Course Code	21MEE352J	Course Name	PROGRAMMING FOR MACHINE LEARNING	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:	*develop the basics of machine learning*
CLR-2:	*deal with probability theory and hypothesis testing in machine learning*
CLR-3:	*explore the classification models in machine learning*
CLR-4:	*demonstrate various clustering models and dimensionality reduction in machine learning*
CLR-5:	*delve with artificial neural networks and their types*

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:	*investigate the given problem through data-handling techniques*	-	2	-	3	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*solve the given problem through proper probability and hypothesis testing methods*	-	2	-	3	-	-	-	-	-	-	-	-	2	-	-
CO-3:	*implement various classification models to solve the engineering problem*	-	2	-	3	-	-	-	-	-	-	-	-	2	-	-
CO-4:	*categorize the given problem through various clustering models and apply suitable dimensionality reduction techniques to handle data sets with large variables*	-	2	-	3	-	-	-	-	-	-	-	-	2	-	-
CO-5:	*investigate the given problem through proper ANN techniques*	-	2	-	3	-	-	-	-	-	-	-	-	2	-	-

Unit-1 - Machine Learning Basics Introduction ***9 Hour***

Statistics & Applications solving: Central Limit theorem (histogram), Mean, Median, Mode, Variance, Standard deviation, Quartile deviation, Skewness and kurtosis, Population vs samples, sampling methods. Machine learning basics with python: Data types, Data structures, Numpy, Pandas, Matplotlib/Seaborn, Scikit learn/Keras. Data Manipulation: Variables – Discrete, Continuous, Ordinal, Nominal, Univariate, Bivariate, Multivariate variables. Correlation – Pearson, Rank, Correlation matrix, Cramers V. Data Cleaning – Identifying outliers, Handling missing values. LAB1: Statistical analysis. LAB2: Write a program for Data Manipulation and Cleaning LAB3: Write program for Statistical testing

Unit-2 - Probability Theory and Hypothesis Testing ***9 Hour***

Introduction to probability, probability event and rule, Baye's theorem, computing probability using bayes formula, application of bayes formula, Random variables, probability mass function, probability density function, binomial distribution and its application, Poisson distribution and its application, negative binomial distribution, exponential distribution, finding best probability distribution in a data set. Hypothesis testing: Testing of hypothesis, one-tailed and two-tailed tests, Z statistic and decision rule, one sample t statistic and decision rule, two sample t statistic and decision rule, chi-square test statistic, concept of the parametric and non-parametric test, ANOVA. Regression – Linear regression, OLS, L1 and L2 Regularization. Confusion matrix. LAB4: Solve the given problem by applying Bayes' theorem LAB5: Solve the probability problems, LAB6: ANOVA problems

Unit-3 - Classification Model ***9 Hour***

Introduction to classification & applications, Impact of classification, classification techniques, probabilistic method - Naive Bayes classifier, linear classifiers – support vector method, decision boundaries, decision tree – hunts algorithm, tree induction, spliting continuous variables, measure of impurity, Gini, Entropy, Underfitting and overfitting, random forest classifier. LAB7: Execution of Linear Regression to predict the feasible data LAB8: Compute the Accuracy of the Classifier, considering few test data set LAB9: Use an appropriate data set for building the decision tree

Unit-4 - Clustering Model	***9 Hour***
Introduction to clustering and applications, distance metrics, K-means / median clustering, hierarchical / Agglomerative clustering, DBSCAN. Dimensionality reduction – the curse of dimensionality, LDA, PCA, Factor analysis. LAB10: Program to implement K-means Algorithm to classify the iris data set. LAB11: Perform factor analysis through clustering models LAB12: Perform principal component analysis.	
Unit-5 - Programming for Artificial Neural Network	***9 Hour***
Perceptron, Single layer perceptron, multi-layer perceptron, Backpropagation, feed-forward network, activation functions, CNN, RNN, LSTM. LAB13: Solve a problem through CNN. LAB14: Solve a problem through RNN LAB15: Solve a problem through LSTM.	

Learning Resources	1. *Stephen Marsland, "Machine Learning – An Algorithmic Perspective", Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.* 2. *Tom M Mitchell, "Machine Learning", First Edition, McGraw Hill Education, 2013.* 3. *Alex Smola and S.V.N. Vishwanatha, "Introduction of Machine Learning", First Edition, @ Cambridge University, 2008.* 4. *Michael Bowles, "Machine Learning in Python", John Wiley & Sons, Inc., 2015.* 5. *Shai Shalev-Shwartz, Shai Ben-David, "Understanding Machine Learning from Theory to Algorithms", First edition, Printed in the United States of America, 2014.* 6. *Peter Flach, —Machine Learning: The Art and Science of Algorithms that Make Sense of Data, First Edition, Cambridge University Press, 2012.*	7. *Jason Bell, —Machine learning – Hands on for Developers and Technical Professionals, First Edition, Wiley, 2014.* 8. *Ethem Alpaydin, —Introduction to Machine Learning 3e (Adaptive Computation and Machine Learning Series), Third Edition, MIT Press, 2014.* 9. *Mark Lutz, —Learning Python: Powerful Object-Oriented Programming, Fifth Edition, O'Reilly, Shroff Publishers and Distributors, 2013.* 10. *Pedro Larrañaga, David Atienza, Javier Diaz-Rozo, Alberto Ogbechie, Carlos Esteban Puerto-Santana, Concha Bielza - Industrial Applications of Machine Learning, CRC press, Taylor &Francis group, 2019*

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. *Dr. N Saravanan, Principal Engineer, Smart Implements & Machinery and Sustainability, Mahindra Research Valley, Chengalpattu, Tamil Nadu*	1. *Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	1. *Dr. S. Murali, SRMIST*
2. *Mr. N Parameswaran, Manager-Production Engineering at Nokia Solutions and Networks Pvt Ltd Chengalpattu, Tamil Nadu, India*		2. *Dr. S. Prabhu, SRMIST*

Course Code	21MEE353T	Course Name	MATHEMATICS FOR MACHINE LEARNING	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:	*introduce the basic foundations of linear algebra and matrices*
CLR-2:	*impart knowledge on analytic geometry*
CLR-3:	*introduce the concept of differentiation and vector calculus*
CLR-4:	*impart knowledge on various optimization techniques*
CLR-5:	*explore the application of optimization techniques for machine learning 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:	*acquire the problem-solving knowledge using linear algebra and matrices*	-	*3*	*2*	-	-	-	-	-	-	-	-	-	*1*	*1*	-
CO-2:	*apply the analytic geometry in formulating Mathematical models*	-	*3*	*2*	-	-	-	-	-	-	-	-	-	*1*	*1*	-
CO-3:	*understand the application of differentiation and vector calculus*	-	*3*	*1*	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	*acquire knowledge on various optimization techniques*	-	*3*	*3*	-	-	-	-	-	-	-	-	*1*	*2*	*1*	-
CO-5:	*apply various machine learning Algorithms for Engineering problems*	-	*3*	*3*	-	-	-	-	-	-	-	-	*1*	*2*	*1*	-

Unit-1 - Linear Algebra and Matrix Decomposition	***9 Hour***
System of linear equations, Matrix addition and multiplication, Inverse and transpose of a matrix, Rank of matrix, Matrix decomposition, Determinant and trace of a matrix, Solving system of linear equations, Eigen values and Eigen vectors, Cholesky decomposition, Eigen decomposition and diagonalization, Singular value decomposition, Matrix approximation, Matrix phylogeny	
Unit-2 - Analytic Geometry	***9 Hour***
Inner products, lengths and distances, Angles and orthogonality, K means clustering application of future vector, Existence and uniqueness of solutions, Concept of similarity in machine learning applications, Problems on uniqueness of solution, Problems on similarity, Angles and orthogonality, Orthogonal basis and complement, Inner product of function, Kernel methods, Orthogonal projections, Application problem on orthogonal projections Problems on rotation. Gram-Schmidt Orthogonalization	
Unit-3 - Vector Calculus	***9 Hour***
Differentiation, Differentiation of univariate functions, Partial differentiation, Directional derivatives and gradients, Gradients of vector valued function, Gradients of matrices, Back Propagation, Automatic differentiation and its application, Higher order derivatives, Linearization and multivariate Taylor's series	
Unit-4 - Optimization	***9 Hour***
Single variable optimization, Multivariable optimization without constraints, Necessary and sufficient conditions for minimum / maximum, Multivariable optimization with equality Constraints, Solution by method of Lagrange multipliers, Multivariable optimization with inequality constraints, Optimization using gradient decent, Convex optimization.	
Unit-5 - Central Machine Learning Problems	***9 Hour***
Data, models and learning ,Empirical risk minimization, Concept of cost function, Parameter estimation, Relation to parametric estimation, Model selection, Dimensionality reduction with principal component analysis (PCA), Key steps of PCA, Maximum variance perspective, Eigen vector computation, Low rank approximation problem, Structured low rank approximation problem, Density estimation with Gaussian mixture models.	

Learning Resources	1. *Marc Peter Deisenroth, A Aldo Faisal, Cheng Soon Ong, "Mathematics for Machine Learning", Cambridge University Press, 2020.* 2. *Stephan Boyd, LievenVandenberghe, "Introduction to Applied Linear Algebra: Vectors, Matrices and Least Squares", Cambridge University Press, 2018.* 3. *Gilbert Strang, "Linear Algebra and Learning from Data", Wellesley Cambridge Press, 2019.* 4. *Murphy, Kevin P, "Machine Learning – A Probabilistic Perspective", MIT Press, 2012.*	5. *G. Golub and C. Van Loan, "Matrix Computations", Hindustan Book Agency, 2007.* 6. *L. Trefethen and D. Bau, "Numerical Linear Algebra", SIAM, 1997.* 7. *David Watkins, "Fundamentals of Matrix Computations", Wiley Inter science, 2002.* 8. *B. N. Datta, "Numerical Linear Algebra and Applications", Prentice Hall of India, 2010.* 9. *Muller, Andreas C and Guido, Sarah, "Introduction to Machine Learning with Python – A guide for data Scientists", O'Reilly 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*	*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. N Saravanan, Principal Engineer, Smart Implements & Machinery and Sustainability, Mahindra Research Valley, Chengalpattu, Tamil Nadu*	1. *Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	1. *Dr. R. Rajaraman, SRMIST*
2. *Mr. N Parameswaran, Manager-Production Engineering at Nokia Solutions and Networks Pvt Ltd Chengalpattu, Tamil Nadu, India*		2. *Dr. C. Rajesh, SRMIST*

Course Code	21MEE354T	Course Name	SOFT COMPUTING TECHNIQUES AND 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:	*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 modelling*
CLR-4:	*apply the different types of Artificial Neural Network Techniques*
CLR-5:	*practice on various soft computing techniques used 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:	*discuss the basics of soft computing techniques*	-	-	2	-	-	-	-	-	-	-	-	-	2	-	-
CO-2:	*analyze the Fuzzy logic concept and hybrid modelling*	-	-	3	-	-	-	-	-	-	-	-	-	2	-	-
CO-3:	*illustrate the different techniques of Genetic algorithm*	-	-	3	-	-	-	-	-	-	-	-	-	2	-	-
CO-4:	*analyze the different models of deep learning Techniques*	-	-	3	-	-	-	-	-	-	-	-	-	2	-	-
CO-5:	*illustrate the different computational analysis for Industrial applications*	-	-	-	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- Supervised and Unsupervised learning Techniques-Single and Multi-objective optimization techniques- Practice on Gradient Descent Algorithm.

Unit-2 - Fuzzy Logic Analysis ***9 Hour***

Introduction to Fuzzy logic, Fuzzy sets, Membership functions, Fuzzy rules, Fuzzy logic architecture-Adaptive Neuro-Fuzzy Inference Systems (ANFIS) modelling with applications-Simulated annealing-Evolutionary computation.

Unit-3 - Genetic Algorithm Optimization ***9 Hour***

Introduction, Population, Fitness function, Crossover, Mutation, Reproduction-Solving single-objective optimization problems using GAs- hybrid techniques like ANN-GA, ANN-PSO- Multi-Objective Optimization Using Weighted Principal Component Analysis-Particle swarm optimization (PSO) Algorithm-Simulated Annealing..

Unit-4 - Deep Learning Computing Techniques ***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

Unit-5 - Soft Computing Applications ***9 Hour***

Applications of GA in Mechanical Industries- Artificial Neural Networks in CFD applications-Applications of CNN in Robot vision- Applications of Fuzzy logic in Machining, Robotics and Composites-Application of soft computing techniques to solve design, thermal and manufacturing related case studies.

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, 2000.* 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.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*	*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. N Saravanan, Principal Engineer, Smart Implements & Machinery and Sustainability, Mahindra Research Valley, Chengalpattu, Tamil Nadu*	1. *Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	1. *Dr. S. Prabhu, SRMIST*
2. *Mr. N Parameswaran, Manager-Production Engineering at Nokia Solutions and Networks Pvt Ltd Chengalpattu, Tamil Nadu, India*		2. *Mr. R. Saravanakumar, SRMIST*

Course Code	21MEE355T	Course Name	ARTIFICIAL NEURAL NETWORK	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:	*identify the fundamental concepts of Artificial Neural Networks (ANN)*
CLR-2:	*utilize the core functions of ANN in Mechanical Engineering*
CLR-3:	*apply technical aspects of ANN*
CLR-4:	*utilize the self-organizing maps in applications*
CLR-5:	*analysis of dynamic programming in ANN*

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 fundamental concepts and core functions*	-	2	-	-	2	-	-	-	-	-	-	-	1	-	-
CO-2:	*construct single-layer perceptron in ANN modeling*	-	3	-	3	3	-	-	-	-	-	-	-	2	-	-
CO-3:	*demonstrate the applications and use of Back Propagation Neural Networks & PCA*	-	3	-	3	3	-	-	-	-	-	-	-	2	-	-
CO-4:	*construct self-organizing maps and their applications*	-	3	-	3	3	-	-	-	-	-	-	-	2	-	-
CO-5:	*analyze dynamic programming for various applications*	-	3	-	3	3	-	-	-	-	-	-	-	2	-	-

Unit-1 - Introduction to Artificial Neural Networks	***9 Hour***
Introduction to ANN, History of ANN, Biological Neurons and Their Artificial Models, Models of Artificial Neural Networks, Learning and Adaptation, Neural Network Learning Rules, Hebbian Learning Rule, Perceptron Learning Rule, Delta rule – Perceptron Types of activation Functions with case studies, Types of learning	
Unit-2 - Single Layer Perceptron	***9 Hour***
Classification model, Features, and decision regions, Perceptron –Convergence Theorem & Linear separability, Solving OR – gate problem using perceptron with case studies. The XOR problem – Single layer neural network, Adaptive Filtering Problem, Unconstrained Organization Techniques, Linear Least Square Filters, Least Mean Square Algorithm - Learning Curves, Learning Rate – feed-forward neural network, Multi-layer perceptron - output representation and decision rule	
Unit-3 - Backpropagation Neural Networks and PCA	***9 Hour***
Back propagation neural network, Cross-validation - Network pruning Techniques, Virtues and limitations of backpropagation learning, Principal-Components Analysis, case studies, Perturbation Theory, Basic Issues Involved in the Coding of Natural Images.	
Unit-4 - Self-Organizing Maps	***9 Hour***
Markov Self organizing Maps (SOM), Introduction to SOM, SOM - Two Basic Feature, Mapping Models, Properties of the Feature Map, Contextual Maps - Hierarchical Vector Quantization, Kernel Self-Organizing Map, Relationship Between Kernel SOM, Kullback Leibler Divergence	
Unit-5 - Dynamic Programming	***9 Hour***
Markov Decision Process, Policy and Value Iteration, Temporal-Difference Learning & its case studies, Q-Learning & its case studies, Least-Squares Policy Evaluation, Dynamic Systems, Stability of Equilibrium States, Types of neural networks - Radial basis function networks, Recurrent neural networks (RNN) & Convolutional neural networks (CNN)	

Learning Resources	1. *Simon Haykins, "Neural Networks - A comprehensive foundation", Macmillan College, Proc. Con. Inc. New York, 2009* 2. *Vallum B. R and Hayagriva V.R "C++, Neural networks and Fuzzy logic", BPB Publications*	3. *Zurada J. M "Introduction to Artificial Neural systems", Jaico Publishing House, New Delhi* 4. *Millon W. T, Sutton R.S and Werbos P.J, "Neural Networks for control", MIT Press* 5. *Kosko,"Neural Networks and Fuzzy systems", Prentice hall of India Pvt. Ltd., New Delhi*

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. N Saravanan, Principal Engineer, Smart Implements & Machinery and Sustainability, Mahindra Research Valley, Chengalpattu, Tamil Nadu*	1. *Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	1. *Mr. V. Veeranaath, SRMIST*
2. *Mr. N Parameswaran, Manager-Production Engineering at Nokia Solutions and Networks Pvt Ltd Chengalpattu, Tamil Nadu, India*		2. *Dr. M.R. Stalin John, SRMIST*

Course Code	21MEE356T	Course Name	MACHINE DIAGNOSTICS AND CONDITION MONITORING	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:	*identify the defects and apply failure analysis*
CLR-2:	*utilize the maintenance systems, manual, records and documents*
CLR-3:	*apply the various sensors for machine condition monitoring*
CLR-4:	*identify the type of Signal conditioning and monitor machine condition*
CLR-5:	*apply instrumentation and interface methods for acquiring data*

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:	*understand machine maintenance and failure analysis*	-	-	*3*	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*distinguish various instrumentation techniques for machine diagnostics and condition monitoring*	-	*2*	*1*	-	-	-	-	-	-	-	-	-	-	*2*	-
CO-3:	*identify the various sensors suitable for condition monitoring of machineries*	-	*2*	*2*	-	*1*	-	-	-	-	-	-	-	-	*1*	-
CO-4:	*explore the different instruments used for signal conditioning*	-	-	*3*	-	*1*	-	-	-	-	-	-	-	-	*1*	-
CO-5:	*identify the requirements of the maintenance and solutions*	-	-	*3*	-	-	-	-	-	-	-	-	-	-	*1*	-

Unit-1 - Machine Fault Diagnostics and Failure Analysis ***9 Hour***

Introduction to Machine diagnostics, Present status, and fault prognosis, future needs, Principles of maintenance – Introduction, reactive maintenance, preventive maintenance, predictive maintenance. Enterprise resource planning, Bath tub curve, Failure mode, effects and criticality analysis (FMECA) - Implementation of FMECA for machinery maintenance, risk priority number for FMECA Engineering. Failure analysis: Introduction, overview of failure analysis, Failure mode. Failure analysis – Manufacturing and installation defects of metal removal and metal working process, heat treatment, welding and cleaning / finishing Assembly at factory or installation at site inspection techniques, Laboratory analysis. Material selection, failure investigation procedure. Failure analysis sampling guide – Before beginning sample removal, Selection of samples for laboratory evaluation. Preparing the failure report

Unit-2 - Instrumentation for Machine Diagnostics and Condition Monitoring ***9 Hour***

Introduction, Measurement standards and errors, Calibration principles. Static and dynamic measurements, Frequency response, Dynamic range, Force measurements, Basic measuring equipment – RMS/Peak meters. Oscilloscope, Power supply, Counters. Vibration – velocity and acceleration, Rotational speed – Stroboscope, Inductive probe, Optical tachometer and Optical encoder, Laser based measurements – Laser vibrometer, rotational laser vibrometer, Chemical composition measurement, Atomic emission and absorption spectrophotometer, Ultrasonic thickness measurement

Unit-3 - Sensors for Condition Monitoring ***9 Hour***

Temperature sensors, types of Temperature sensors, Thermocouple, resistive temperature detector (RTD), Thermistors, comparing temperature sensor, Displacement sensors, types of Displacement sensors, Strain gauge, Linear variable displacement transducer, Potentiometer, Optical shaft encoder, Pressure sensors, types of pressure sensors, Electrical type pressure sensor, Vacuum measurements, Flow sensors, types of flow sensors, Electromagnetic flow meter, Ultrasonic flow meter, Smart Sensors - Mechanical - electronic, transitions in sensing, Applications, Process monitoring by AE sensors, Actuators, DC motor, AC motor, Stepper motor, Servo motors, Non-destructive testing in condition monitoring-Introduction, visual examination, Liquid penetrant testing, Magnetic particle testing, Eddy current testing, Radiography, Ultrasonic testing, NDT by AE sensors and Leak testing

Unit-4 - Signal Conditioning and Operational Amplifier Circuits	**9 Hour**
Principles of signal – conditioning, Common signal conditioning operations, Operational amplifiers, Op Amp terminals, Op Amp characteristics, Ideal Op Amp characteristics, Amplifiers types, Inverting and non-inverting amplifier, Differential amplifier, instrumentation amplifier, Isolation amplifier, Bridge circuits, Wheatstone bridge, Bridge amplifier, Wiring configuration, Filters, RC filters, Active filters, Other Op Amp circuits, integrator, differentiator, comparator, logarithmic amplifier. Voltage to current converter, current to voltage converter, voltage-controlled oscillator, Noise and Noise reduction techniques, induced noise, grounding, shielding, filtering, Sound intensity measurement	
Unit-5 - PC Based Instrumentation System	**9 Hour**
Introduction to PC based instrumentation system, PC interfaces, Software for PC interfacing, Features of PC interfacing, Principles of Data Acquisition, Sampling concepts, Digital to Analog convertor, Analog to Digital convertor, Data acquisition system, Data acquisition configuration, Hardware organization of IBM PC, Bother board components, BIOS services, System resource, interrupt request lines, DMA channels, I/O Space, utilization of system resources System control chips and peripheral control chips, Expansion buses and I/O ports, Peripherals, BIOS services	

Learning Resources	1. *Amiya R Mohanty, Machinery condition monitoring principles and practices - CRC Press, Taylor &Francis Group. 2017* 2. *N. Mathivanan, PC – based Instrumentation concepts and practice, prentice hall of India Private Limited, New Delhi- 110001, 2007.* 3. *Baldevraj, Jayakumar T., Thavasimuthu M., Practical, Non-Destructive Testing-Narosa Publishers 2008.* 4. *Sujatha, C. Vibration and acoustics. Tata McGraw-Hill Education, 2010.*	5. *Isermann. R, Fault diagnosis applications- Springer, 2011* 6. *Luiz Octavio Amaral Affonso, Machinery Failure Analysis Hand Book, Gulf Publishing Company, Austin, United States 2013.* 7. *Fakher chaari, Radoslaw Zimroz Walter Bartelmus, Advances in Condition Monitoring of Machinery in Non-Stationary Operations, 1st Edition, Springer 2015.* 8. *Frank, Randy. Understanding smart sensors. Artech House, 2013.* 9. *Gautschi, G. Piezoelectric Sensorics: Force Strain Pressure Acceleration and Acoustic Emission Sensors Materials and Amplifiers. 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. *Dr. N Saravanan, Principal Engineer, Smart Implements & Machinery and Sustainability, Mahindra Research Valley, Chengalpattu, Tamil Nadu*	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. M. Prakash, SRMIST*

Course Code	21MEE357T	Course Name	DIGITAL SIGNAL AND IMAGE PROCESSING	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:	*get exposed to simple image enhancement techniques in Spatial and Frequency domain*
CLR-3:	*familiarize with the existing concepts of signal processing*
CLR-4:	*learn concepts of Edge detection and segmentation techniques*
CLR-5:	*provide knowledge on Feature extraction and object recognition*

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:	*understand the basic concepts of image acquisition and fundamentals of image processing*	2	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	*learn the low-level image processing like smoothing, discretization and thresholding*	-	2	3	-	-	-	-	-	-	-	-	-	2	-	-
CO-3:	*identify the difference between the types signals and filters in spatial domain*	-	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	*impart the basis of representation techniques to segment the features of image*	-	3	3	-	-	-	-	-	-	-	-	-	3	-	-
CO-5:	*asses the descriptors to identify the segmented features for vision-based system*	-	3	3	-	-	-	-	-	-	-	-	-	-	3	-

Unit-1 - Fundamentals of Digital Signal Processing	***9 Hour***
Introduction to Digital Signal Processing, Classification of systems- Continuous, discrete, linear, causal, stability, dynamic, recursive, time variance- Classification of signals- continuous and discrete, energy and power, mathematical representation of signals, Spatial Domain, Frequency Domain, Introduction to Fourier Transform-DFT,FFT, Filters – Ideal, Butterworth and Gaussian filters, Band reject Filters, Band pass Filters	
Unit-2 - Image Acquisition	***9 Hour***
Elements of visual perception, structure of eye, Image formation in eye, Image acquisition, Illumination and its types, Camera Model and Imaging Geometry, Camera calibration and stereo imaging- Point sensor, line sensor, planar sensor- camera transfer characteristic Pin hole camera, CCD, CMOS Cameras.	
Unit-3 - Elements of Image Processing Techniques	***9 Hour***
Image digitization, Representing Digital Images, Discretization, Neighbors of a pixel, connectivity, Distance measures, preprocessing Neighborhood averaging, Image Enhancement, Histogram Equalization, Histogram Specification, Thresholding, Local and Global Enhancement..	
Unit-4 - Image Segmentation	***9 Hour***
Edge detection, Edge linking via Hough transform – Thresholding - Region based segmentation – Region growing – Region splitting and merging – Morphological processing- erosion and dilation, Segmentation by morphological watersheds – basic concepts – Dam construction – Watershed segmentation algorithm.	
Unit-5 - Feature Extraction and Object Recognition	***9 Hour***
Boundary representation, Boundary description, Freeman chain code, Fourier Descriptor, Regional Descriptors – Topological feature, Texture - Patterns and Pattern classes - Recognition based on matching, mahalanobic procedure, Texture Image Analysis, Applications - Automatic part Recognition, Automated Navigation guidance by vision system.	

Learning Resources	1. *Rafael C. Gonzalez, Richard E. Woods, _Digital Image Processing', Pearson, Fourth Edition, 2017* 2. *Mikell P Groover & Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, "Industrial Robotics, Technology Programming and Applications", Tata McGraw-Hill Education, 2011.* 3. *Kenneth R. Castleman, 'Digital Image Processing', Pearson, 2006.*	4. *D. Sundararajan, "Digital Image Processing -A Signal Processing and Algorithmic Approach", Springer, 2017.* 5. *William K. Pratt, 'Digital Image Processing', John Wiley, New York, 2007.* 6. *Anil K. Jain, 'Fundamentals of Digital Image Processing', Pearson, 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*	*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. N Saravanan, Principal Engineer, Smart Implements & Machinery and Sustainability, Mahindra Research Valley, Chengalpattu, Tamil Nadu*	1. *Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	1. *Mr. V. Manoj Kumar, SRMIST*
2. *Mr. N Parameswaran, Manager-Production Engineering at Nokia Solutions and Networks Pvt Ltd Chengalpattu, Tamil Nadu, India*		2. *Mr. N. Karthikeyan, SRMIST*

Course Code	21MEE358T	Course Name	MACHINE LEARNING THEORY AND 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:	*familiar with the concepts of Machine learning and its variants*
CLR-2:	*identify the type of machine learning*
CLR-3:	*introduce the concepts of Deep Learning*
CLR-4:	*introduce the concepts of Reinforcement learning*
CLR-5:	*impart knowledge about use of machine learning in various industries*

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:	*knowing the basic concepts of machine learning*	-	2	2	-	2	-	-	-	-	-	-	-	-	2	-
CO-2:	*learning the concepts clustering, Dimensionality reduction techniques*	-	2	1	-	2	-	-	-	-	-	-	-	-	3	-
CO-3:	*understand the concepts and the use of deep learning*	-	-	3	-	2	-	-	-	-	-	-	-	-	3	-
CO-4:	*understand the concepts and the use of reinforcement learning*	-	2	2	-	2	-	-	-	-	-	-	-	-	3	-
CO-5:	*ability to apply the machine learning concepts in Industry*	-	1	3	-	1	-	-	-	-	-	-	-	-	2	-

Unit-1 - Introduction to Machine Learning	***9 Hour***
Introduction and basic concepts - Need for machine learning - Types of machine learning - Supervised, Unsupervised learning - Reinforced learning - Deep learning Versus Machine Learning - Relation between - Machine Learning and Statistics - Machine Learning methods based on time – Static learning - Machine Learning methods based on time – Dynamic learning - Function Approximation	
Unit-2 - Supervised and un Supervised Learning	***9 Hour***
Supervised Learning – Classification - Artificial Neural Networks - Bayesian models - Decision trees - Support vector machines - K-nearest neighbor clustering - Regression analysis - Linear regression – Multiple linear regression - Logistic regression Model representation - Unsupervised Learning - Clustering, types of clustering - K - means clustering - Dimensionality reduction - Semi-supervised -learning - Expectation maximization - Hybrid Learning techniques	
Unit-3 - Deep Learning	***9 Hour***
Fundamentals of deep learning - Gradient-Based learning - Back-Propagation - Activation functions - Feature learning - Convolution Neural Networks (CNN) - Recurrent Neural Networks - Deep Feed – forward networks Platform for deep learning - Deep learning software libraries - Applications of deep learning - Case studies on application of deep learning - Deep learning enabled advanced analytics for smart manufacturing	
Unit-4 - Reinforced Learning	***9 Hour***
Elements of Reinforcement learning - Multi-armed Bandits - Finite Markov Decision Processes – The agent – Environment Interface - Goals and Rewards, Returns and Episodes - Unified Notation for Episodic and Continuing Tasks - Policies and Value functions - Optimal Policies and Optimal Value Functions - optimality and Approximation - Dynamic Programming - Policy Evaluation, Policy improvement, Policy iteration, Value iteration - Monte-Carlo Reinforcement Learning - Temporal Difference Learning	

Unit-5 - Applications of Machine Learning in Industrial Sectors	***9 Hour***
Applications of machine learning in Industrial sectors - Energy sector: oil and gas - Basic materials sector: Chemicals and Basic resources - Industrials sector - Industrial manufacturing - Industry 4.0: Introduction - Industry smartization - Industry smartization; Component level case study - Industry smartization: Machine level case study - Industry smartization; Production level case study - Industry smartization: Distribution level case study - Machine Learning Challenges and Opportunities within Smart Industries	

Learning Resources	1. *Simeone O. Machine learning for engineers. Cambridge University Press; 2022 Nov 3.* 2. *Panchal JH, Fuge M, Liu Y, Missoum S, Tucker C. Machine learning for engineering design. Journal of Mechanical Design. 2019 Nov 1; 141(11).* 3. *Aurélien Géron, Hands on Machine Learning with Scikit-learn and Tensor Flow, O'Reilly Publishers, 2016.*	4. *Sutton, Richard S., and Andrew G. Barto. Reinforcement learning: An introduction. MIT press, 2018.* 5. *Larrañaga, P., Atienza, D., Diaz-Rozo, J., Ogbechie, A., Puerto-Santana, C. E., &Bielza, C., Industrial Applications of Machine Learning. CRC Press, 2018.* 6. *Dattaraj Jagdish Rao, The Journey of a Machine Learning Model to Production, Wiley, 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%*	-	*30%*	-
Level 2	*Understand*	*30%*	-	*20%*	-	*30%*	-
Level 3	*Apply*	*20%*	-	*30%*	-	*20%*	-
Level 4	*Analyze*	*20%*	-	*30%*	-	*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 Saravanan, Principal Engineer, Smart Implements & Machinery and Sustainability, Mahindra Research Valley, Chengalpattu, Tamil Nadu*	1. *Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	1. *Dr. A. Arul Jayakumar, SRMIST*
2. *Mr. N Parameswaran, Manager-Production Engineering at Nokia Solutions and Networks Pvt Ltd Chengalpattu, Tamil Nadu, India*		2. *Dr. Shubhabrata Datta, SRMIST*

Course Code	21MEE359T	Course Name	ARTIFICIAL INTELLIGENCE 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 Artificial Intelligence*
CLR-2:	*be familiar with Machine learning and its applications*
CLR-3:	*well-acquainted with Artificial intelligence in Robotics*
CLR-4:	*be familiar with deep learning and its application*
CLR-5:	*be familiar with application of AI in Mechanical and Manufacturing Industry*

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 and the purpose of Artificial Intelligence*	-	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-2:	*illustrate the different applications of Machine learning*	-	2	-	-	-	-	-	-	-	-	-	-	-	3	-
CO-3:	*apply the concept of AI in Robotics field*	-	-	3	-	-	-	-	-	-	-	-	-	2	-	-
CO-4:	*evaluate the different applications of deep learning methods*	-	-	3	-	-	-	-	-	-	-	-	-	2	-	-
CO-5:	*apply the concept of Artificial Intelligence in Mechanical and Manufacturing Industries*	-	-	-	3	-	-	-	-	-	-	-	-	-	3	-

Unit-1 - Introduction to Artificial Intelligence	***9 Hour***
Introduction to AI, Problem formulation, Problem Definition, Production systems, Control strategies, Search strategies, Problem characteristics, Production system characteristics, Specialized production systems, Problem solving methods, Problem graphs, Matching, Indexing and Heuristic functions, Hill Climbing, Depth first and Breath first, Constraints satisfaction — Related algorithms, Measure of performance and analysis of search algorithms.	
Unit-2 - Machine Learning and its Applications	***9 Hour***
Introduction: Basic definitions, types of learning, hypothesis space and inductive bias, evaluation, cross-validation. Linear regression, Decision trees, over fitting. Instance based learning, Feature reduction, Collaborative filtering based recommendation. Probability and Bayes learning, Logistic Regression, Support Vector Machine, Kernel function and Kernel SVM. Computational learning theory, PAC learning model, Sample complexity, VC Dimension, Ensemble learning- case studies	
Unit-3 - Artificial Intelligence in Robotics	***9 Hour***
Reinforcement Learning- planning and search, localization, tracking, mapping and control- A search algorithms- path smoothing algorithms - SLAM algorithm- Precision agriculture- Assistance robots-Robot Performance optimization-Case studies.*	
Unit-4 - Deep Learning and its Applications	***9 Hour***
Biological Motivation-Activation function-Cost function- Collaborative filtering-Vectorization-Back Propagation Algorithm with applications -Feed-Forward Neural Network Algorithm-Recurrent Neural Network Algorithm with applications -Convolutional Neural Network with applications	
Unit-5-Application of Artificial Intelligence in Mechanical Manufacturing Industries	***9 Hour***
Fault diagnosis- Quality inspection- Improving the safety of working places- Material modeling and smart materials-Automobile engineering- building self-driving cars and autonomous vehicles, Auto parking-Machine learning in Machine Tools and Manufacturing Industries.	

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. *E. Alpaydin, Introduction to Machine Learning, Prentice Hall of India, 2006.* 3. *Haykin Simon., Neural networks a comprehensive foundation, Pearson Education, 2nd Edition, ISBN-13: 978-0138958633, 1997.* 4. *Gebrail Bekda,Sinan Melih Nigdeli,Melda Yücel, "Artificial Intelligence and Machine Learning Applications in Civil, Mechanical, and Industrial Engineering (Advances in Computational Intelligence and Robotics)", 2019.* 5. *Xiao-Zhi Gao, Rajesh Kumar, Sumit Srivastava, Bhanu Pratap Soni, "Applications of Artificial Intelligence in Engineering", Proceedings of First Global Conference on Artificial Intelligence and Applications, ISBN: 978-981-33-4604-8,2020.* 6. *Donald.A.Waterman, A guide to expert systems Addison Wesley publishing company , 1997* 7. *Kaushik Kumar, Divya Zindani, Paulo Davim, Artificial Intelligence in Mechanical and Industrial Engineering , ISBN 9781003011248, CRC Press, 2021.* 8. *IFR_Artificial_Intelligence_in_Robotics_Position_Paper_V02.pdf* 9. *Rajasekaran,S., Vijayalakshmi Pai,GA., Neural Network, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications, Prentice Hall India.2010.* 10. *Dan.W. Patterson, "Introduction to Artificial Intelligence and Expert Systems", PHI Learning, 2009.* 11. *Russell Stuart, Norvig Peter, "Artificial Intelligence Modern Approach", Pearson Education series in AI, 3rd Edition, 2010.* 12. *Goodfellow, Bengio, Courville, Deep Learning, MIT Press, 2017.* 13. *Deepak Khemani "Artificial Intelligence", Tata Mc Graw Hill Education 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. *Dr. N Saravanan, Principal Engineer, Smart Implements & Machinery and Sustainability, Mahindra Research Valley, Chengalpattu, Tamil Nadu*	1. *Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in*	1. *Dr... S. Prabhu, SRMIST*
2. *Mr. N Parameswaran, Manager-Production Engineering at Nokia Solutions and Networks Pvt Ltd Chengalpattu, Tamil Nadu, India*		2. *Mr. S. P.Sundar Singh Sivam, SRMIST*

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

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