DEPARTMENT OF MECHANICAL ENGINEERING

M.TECH. (CAD/CAM)

SARDAR VALLABHBHAI NATIONAL INSTITUTE OF TECHNOLOGY
Ichchhanath, Surat-395007, Gujarat, India
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MISSION & VISION STATEMENT OF INSTITUTE

Vision statement

To be one of the leading technical institutes disseminating globally acceptable education, effective industrial training and relevant research output.

Mission statement

To be a globally accepted center of excellence in technical education catalyzing absorption, innovation, diffusion and transfer of high technologies resulting in enhanced quality for all the stakeholders.

MISSION & VISION STATEMENT OF THE DEPARTMENT

Vision statement

Department of Mechanical Engineering, Sardar Vallabhbhai National Institute of Technology, Surat perceives to be globally accepted center of quality technical education based on innovation and academic excellence.

Mission statement

Department of Mechanical Engineering, Sardar Vallabhbhai National Institute of Technology, Surat strives to disseminate technical knowledge to its undergraduate, post graduate and research scholars to meet intellectual, ethical and career challenges for sustainable growth of humanity, nation, and global community.

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

The overall educational objective for **Master of Technology in CAD/CAM** is to educate students with excellent technical capabilities in the mechanical engineering discipline with the knowledge of computer aided design and manufacturing, who will be responsible citizens and continue their professional advancement through life-long learning.

As mechanical engineers with expertise in CAD/CAM, postgraduates are prepared with following educational objectives:

PEO1	To impart the knowledge of engineering subject matter incorporating computer as a tool and building a bright career in the area of design, simulation, manufacturing and production.
PEO2	To create technical ability in students by hands-on experience of design software to develop digital parts and CAM software to generate tool path for machining and conducting various experiments using latest infrastructure to enhance research approach.
PEO3	To construct the confidence by employing various learning resources for solving engineering / industrial problems, designing products for social economic issues to explore skill of entrepreneur.
PEO4	To develop professionalism to formulate and solve problems of interest individually and in team with high value of ethics.
PEO5	To apply an environment of communication through oral and written presentation of technical reports derived research reports so as to interact with academicians, researchers, and industrial practices.

PROGRAM OUTCOMES (PO)

PO1	An ability to independently carry out research /investigation and development work to solve practical problems.
PO2	An ability to write and present a substantial technical report/document.
PO3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.
PSO1	Design, analyse, formulate and solve engineering problems using computer software, tools and techniques.
PSO2	Adopt and demonstrate multidisciplinary approach to solve design, manufacturing and allied problems.

COURSE STRUCTURE FOR M. TECH. (CAD/CAM)

SEMESTER –I

Code №	Subject	L	T	P	Exam Scheme				Total	Credits
					Theory		Tuto.	Pract.		
					Hrs.	Marks	Marks	Marks		
MECC101	Core 1 Finite Element Methods	3	0	2	3	100	-	50	150	4
MECC102	Core 2 Computer Aided Design	3	0	2	3	100	-	50	150	4
MECC103	Core 3 Computer Aided Manufacturing	3	0	2	3	100	-	50	150	4
MECC110 **MECC111** **MECC112** **MECC113** **MECC114**	Core Elective 1 1. Advanced Mechanics of Solids 2. Product Design and Development 3. Concurrent Engineering: Tools, Techniques and Applications 4. Condition Monitoring and fault diagnosis of Rotating Machinery 5. Material Characterization and Testing	3	0	0	3	100	-	-	100	3
MECC120 **MECC121** **MECC122** **MECC123** **MECC124**	Core Elective 2 1. Fracture Mechanics 2. Industrial Robotics 3. Computer Aided Production Planning 4. Design of Pressure Vessels 5. Failure analysis and NDE	3	0	0	3	100	-	-	100	3
MECC104	**Software Practice 1**	0	0	4	2	-	-	100	100	2
MECC105	**Laboratory Practice 1**	0	0	4	2	-	-	100	100	2
Total Credits										**22**

SEMESTER –II

Code №	Subject	L	T	P	Exam Scheme				Total	Credits
					Theory		Tuto.	Pract.		
					Hrs.	Marks	Marks	Marks		
MECC201	**Core 1** Computer Aided Machine Design	3	0	2	3	100	-	50	150	4
MECC202	**Core 2** Rapid prototyping and Tooling	3	0	0	3	100	-	-	100	3
MECC230 **MECC231** **MECC232** **MECC233** **MECC234** **MECC235**	**Core Elective 3** 1. Design of Experiments 2. Instrumentation and Experimental Methods 3. Smart Materials and Manufacturing 4. Computer Aided Tool Design 5. Laser Based Micro Manufacturing 6. Quality Engineering and Management	3	0	0	3	100	-	-	100	3
MECC240 **MECC241** **MECC242** **MECC243** **MECC244**	**Core Elective 4** 1. Optimization Techniques 2. Theory of Elasticity and Plasticity 3. Industrial Tribology 4. Mechanics of composite Materials 5. Surface Engineering	3	0	0	3	100	-	-	100	3
MECC210	**Institute Elective** 1. Extended Finite Element	3	0	0	3	100	-	-	100	3

MECC211	Methods 2. Computational Fluid Dynamics Techniques									
MECC203	**Software Practice 2**	0	0	4	2	-	-	100	100	2
MECC204	**Laboratory Practice 2**	0	0	4	2	-	-	100	100	2
Total Credits										**20**

SEMESTER –III

Code No.	Subject	L	T	P	Exam Scheme				Total	Credits
					Theory		Tuto.	Pract.		
					Hrs.	Marks	Marks	Marks		
MECC301	**Dissertation Preliminaries**	0	0	12	-	-	-	300	300	6
MECC302	**Seminar**	0	0	4	-	-	-	100	100	2
Total Credits										**8**

SEMESTER -IV

Code No.	Subject	L	T	P	Exam Scheme				Total	Credits
					Theory		Tuto.	Pract.		
					Hrs.	Marks	Marks	Marks		
MECC401	**Dissertation**	0	0	24	-	-	-	600	600	12
Total Credits										**12**

CREDIT MATRIX

Category	Credits to be earned				
	Sem- I	Sem - II	Sem- III	Sem - IV	Total
Core Courses	12	7	-	-	19
Elective Courses	6	9	-	-	15
Software/ Laboratory	4	4	-	-	8
Seminar	-	-	2	-	2
Dissertation	-	-	6	12	18
Total Credits	22	20	8	12	62

DEPARTMENT OF MECHANICAL ENGINEERING

POOL OF ELECTIVES FOR ALL P.G. PROGRAMS

SEMESTER-I	
CORE ELECTIVE-1	**CORE ELECTIVE-2**
1. Additive Manufacturing 2. Advanced Mechanical Vibrations 3. Advanced Mechanics of Solids 4. Advanced Welding Technology 5. Atomization and Sprays 6. Bio-Mass Conversion Systems 7. CAD for Manufacturing 8. Combustion 9. Concurrent Engineering: Tools, Techniques & Applications 10. Condition Monitoring and Fault Diagnosis of Rotating Machinery 11. Design of Reacting Systems 12. Electrical Vehicles and Advanced IC Engines 13. Electro-Chemical Engineering Storage 14. Environmental Pollution and Control 15. Industrial Tribology 16. Measurement and Data Analysis 17. Manufacturing Metallurgy 18. Material Characterization and Testing 19. Metal Cutting and Tool Design 20. Nonlinear Dynamics and Chaos 21. Power Plant Engineering 22. Product Design & Development 23. Theory of Plasticity	1. Advanced Metrology and Computer Aided Inspection 2. Analysis and Design of Thermal Turbo Machines 3. Computational Fluid Dynamics 4. Computer Aided Production Planning 5. Concurrent Engineering 6. Design of Pressure Vessels 7. Design of Refrigeration and Air Conditioning Systems 8. Electrical Vehicles and Advanced IC Engines 9. Energy and Exergy Analysis of Turbomachines 10. Failure Analysis & NDE 11. Finite Element Method in Thermal Engineering 12. Fracture Mechanics 13. Gas Dynamics and Compressible Fluid Flow 14. Hydrogen Energy Applications to Propulsion and Future Modes of Transport 15. Industrial Robotics 16. Jet and Rocket Propulsion 17. Measurements and Data Analysis in Thermal Engineering 18. Operation Planning and Control 19. Optimization Techniques 20. Rotor Dynamics, Vibration and Stress Analysis 21. Sensors in Manufacturing Systems 22. Unconventional Turbomachines

DEPARTMENT OF MECHANICAL ENGINEERING

POOL OF ELECTIVES FOR ALL P.G. PROGRAMS

SEMESTER-II	
CORE ELECTIVE-3	**CORE ELECTIVE-4**
1. Advanced Welding Technology 2. Automation in Manufacturing 3. Bio fluidic and Bio Heat Transfer 4. Cascade Aerodynamics 5. Combustion 6. Composite Design and Manufacturing 7. Computational Fluid Dynamics 8. Computer Aided Tool Design 9. Condition Monitoring and Fault Diagnosis of Rotating Machinery 10. Design of Heat Exchangers 11. Design of Pressure Vessel & Piping 12. Finite Elements Methods 13. Industrial Tribology 14. Instrumentation and Experimental Methods 15. Laser Based Micro Manufacturing 16. Lifecycle Analysis of Turbomachines 17. Metal Cutting 18. Micro Hydro Turbine 19. Quality Engineering and Management 20. Renewable Energy Systems 21. Smart Materials & Manufacturing 22. Theory and Design of Cryogenic Systems 23. Turbulence and Turbulent Flows	1. Combustion 2. Concurrent Engineering 3. Design of Heat Exchangers 4. Flow & Flame Diagnostics 5. Fundamentals of Solid Propellant and Multi-Phase Combustion 6. Hydrodynamic Stability 7. Industrial Refrigeration 8. Industrial Tribology 9. Mechanics of Composite Laminates 10. Mechanics of Composite Materials 11. Nano fluid and its Applications in Thermal Systems 12. Non Destructive Techniques 13. Numerical Methods in Manufacturing 14. Operations Research 15. Optimization Techniques 16. Quality Engineering and Management 17. Surface Engineering 18. Theory of Elasticity and Plasticity 19. Thermo-Acoustic Instabilities 20. Transport in Porous Media 21. Turbulent Combustion

MECC101	:	FINITE ELEMENT METHODS	L	T	P	Credits
			3	0	2	04

Course Outcomes (COs)

At the end of the course the students will be able to,

CO1	Explain the fundamental concepts of the theory of the finite element method.
CO2	Develop element characteristic equation and generation of global equation.
CO3	Apply suitable boundary conditions to a global equation for bars, trusses and beams.
CO4	Evaluate the governing FE equations for solving 1D and 2D problems.
CO5	Apply the FE analysis for practical applications in static and dynamic condition.
CO6	Apply the FE method for thermal, potential flow and transient problems.

Syllabus

Introduction Relevance of finite element analysis in design, Modeling and discretization, Interpolation, Elements, Nodes and degrees-of-freedom, Applications of FEA. One-Dimensional Elements and Computational Procedures: Bar elements, Beam elements, Bar and beam elements of arbitrary orientation, Assembly of elements, Properties of stiffness matrices, Boundary conditions, Solution of equations, Mechanical loads and stresses, Thermal loads and stresses.	05 Hours
Basic Elements Truss and Beam Interpolation and shape functions, Element matrices, Linear triangular elements (CST), Quadratic triangular elements, Bilinear rectangular elements, Quadratic rectangular elements, Solid elements, Higher order elements, Development of Truss equations, Development of beam equations, Nodal loads-stress calculations.	08 Hours
Isoperimetric Elements Bilinear quadrilateral elements, Quadratic quadrilaterals, Hexahedral elements, Numerical integration, Quadrature, Static condensation, Load considerations, Stress calculations, Examples of 2D and 3D applications.	07 Hours
Finite Elements in Structural Dynamics Applications Solid and Structural Mechanics Applications: One dimensional problem static analysis of trusses, Analysis of plates, Solid of revolution. Dynamic analysis: Dynamic equations, Mass and damping matrices, Natural frequencies and modes, Damping, Model methods, Ritz vectors, Component mode synthesis, Direct integration techniques, Explicit and implicit methods, Analysis by responses spectra	10 Hours
Heat Transfer and Fluid Mechanics Applications Heat Transfer, Element formulation, Reduction -nonlinear problems, Transient thermal analysis, Acoustic frequencies and modes, fluid structure interaction problems, Plane incompressible and rotational flows.	07 Hours

FEA Applications in Other Fields Applications of FEA in torsion, Potential flow seepage, Fluid flow in ducts.	05 Hours

(Total Lecture Hours: 42)

List of Practicals

1. Analysis of 2-D Truss.
2. Analysis of 2-D Frame.
3. Analysis of L Shaped Bracket.
4. Analysis of Square plate with circular hole.
5. Analysis of Solid.
6. Dynamic and Modal analysis of Cantilever beam.
7. Analysis of 2-D heat flow problem.
8. Analysis of 2-D transient heat flow in plate.
9. Simulation of flow over car body.

Books Recommended

1	R. D. Cook. *Concepts and applications of finite element analysis*. John Wiley & Sons, 2007.
2	D. L. Logan. *A first course in the finite element method*. Cengage Learning, 2016.
3	J. N. Reddy. *An introduction to the finite element method*, Vol. 1221, New York: McGraw-Hill, 2004.
4	T. Chandrupatla, A. Belegundu. *Introduction to finite elements in engineering*. Cambridge University Press, 2021.
5	O. C. Zienkiewicz, R. L. Taylor, J. Z. Zhu. *The finite element method: its basis and fundamentals*. Elsevier, 2005.

MECC102	:	COMPUTER AIDED DESIGN	L	T	P	Credits
			3	0	2	04

Course Outcome

At the end of the course the students will be able to,

CO1	Understand the concept of computer graphics, drafting, and modelling using different commands and graphical user interface
CO2	Apply the concept of transformation for generating different positions of given problem with defined geometry
CO3	Create 3D models assemblies and generative drawings of a given engineering part or product
CO4	Apply the knowledge of programming for complex shape required in engineering for drafting or modelling
CO5	Determine the coordinates of space curves and parametric curves required for generating features in CAD models
CO6	Analyze surfaces based on different criteria's and process of creation

Syllabus

Introduction to Computer Graphics Basics of Computer Aided Design, Introduction to Computer graphics, DDA and Bresenham's algorithm for generating various figures, and basics of CAD/CAM hardware.	03 Hours
Transformation of Geometries 2D Transformation of geometries and 3D Transformations for Translation, Rotation, Scaling, Symmetry, Reflection, and Homogeneous Transformations, Orthographic Projections, Axonometric Projections, Oblique Projections, Perspective Transformation.	10 Hours
Parametric and Non-Parametric Curves Representation of curves – Explicit and Implicit Equations Parametric and non-parametric Curves, Splines, Bezier, B-Splines and generation of surfaces. and surfaces.	07 Hours
Computer Aided Drafting and Modeling Introduction to Drafting and modelling of solids, Coordinate system, Fundamentals of solid modeling, Customization, 3D sketches, Datum features, Modeling operation Strategy and creating features, Geometric constraints, Modeling aids & tools, Generalized, views, Presentation of dimensioning / tolerances/symbols & annotation, Associatively, Parent child relationship, Parametric design, Programming techniques in drafting/ modeling/analysis,	12 Hours

Concept of computer animation, Properties calculation Hidden line and surface removal.	
Design of Surfaces Surface design, and Surface analysis	05 Hours
Assembly of CAD Parts and Surface Top down and Bottom up approaches of creating and assembly. Presentation of assembly	05 Hours

(Total Lecture Hours: 42)

List of Practical

1. Introduction to drafting technologies & drafting practice.
2. Introduction interfacing of drafting package using program techniques.
3. Sketching/Drafting of assigned problem using programming.
4. Practice for 3-D modeling.
5. Modeling of assigned problem.
6. Modeling using parametric relations.
7. Modeling using linkage options.
8. Practice for assembly creation.
9. Practice for view generation.
10. Model/View associatively

Books Recommended

1	D. Hearn. *Computer graphics, C version*. Pearson Education India, 2014.
2	D. F. Rogers, J. A. Adams. *Mathematical elements for computer graphics*. McGraw-Hill, Inc, Second edition, 2017.
3	I. Zeid. *CAD/CAM theory and practice*. McGraw-Hill Higher Education, 2009.
4	M. Chris. *CAD/CAM: Principles, Practice and Manufacturing*, Prentice Hall, 1999.
5	P. N. Rao. *CAD/CAM: principles and applications*. Tata McGraw-Hill Education, 2017.

MECC103	:	COMPUTER AIDED MANUFACTURING	L	T	P	Credits
			3	0	2	04

Course Outcomes

At the end of the course the students will be able to,

CO1	Compare different types of automation using fundamental of CAM and Automation.
CO2	Demonstrate work zero, machine zero, tool zeros, work offset, tool length offset, and cutter radius offset and canned cycles.
CO3	Develop a CNC part program using cutter radius offset commands
CO4	Develop a CNC part program by applying various features, such as cutter radius offset, subprogram, mirror, canned cycles, and pocket cycles, of machining centre to reduce programming task.
CO5	Develop a NC/CNC part program manually and using CAD/CAM software for a given part drawing having multiple operations.
CO6	Illustrate concept of Group Technology and Flexible Manufacturing system.

Syllabus

Introduction to CAD, CAM, CIM, NC/CNC, DNC and Automation Definition of CAD, CAM, CIM, NC, CNC, DNC. Understanding differences among these terms. Direct Numerical Control and Distributed Numerical Control. Automated manufacturing systems and basic types, manufacturing support systems.	02 Hours
NC/CNC Machine Tools Components of NC/CNC system, Specification of CNC system, Classification of CNC machines, Constructional details of CNC machines, Axis designation, CNC control loops.	04 Hours
CNC Part Programming – Milling Basic Programming terms, Programming format, Preparatory (G-Codes) and Miscellaneous (m-Codes) functions, Machine zero, work zero and tool zero, Work offsets, Tool length offset and setup methods, cutter radius offset, CNC milling cutter holder, Part programming for milling – linear and circular interpolation, subprogram, fixed cycles, mirrors commands, machining large hole pattern, polar coordinates, round and rectangular pocket machining and cycles	25 Hours
Automatically Programmed Tools (APT) Introduction to APT, geometry and motion statements, programming for geometry, drill cycles, and hole pattern.	04 Hours
Introduction to CAM software Modeling, toolpath generation, simulation of toolpath, generating CNC program.	02 Hours
Group Technology (GT), Flexible Manufacturing Systems (FMS) and Compute	05

Aided Process Planning (CAPP) Introduction to GT, implementation considerations, benefits and applications, GT methods - visual search method, production flow analysis, Parts classification and coding. Introduction, General Considerations for FMS, types of FMS, Flexibilities, their measurements, Computer control in FMS, Automated material handling systems, AGVs, Automatic storage and retrieval systems, Manufacturing cells, cellular v/s flexible manufacturing. Manual and computer aided process planning, steps, and types.	Hours

(Total Lecture Hours: 42)

List of Practicals

1. Demonstration of CNC Milling machine with user interface and calculating the coordinates of given geometry in absolute end increment mode for cutter path.
2. Introduction of G codes and M codes and write the CNC part programming for a given geometry using linear, Circular interpolation.
3. Write CNC part program using cutter path co-ordinate for a geometry made of lines and arcs.
4. Write the CNC programming for a given geometry using Mirror and Subroutine.
5. Write the CNC programming for a given geometry using Polar Co-ordinate for drilling cycles.
6. Write the CNC programming for a given geometry using Tool Radius Compensation and Repeat loop for Peck drilling cycles.
7. Introduction and programming of canned cycles of milling machine.
8. Demonstration of AS/RS and AVG operation.

Books Recommended

1	S. F. Krar, A. Gill. *CNC: Technology and Programming*, McGraw-Hill, 1989.
2	P. Smid. *CNC programming handbook: a comprehensive guide to practical CNC programming*. Industrial Press Inc, 2003.
3	S. K. Sinha. *CNC Programming (FANUC Control)*, Galgotia Publications Pvt Ltd., 2011.
4	S. H. Suh, S. K. Kang, D. H. Chung, I. Stroud. *Theory and design of CNC systems*. Springer Science & Business Media, 2008.
5	M. P. Groover. *Automation, production systems, and computer-integrated manufacturing*. Pearson Education India, 2016.

MECC110	:	ADVANCED MECHANICS OF SOLIDS	L	T	P	Credits
			3	0	0	03

Course Outcomes

At the end of the course the students will be able to,

CO1	Illustrate the stress at a point and constitutive relations.
CO2	Analyze the transformation of stress and strain in 3D including the utilization of yield criteria.
CO 3	Design the curved beams for different types of stresses.
CO 4	Analyze the shear stresses in non- circular shafts.
CO 5	Estimate the bending stresses in un-symmetric straight beams.
CO 6	Analyze the strain at a point in rotating disks.

Syllabus

Introduction Stress definition and stress-traction relations; Deformation, strain definition, strain-displacement relation; Constitutive equations; Equilibrium and compatibility equations.	06 Hours
Analysis of Stresses and Strains in rectangular and polar coordinates Cauchy's formula, Principal stresses and principal strains, 3D Mohr's Circle, Octahedral Stresses, Hydrostatic and deviatoric stress, Two-dimensional problem solutions, Plane stress and plane strain, compatibility conditions. Advanced two-dimensional problems.	12 Hours
Introduction to curvilinear coordinates Generalized Hooke's law and theories of failure. Energy Methods. Bending of symmetric and unsymmetric straight beams, effect of shear stresses, curved beams, Shear centre.	12 Hours
Torsion of prismatic solid sections Prandtl stress function, thin-walled sections, circular, rectangular and elliptical bars, membrane analogy. Thick and thin-walled cylinders, Composite tubes, Rotating disks and cylinders.	12 Hours

(Total Lecture Hours: 42)

Books Recommended

1	M. H. Sadd. *Elasticity: theory, applications, and numeric*, 3rd edition, Academic Press, 2014.
2	L. S. Srinath. *Advanced mechanics of solids*, 3rd Edition, McGraw-Hill, 2009.
3	R. G. Budynas. *Advanced Strength and Applied Stress Analysis*, 2nd Edition, McGraw Hill, 2017.
4	P. Boresi, R. J. Schmidt. *Advanced Mechanics of Materials*, 6th Edition, John Willey and Sons,1985.
5	F. P. Beer, E. R Johnston. *Mechanics of Materials* | 8th Edition (in SI Units), McGraw Hill.

MECC111	:	PRODUCT DESIGN AND DEVELOPMENT	L	T	P	Credits
			3	0	2	04

Course Outcomes

At the end of the course the students will be able to,

CO1	Illustrate the importance of conceptual design to the product development.
CO2	Apply the market research analysis to identify customer needs.
CO3	Apply the creative thinking tools for the development of new design concepts.
CO4	Analyse the optimal design concept using decision making methodology.
CO5	Illustrate the embodiment design and robust design concepts.
CO6	Analyse the various factors like human and cost in relation to industrial design.

Syllabus

Need for Developing Products The importance of engineering design, types of design, the design process, relevance of product lifecycle issues in design, designing to codes and standards, societal considerations in engineering design, generic product development process, various phases of product development, planning for products, establishing markets, market segments, relevance of market research **Identifying Customer Needs** Voice of customer, customer populations, hierarchy of human needs, need gathering methods, affinity diagrams, needs importance, establishing engineering characteristics competitive benchmarking, quality function deployment, house of quality, product design specification, case studies.	14 Hours
Creative Thinking Creativity and problem solving, creative thinking methods, generating design concepts, systematic methods for designing, functional decomposition, physical decomposition, functional representation, morphological methods, TRIZ axiomatic design. **Decision Making** Decision theory, utility theory, decision trees, concept evaluation methods, Pugh concept selection method, weighted decision matrix, analytic hierarchy process, introduction to embodiment design, product architecture, types of modular architecture, steps in developing product architecture.	14 Hours
Industrial Design Human factors design, user friendly design, design for serviceability, design for environment, prototyping and testing, cost evaluation, categories of cost, overhead costs, activity based costing, methods of developing cost estimates, manufacturing cost, value analysis in costing.	14 Hours

(Total Hours: 42)

Books recommended

1	K. T. Ulrich and S. D. Eppinger. *Product Design and Development*, McGraw-Hill Education, 2016
2	C. L. Dym, P. Little and E. Orwin. *Engineering Design: A Project-Based Introduction*, 4th Edition, John Wiley & Sons Inc., 2013.
3	G. E. Dieter and L. C. Schmidt. *Engineering Design*, McGraw-Hill International Edition, 2013.
4	A. Jamnia. *Introduction to Product Design and Development for Engineers*, CRC Press, 2018.
5	K. Prashant. *Product Design: Creativity, Concepts and Usability*, PHI Learning Private Limited, 2012.

MECC112	:	CONCURRENT ENGINEERING: TOOLS, TECHNIQUES AND APPLICATIONS	L	T	P	Credits
			3	0	0	03

Course Outcomes

At the end of the course the students will be able to,

CO1	Support the multi-disciplinary integrated product development teams and Plan and implement a new product development program.
CO2	Apply appropriate concurrent engineering tools and techniques to design and develop environment-friendly products by leveraging both manufacturing cost and lifecycle cost.
CO3	Determine the customer needs and ensure that the product design is robust and meets the professional standards with better quality.
CO4	Design and develop the products with high reliability, maintainability, and availability.
CO5	Apply the information technology tools for collaborative product design and development.
CO6	Demonstrate the applications of concurrent design of structures, products and components.

Syllabus

Introduction Motivation, definition, and philosophy of Concurrent Engineering (CE); sequential and concurrent processes; Principles of CE; Organizing for CE; CE teams and team dynamics; Role of CAD/CAM/CAE/CIM and automation in CE; Managing product development projects; Decomposition of product development stages; Benefits of CE; Implementation issues of CE.	06 Hours
Concurrent Engineering Tools and Techniques Design for manufacturing (DFM), Design for assembly (DFA); Factors influencing form design; Casting and machining considerations; Design for manufacturing and Assembly (DFMA) guidelines and examples; Lifecycle design of products with circular economy concept; Design for environment (DFE) with examples; Design for (-to-)cost; Design for X (DFX); Value engineering.	10 Hours
Design for quality; Taguchi's methods for designing robust products; Design of Experiments (DOE) with examples; Design optimization; Quality function deployment (QFD) with examples.	06 Hours
Design for reliability, maintainability and availability with examples; Failure modes and effects analysis (FMEA); Fault tree analysis (FTA); Rapid prototyping methods; Design simulation; Virtual and augmented reality environments for CE.	08 Hours

Role of Information Technology In Concurrent Engineering Information technology (IT) components and functions; Artificial Intelligence for IT operations used for product design; Collaborative product development; Collaborative product commerce, Cloud IoT for CE.	06 Hours
Selected Applications of Concurrent Engineering Design of aerospace and naval structures made of composite materials; Design of automotive components; Design of medical devices; Design of electronic products; Design of white goods parts.	06 Hours

(Total Lecture Hours: 42)

Books Recommended

1	B. Prasad. *Concurrent Engineering Fundamentals I & II*, Prentice Hall, New Jersey, 1996.
2	I. Moustapha. *Concurrent Engineering in Product Design and Development*, New Age International, New Delhi, 2006.
3	G. Boothroyd, P. Dewhurst, W. Knight. *Product Design for Manufacture and Assembly*, 3rd Edition, Routledge, Boca Raton, 2010.
4	J. R. Hartley. *Concurrent Engineering: Shortening Lead Times, Raising Quality, and Lowering Costs*, 4th Edition, Routledge, Boca Raton, 2017.
5	K. T. Ulrich, S. D. Eppinger, M. C. Yang. *Product Design and Development*, 7th Edition, McGraw Hill Education (India), Noida, 2020.

MECC113	:	CONDITION MONITORING AND FAULT DIAGNOSIS OF ROTATING MACHINERY	L	T	P	Credits
			3	0	0	03

Course Outcomes

At the end of the course the students will be able to

CO1	Describe basic terminologies used in condition monitoring of rotating machinery.
CO2	Examine vibration analysis problems of complex rotating systems.
CO3	Understand and analyze rotor systems with non-linear effects included.
CO4	Identify and analyze rotating machinery faults using different methods.
CO5	Illustrate the utility of instrumentation and terminology used in signal analysis for fault detection in rotating machinery.
CO6	Analyse various plots used in condition monitoring of rotors to predict rotor faults.

Syllabus

Introduction To Condition Monitoring Introduction to condition monitoring, Maintenance approach, Basics of machinery vibration, Conventions and characteristics - amplitude, frequency and phase	06 Hours
Vibration Analysis Of Complex Rotating Systems Asymmetric rotors, Axial vibrations, Torsional vibration - Holzer`s method, Transfer Matrix method, Geared and Branched systems, Effect of isotropic and anisotropic supports, Alford force, Whirling of rotor, Campbell diagram, Overhung rotors, Morton effect, Temperature effect on vibration.	12 Hours
Rotating Machinery Faults And Detection Rotating machinery faults and its detection - Unbalance, Misalignment, Bent rotors, Bearing defects,Oil Whirl, Oil whip, Looseness, Electric motor defect, Rotor stator rub etc., frequency range of faults, Non-destructive testing, Acoustic emission technique and applications, Introduction to Active magnetic bearing.	14 Hours
Instrumentation And Signal Analysis Instrumentation and Fault Detection Transducers - Displacement, Velocity and Acceleration, Computer aided data acquisition, Oscilloscope, Vibration Exciter systems, Signal Analysis,Basics of FFT, Trend plot, Time domain plot, Frequency domain plot, Spectrum plot, Waterfall plot, RMS, Peak and Peak-peak value, Case studies - Spectrum interpretation charts.	10 Hours

(Total Hours: 42)

Books Recommended

1	Rajiv Tiwari, *Rotor Systems: Analysis and identification*, CRC Press, 1st edition, 2017.
2	Michael I. Friswell, John E. T. Penny, Seamus D. Garvey, Arthur W. Lees, *Dynamics of Rotating machines*, Cambridge University Press, 2010.
3	A. Davies, *Handbook of Condition Monitoring: Techniques and Methodology,* Springer Science & Business Media, 1998.
4	J. S. Rao, *Rotor Dynamics*, New Age International Ltd. 3rd edition, 2018.
5	Peter Tavner, Li Ran and Christopher Crabtree, "*Condition Monitoring of Rotating Electrical Machines*", The Institution of Engineering and Technology, 3 rd Edition, 2020.

MECC114	:	MATERIAL CHARACTERIZATION AND TESTING	L	T	P	Credits
			3	0	0	03

Course Outcomes

At the end of the course the students will be able to,

CO1	Understand importance of Materials characterization techniques.
CO2	Describe principles of operation and uses of Thermal analysis equipment.
CO3	Explain the production of X-rays, electrons and the electron-specimen interaction mechanisms.
CO4	Describe fundamental principles of operation of four materials characterization techniques, namely optical microscopy, scanning electron microscopy, transmission electron microscopy and scanning probe microscopy.
CO5	Relate the micro and nano-images obtained with the different materials characterization techniques to the behavior of materials and their mechanical properties.
CO6	Understand importance of various non-destructive evaluation for material Characterization.

Syllabus

Importance of Material Characterisation Classification of techniques for characterization, macro and micro characterization structure of solids, Basic principles & concepts.	02 Hours
Thermal analysis Technique and Metallographic techniques Introduction, Instrumentation, experimental parameters, Different types used for analysis, Thermo gravimetry, Differential thermal analysis, Differential Scanning Calorimetry, Basic principles, Instrumentation, working principles, Applications, Limitations.	05 Hours
Diffraction Method Braggs Law, X ray Diffraction methods, Determination of crystal structure, Lattice Parameter, Residual Stress, crystallite size, Applications, Limitations.	05 Hours
Microscopy Optical Microscopy - Introduction, Optical principles, Instrumentation, Specimen preparation, quantitative metallography Interaction of electron beam with materials; scanning electron microscopy– construction and working of SEM, various imaging techniques, applications; FESEM transmission electron microscopy - specimen preparation for TEM; applications of TEM; various imaging techniques, applications, Applications, Limitations.	06 Hours

Spectroscopy Techniques for Chemical Analysis Atomic absorption spectroscopy, X-ray spectrometry, infrared spectroscopy, XRF, UV-Visual (UV-VIS), IR, and Raman spectroscopy. Mass spectroscopy: Principles and brief account, EDS, WDS, EPMA Instrumentation, Working procedure, Applications, Limitations.	06 Hours
Surface Characterisation XPS(ESCA), UPS, Auger Electron Spectroscopy, Electron Probe Microanalysis (EPMA), Working procedure, Applications, Limitations.	06 Hours
Nano-mechanical characterization AFM, STM and Nano indentation studies, Introduction, Basic principles - applications and limitations.	06 Hours
Non-Destructive testing Introduction, Liquid penetrant inspection, Magnetic particle inspection, Ultrasonic inspection, Eddy current inspection, X-ray radiography.	06 Hours

(Total Lecture Hours: 42)

Books Recommended

1	S. Zhang, Lin Li, A. Kumar. *Materials Characterisation Techniques*, CRC press, 2008.
2	Y. Leng. *Materials Characterisation: Introduction to Microscopic and Spectroscopic Methods*, John Wiley & Sons (Asia), 2013.
3	D. A. Skoog, F. J. Holler, S. R. Crouch. *Instrumental analysis* (Vol. 47). Belmont: Brooks/Cole, Cengage Learning, 2017.
4	W. Kemp. *Organic Spectroscopy*, 3rd ed., Palgrave Macmillan, 2019.
5	C. R. Brundle, C. A. Evans, S. Wilson. *Encyclopedia of Materials Characterisation*, Butterworth-Heineman, 1992.

MECC120	:	FRACTURE MECHANICS	L	T	P	Credits
			3	0	0	03

Course Outcomes

At the end of the course, the students will be able to

CO1	Explain the basic, principles of fracture mechanics.
CO2	Explain the theory of elasticity and plasticity.
CO3	Evaluate the stress intensity factor by various methods.
CO4	Solve the problems on J-integral and crack arrest
CO5	Analyse the different modes of fracture.
CO6	Apply the fracture analysis on practical applications.

Syllabus

Overview of Fracture Mechanics Introduction and history, kinds of failure, brittle and ductile fracture, modes of fracture, Defects and cause of defects in the materials, Different types of loadings, Fracture Mechanics and the Energy Balance Approach, Micro and macro crack. Stress concentration due to hole. Case study of failure of structures due to fracture.	10 Hours
The Energy Release Rate Griffith analysis, Criteria for crack growth, The crack resistance (R curve), Compliance, Stability, Fracture beyond general yield. The Crack-tip opening displacement. The Use of CTOD criteria. Experimental determination of CTOD, energy release rate.	08 Hours
Stress Intensity Factor Linear Elastic Fracture Mechanics, Crack in plate with finite dimension, edge crack, embedded crack, First mode, second mode and mixed mode stress intensity factor, relation between stress intensity factor (SIF) and energy release rate (G) and critical stress intensity factor, Westergaard's approach, Numerical examples on the evaluation of different SIF	08 Hours
J Integral, Dynamics and Crack Arrest Concept of J integral. Limitation of J integral. Experimental determination of J integral and the parameters affecting J integral. Crack speed and kinetic energy. Dynamic stress intensity and elastic energy release rate. Crack branching. Principles of crack arrest. Crack arrest in practice. Dynamic fracture toughness.	08 Hours
Crack Propagation and Applications of Fracture Mechanics Crack growth and the stress intensity factor. Factors affecting crack propagation, Paris law, Required information for fracture mechanics approach and engineering applications of fracture mechanics.	08 Hours

(Total Lecture Hours: 42)

Books Recommended

1	P. Kumar. *Elements of fracture mechanics*, Tata McGraw Hill, New Delhi, 2017.Mc Graw Hill Education, 2009.
2	T. L. Anderson. *Fracture Mechanics-Fundamental and Application*, CRC Press, Fourth Edition, 2017.
3	D. Broek. *Elementary Engineering Fracture Mechanics*, Kluwer Academic Publications, Fourth Edition, 2011
4	K. Hellan. *Introduction to fracture mechanics*, McGraw Hill, 2nd Edition, 2016.
5	S. K. Maiti. *Fracture mechanics: Fundamentals and Applications*, Cambridge University Press, First edition, 2015

MECC121	:	INDUSTRIAL ROBOTICS	L	T	P	Credits
			3	0	0	03

Course Outcomes

At the end of the course the students will be able to,

CO1	Explain the basics of robotic systems.
CO2	Apply the concept of robot arm kinematics.
CO3	Analyze statics and dynamics of robots.
CO4	Analyze manipulator trajectories and robot end-effectors.
CO5	Analyze control of robot manipulators.
CO6	Illustrate robot programming, sensing and vision.

Syllabus

Introduction Introduction to robots, Robot manipulators, Robot anatomy, Coordinate systems, Work envelope, Types and classification, Specifications, Actuators and drives.	04 Hours
Mathematical Representation of Robots Rotations and translation of vectors, Transformations and Euler angle representations, Homogenous transformations, Representation of position and orientation of a rigid body, Homogeneous transformations, Denavit-Hartenberg (D-H) notations and parameters, Representation of joints, link representation using D-H parameters.	05 Hours
Forward and Inverse Kinematics Introduction, Forward and inverse kinematics problems. **Velocity and Statics analysis** Linear and angular velocity of links, Velocity propagation, Jacobians for robotic manipulators, Statics and force transformation of robotic manipulators, Singularity analysis	10 Hours
Robot Dynamic analysis Introduction, Forward and inverse dynamics, Mass and inertia of links, Lagrangian formulation for equations of motion for robotic manipulators, Newton-Euler formulation method.	05 Hours
Trajectory Planning and Control Joint and Cartesian space trajectory planning and generation, Classical control concepts using the example of control of a single link, Independent joint PID control, Control of a multi-link manipulator, Nonlinear model based control schemes.	11 Hours

Force Control of manipulators Hybrid position/force control.	02 Hours
Robot Programming, Sensing and Vision Robot Programming, Introduction to sensing and vision in robotics.	05 Hours

(Total Lecture Hours: 42)

Books Recommended

1		A. Ghosal.*Robotics: Fundamental Concepts and Analysis*, OxfordUniversity Press, 2006.
2		J. J. Craig.*Introduction to Robotics: Mechanics and Control*, 4th edition, Pearson, 2018.
3		R. J. Schilling. *Fundamentals of Robotics Analysis and Control*, Pearson Education India, 2015.
4		K. S. Fu, R. C. Gonzalez, C. S. G. Lee. *Robotics: Control, Sensing, Vision, and Intelligence*, McGraw Hill 1987.
5		S. K. Saha. *Introduction to Robotics*, McGraw Hill Education India, 2014.

MECC122	:	COMPUTER AIDED PRODUCTION PLANNING	L	T	P	Credits
			3	0	0	03

Course Outcomes

At the end of the course the students will be able to,

CO1	Explain different methods of computer aided process planning (CAPP) and distinguish between process planning and production planning.
CO2	Determine the forecast of a product for the given historical data using forecasting models.
CO3	Solve the facility layout problems using different algorithms and create part families and machine cells in a manufacturing facility using group technology approach.
CO4	Prepare material requirement plan for a product and explain enterprise resource planning (ERP).
CO5	Create schedules for multiple machines/workstations and describe the capacity planning.
CO6	Explain different computer aided measurement and inspection techniques.

Syllabus

Introduction Production systems and their types -mass production, batch production and job shop production systems. Introduction to process planning in manufacturing, Role of process planning. Computer aided process planning (CAPP) - variant and generative type process planning.	05 Hours
Computer Aided Forecasting Introduction to forecasting, sources of data, demand patterns, forecasting errors, forecasting models – Quantitative: moving average, linear regression and exponential smoothing methods; Qualitative - Delphi method.	05 Hours
Facility Layout Planning Introduction to facility layout, objectives, types of facility layout- line layout, process layout, cellular layout and fixed position layout, advantages and disadvantages. Assembly line balancing, line balancing algorithms- largest candidate rule, Kilbridge and Wester method, and ranked positional weights method. Heuristics of process layout problems - computerized relative allocation of facility technique, automated layout design program and computerized relationship layout planning. Multi objective approach for facility layout planning.	10 Hours
Group Technology Introduction, benefits of group technology, part families, part classification and coding, applications of GT. Algorithms and models for Group Technology - Rank	05 Hours

order clustering algorithm and Bond energy algorithm.	
Material Requirement Planning Introduction, Objective of the MRP system, inputs to the MRP System – product structure or bill of materials (BOM), master production schedule (MPS) and inventory status file. MRP calculations. Manufacturing resources planning (MRP-II). Enterprise resource planning (ERP).	05 Hours
Scheduling and Capacity Planning Introduction, Single machine scheduling –shortest processing time rule, weighted mean flow time rule, earliest due date rule, model to minimize total tardiness, branch and bound algorithm. Introduction to parallel processors under single machine scheduling. Flow shop scheduling – Johnson's algorithm. Job shop scheduling. Capacity planning – measure of capacity, capacity strategies, tools for capacity planning.	07 Hours
Computer Aided Measurement and Inspection Computer Aided Testing, Contact and Non-contact type inspection, Co-ordinate measuring machines (CMM), types of CMM, Applications of CMM and its Benefits, Laser viewers for production profile checks, Machine vision technology, Microprocessors in metrology.	05 Hours

(Total Lecture Hours: 42)

Books Recommended

1	R. Panneerselvam. *Production and Operations Management*, 3rd Edition, PHI Learning Pvt Ltd, 2015.
2	M. P. Groover. *Automation production systems and computer integrated manufacturing*, 5th edition, Pearson Edu Ltd, 2019.
3	E. E. Adam, R. J. Ebert. *Production and Operations Management*, 5th Edition, Prentice Hall of India, 2015.
4	J. Heizer, B. Render, C. Munson. *Operations Management*, Pearson Edu Ltd, 12th Edition, 2017.
5	S. N. Chary. *Production and operations management*, McGraw Hill Education (India) Pvt. Ltd, 6th Edition, 2019.

MECC123	:	DESIGN OF PRESSURE VESSELS	L	T	P	Credits
			3	0	0	03

Course Outcomes

At the end of the course the students will be able to

CO1	Illustrate the different types of loads and their effects in pressure vessel.
CO2	Evaluate the different types of stresses in pressure vessel.
CO3	Design the various supports of the pressure vessel.
CO4	Design the shells, heads and nozzles.
CO5	Use the ASME & IS codes to Design pressure vessel.
CO6	Evaluate the various stresses under thermal and fatigue loadings.

Syllabus

Introduction: Overview of various parts of pressure vessels, classification of pressure vessels, applications, factors influencing the design of vessels - material selection, loads & types of failures.	10 Hours
Stresses in pressure vessels: stresses in circular ring, cylinder & sphere, membrane stresses in vessels under internal pressure, thick cylinders, multi layered cylinders, auto-frottage of thick cylinders and their significance, discontinuity and buckling stresses	10 Hours
Design of pressure vessels as per ASME and IS code: Introduction and importance of codes, Externally and internally pressurized vessels, tall vertical vessels, Supports for vertical & horizontal vessels, nozzles and flanges. shells and heads	12 Hours
Pressure vessels with different conditions: Evaluation of pressure vessels for different conditions: hydro-test condition, thermal stresses, FEM analysis, Fatigue of pressure vessels.	10 Hours

(Total Lecture Hours: 42)

Books Recommended

1	J. F. Harvey. *Theory and Design of Pressure Vessels*, Springer US, 2007.
2	S. Chattopadhyay. *Pressure Vessels: Design and Practice*, CRC Press, 2004.
3	ASME Code Section 8thDiv 1, Div2, ASME, 2021.
4	A. S. Tooth. *Pressure Vessel Design: Concepts and Principles*, 1st Edition, CRC Press, 2012.
5	D. R. Moss, M. M. Basic. *Pressure Vessel Design Manual*, 4th Edition, Elsevier Science, 2012.

MECC124	:	FAILURE ANALYSIS AND NDE	L	T	P	Credits
			3	0	0	03

Course Outcomes

At the end of the course the students will be able to

CO1	Develop knowledge about the basic concept of material selection
CO2	Define tools and techniques of failure analysis, procedural steps for investigation of failure and failure data retrieval.
CO3	Identify the different fracture modes and their characteristics.
CO4	Understand and be able to identify the common modes of failure of engineering components
CO5	Apply understanding to relevant case studies and identify failure mechanisms.
CO6	Understand concept of Non Destructive evaluation and its applications for Failure analysis

Syllabus

Introduction Philosophy of material selection, motivation for selection, relationship to available resources, concept of resource base, Criteria for selection of engineering materials. Case studies in material selection like materials for bearings, gears, automobile structures, aircraft components, ship structures.	05 Hours
General Procedures for Failure Analysis Sources of Failures, Steps in Failure Analysis, collection of data and samples; preliminary examination; non-destructive inspection; mechanical testing; selection and preservation of fracture surfaces; macroscopic and microscopic examination; selection; preparation and examination of metallographic sections; fracture classification; report writing.	05 Hours
Failure of brittle and ductile material Details of fractographic, Crack initiation and propagation in ductile and brittle material, Griffith theory, Irwin's modification, surface and embedded cracks, Surface treatments to minimize the surface cracks, Crack growth mechanism for plane stress and plain strain, Notch sensitivity, stress tri-axiality, Failure due to tension and torsion, Modulus of rupture, stress intensity factor.	07 Hours
Fatigue Failures factors affecting fatigue life; stages of fatigue fracture; fatigue cracking; effects of variables; mean stress; stress concentration; metal characteristics; manufacturing process; elevated temperature fatigue; contact fatigue.	05 Hours

Types of corrosion Stress Corrosion, corrosion cracking, Analysis of corrosion failure, Procedure for analysis of stress corrosion cracking. Effect of Environment. Analysis of corrosion characteristics of metals and alloys in different environment. Types of wear, Role of friction, Interaction of corrosion and wear. Analysis of wear failure.	06 Hours
Elevated-Temperature Failures creep; stress rupture; thermal fatigue; effect of atmospheric environment; failures in industrial application; testing techniques.	04 Hours
Case studies in failure analysis Case histories of component failures. Typical case studies of failure of important components such as gears, shafts, pressure vessels etc. Prevention of failures	05 Hours
Non-destructive evaluation (NDE) Principle and methodology of different NDT methods, Liquid Penetration Testing, Ultrasonic Testing, Radiographic Testing, Magnetic Particle Testing.	05 Hours

(Total Hours: 45)

Books Recommended

1	R. B. Charlie, A. Choudhury. *Failure Analysis of Engineering Materials*, McGraw Hill Education, 2002.
2	R. W. Hertzberg, R. P. Vinci, J. L. Hertzberg. *Deformation and fracture mechanics of engineering materials*. John Wiley & Sons, 2020.
3	V. Ramachandran. *Failure analysis of engineering structures: methodology and case histories*. ASM International, 2005.
4	ASM Handbook, *Failure Analysis and Prevention*, Volume 11, 2002, .ASM International.
5	L. D. C. F. Canale, G. E. Totten, R. A. Mesquita. *Failure analysis of heat treated steel components*. ASM international, 2008.

MECC104	:	SOFTWARE PRACTICE -1	L	T	P	Credits
			0	0	4	02

Course Outcomes

At the end of the course the students will be able to

CO1	Develop 2D & 3D model using CAD package.
CO2	Develop assembly and motion simulation of mechanical components.
CO3	Perform static analysis of 2D & 3D model using FEA package.
CO4	Perform dynamic analysis of mechanical component.

Exercises:

1. Drafting/Modelling of given 2D/3D model.
2. Develop assembly of a given product.
3. Motion Simulation of a given product.
4. Carry out static structural analysis of a given 2D component using FEA.
5. Carry out static structural analysis of a given 3D component using FEA.
6. Dynamics & Modal analysis of a given component.

MECC105	**:**	**LABORATORY PRACTICE 1**	**L**	**T**	**P**	**Credits**
			0	**0**	**4**	**02**

Course Outcomes

At the end of the course the students will be able to

CO1	Understand and demonstrate operation of Coordinate measuring machine (CMM).
CO2	Generate point cloud for a given product.
CO3	Demonstrate and simulate practical skills on CNC machine.
CO4	Develop CNC codes for a given geometry.

Practicals:

1. Demonstration of contact type Coordinate measuring machine (CMM) for reverse engineering.
2. Demonstration of non-contact type Coordinate measuring machine (CMM) for reverse engineering.
3. To carry out point cloud generations for given objects.
4. Demonstration of multi axes CNC machining process.
5. Tool path generation of a given 2D geometry.
6. Tool path generation of a given 3D geometry.

MECC201	:	COMPUTER AIDED MACHINE DESIGN	L	T	P	Credits
			3	0	2	04

Course Outcomes

At the end of the course the students will be able to

CO1	Understand the engineering design process and its role in machine elements.
CO2	Analyze and interpret the design of shafts and its applications.
CO3	Understand various gear and gear boxes problem.
CO4	Explain design requirements of mechanical brake and clutch.
CO5	Explain the desgin requirements of sliding and rolling contact bearings and their applications.
CO6	Understand CAD software to generate a computer model and technical drawing for a simple, well-defined part or assembly.

Syllabus

Introduction Phases of design, Standardization and interchangeability of machine elements, Tolerances from process and function, Individual and group tolerances, Selection of fits for different design situations, Design for assembly and modular constructions, Concepts of integration.	08 Hours
Shafting Analysis and Design of shafts for different applications, detailed design, Preparation of production drawings, integrated design of shaft, Bearing and casing, Design for rigidity.	10 Hours
Gears and Gear Boxes Principles of gear tooth action, Gear correction, Gear tooth failure modes, Stresses and loads, Component design of spur, helical, Bevel and worm gears, Deign for sub assembly, Integrated design of speed reducers and multi-speed gear boxes, application of software packages.	12 Hours
Clutches and Brakes Integrated design of automobile clutches and over running clutches. Dynamics and thermal aspects of vehicle braking – Integrated design of brakes for machine tools, automobiles and mechanical handling equipment	12 Hours

(Total Lecture Hours: 42)

List of practicals

1. Practice/Study of Programming Language C, C++, VB etc.
2. Computer Aided Design of Shafts under Different Loading Conditions.
3. Computer Aided Design of Spur Gear.
4. Computer Aided Design of Helical Gear.
5. Computer Aided Design of Worm Gear.
6. Computer Aided Design of Bevel Gear.
7. Optimum Design of kinematics layout of Gear boxes.
8. Computer Aided Design of Brakes.
9. Computer Aided Design of Clutches
10. Computer Aided Design of Material Handling Equipment

Books Recommended

1	W. C. Orthwein. Clutches and Brakes: Design and Selection, 2nd Edition, Taylor & Francis, 2004.
2	R. C. Juvinall and K. M. Marshek. Fundamentals of Machine Component Design, Wiley India, 2020.
3	G. M. Maitra. Handbook of Gear Design, 2nd Edition, Tata McGraw Hill, 1994.
4	R. G. Budynas and J. K. Nisbett. Shigley's Mechanical Engineering Design, McGraw Hill Publications, 2016.
5	Design Data: Data Book of Engineers, P. S. G. College of Technology, Revised Edition, Coimbatore, 2016.

MECC202	:	RAPID PROTOTYPING AND TOOLING	L	T	P	Credits
			3	0	0	03

Course Outcomes

At the end of the course the students will be able to

CO1	Analyze the role of rapid prototyping in product development cycle and Recommend scope of improvements in product development.
CO2	Integrate design concepts with CAD or reverse engineering for geometry preparation for Rapid prototyping of part.
CO3	Identify defects in the data for rapid prototyping and propose necessary improvements.
CO4	Analyze the working of different rapid prototyping systems and recommend suitable process for a given material and application.
CO5	Explain the concept of rapid tooling.
CO6	Analyze the process chain of different rapid prototyping systems and Create a pathway for rapid manufacturing.

Syllabus

Introduction CAD-CAM and its integration, Development of CAD CAM, The importance of being Rapid, Rapid Prototyping (RP) Defined, Time compression Technologies, Product development and its relationship with rapid prototyping, Process chain for rapid prototyping.	02 Hours
Reverse Engineering Reverse Engineering and CAD model, Digitizing Techniques: Mechanical Contact Digitizing, Optical Non-contact Measurement, CT Scanning Method, Data Processing for Surface Reconstruction, Software for Reverse Engineering, Case studies.	04 Hours
Data Preparation For Rapid Prototyping STL interface Specification, STL data generation, STL data Manipulation, Advantages and limitations of STL file format, Open files, Repair of STL files, Alternative RP interfaces, Part orientation and support generation, Factors affecting part orientation, Various models for part orientation determination, The function of part supports, Support structure design, Automatic support structure generation. Model Slicing and Contour Data organization, Direct and adaptive slicing: Identification of peak features, Adaptive layer thickness determination, Tool path generation.	10 Hours

Liquid Based Rapid Prototyping Processes Photo polymerization, principle and working of stereo lithography apparatus, scanning techniques, curing processes, Mask Projection based RP systems, Two Photon Vat Photo polymerization, Typical materials and applications.	06 Hours
Powder Based Rapid Prototyping Processes Powder fusion mechanism, powder handling and recycling, Principle and working of Selective Laser Sintering, Laser Engineering Net Shaping process, Electron Beam Melting, Binder Jet 3D Printing, process parameters, Typical materials and applications.	08 Hours
Solid Based Rapid Prototyping Processes Basic principle and working of fused deposition modelling process, liquification, solidification and bonding, bio extrusion, Laminated Object Manufacturing process, Wire and Arc based RP system, Typical materials and applications	06 Hours
Rapid Tooling Classification of Rapid Tooling (RT) Routes, RP of Patterns, Indirect RT: Indirect method for Soft and Bridge Tooling, Indirect method for Production Tooling, Direct RT: Direct RT method for Soft and Bridge Tooling, Direct method for Production Tooling, Other RT Approaches. Rapid Manufacturing: Methods, limitations	06 Hours

(Total Lecture Hours: 42)

Books Recommended

1	D. Gibson, Rosen, B. *Stucker*. *Additive Manufacturing Technologies*, Springer Publisher,2010.
2	C. K. Chua, K. F. Leong, C. S. Lim. *Rapid Prototyping – Principles and Applications*, World Scientific, 3rd Edition, 2010.
3	K. V. Patri and M. Weiyin. *Rapid Prototyping: Laser-based and Other Technologies*, Springer Publisher, 2004.
4	R. Noorani. *3D Printing Technology, Applications and Selection*, CRC Press, 2017.
5	M. W. M. Cunico. *3D Printers and Additive Manufacturing: The Rise of The Industry 4.0*, Concept 3D, 2019.

MECC230	**:**	**DESIGN OF EXPERIMENTS**	**L**	**T**	**P**	**Credits**
			3	**0**	**0**	**03**

Course Outcomes

At the end of the course the students will be able to

CO1	Explain the fundamentals of Design of Experiments (DoEs).
CO2	Design and conduct experiments for developing linear model and analyse the resulting data to obtain valid conclusions and optimize the system.
CO3	Choose optimal or good designs for developing nonlinear model efficiently and effectively, and analyse the resulting data to obtain valid conclusions and optimize the system.
CO4	Explain and construct design matrix for conducting experiments for linear and nonlinear model.
CO5	Explain and apply Taguchi´s robust design methodology for mechanical engineering problems.
CO6	Create standard design and custom design as per situations, and analyse the data for valid conclusions using software

Syllabus

Introduction to Design and analysis of experiments Basic Principles of Design and Analysis of Experiments, Guidelines for Designing Experiments, model of a system, types of experimental design (first-order and second-order model), basic statistical concepts, single factor experiments.	04 Hours
Linear experimental designs and optimization Basic definition and principles, 2^k full factorial design, a geometrical representation, standard order form, first order response surface model, estimation of main and interaction effects, statistical analysis, estimation of parameters and model adequacy test, 2^{k-p} fractional factorial design, steps to construct fractional factorial design, first order response surface model, estimation of main and interaction effects, statistical analysis, estimation of parameters and model adequacy test, screening designs	16 Hours
Non-linear experimental designs and optimization Basic definition and principles, 3^k full factorial design, central composite designs, Box-Behnken design, estimation of linear and nonlinear effects, a second order response surface model, sequential approach.	12 Hours

Taguchi Design Introduction to Taguchi design, orthogonal arrays (OA), properties of OA, design of OA, Concept of S/N ratio.	04 Hours
Software Practice Introduction to software used for design and analysis of experiments, systematic analysis and steps involved in software for the analysis of factorial design, fractional factorials method, Taguchi method and response surface methodology, case studies and examples.	06 Hours

(Total Lecture Hours: 42)

Books Recommended

1	D. C. Montgomery. *Design and analysis of experiments*, John wiley & sons.
2	R. K. Roy. *Design of experiments using the Taguchi approach: 16 steps to product and process improvement*, John Wiley & Sons, 2001.
3	K. Hinkelmann, O. Kempthorne. *Design and analysis of experiments, volume 1: Introduction to experimental design*, Vol. 1, John Wiley & Sons.
4	A. Dean, D. Voss. *Design and analysis of experiments*, Springer.
5	J. Antony. *Design of Experiments for Engineers and Scientists*, 2nd Edition, Elsevier Inc., 2014.

MECC231	:	INSTRUMENTATION AND EXPERIMENTAL METHODS	L	T	P	Credits
			3	0	0	03

Course Outcomes

At the end of the course the students will be able to

CO1	Understand of experimental analysis and Instrumentation related to measurement systems.
CO2	Analyse and fit the experimental data. Different kind of errors coming in data will also be analysed.
CO3	Understand how to quantify error and uncertainty in physical measurements.
CO4	Determine the mathematical model of measurement systems and response characteristics.
CO5	Illuminate the concepts of Data acquisition signal process analysis.
CO6	Explain principles, theory and applications of various sensors and transducers of flow and temperature measurements.

Syllabus

Significance of Measurement and Instrumentations Introduction, generalized configuration and functional stages of measuring systems, the transducer and its environment, an overview, sensing process and physical laws, Types of measurement problems. Transducer classification and their modelling, characteristics of instruments, design and selection of components of a measuring system.	05 Hours
Dynamic Response of Instruments Mathematical model of a measuring system, response of general form of instruments to various test inputs; time domain and frequency domain analysis Elementary transfer functions, Bode plots of general transfer functions.	05 Hours
Errors in Measurement and Uncertainty in measurements Errors in instruments, Causes and types of experimental errors, Analysis of experimental data and determination of overall uncertainties in experimental investigation, Uncertainties in measurement of measurable parameters like pressure, temperature, flow etc. under various conditions, Estimation for design and selection for alternative test methods.	06 Hours
Transducers Developments in sensors, detectors and transducer technology, displacement transducers; force, torque and motion sensors, piezoelectric transducers, capacity type transducers, Strain gauge transducers, Accelerometers, pressure transducers based on elastic effect of volume and connecting tubing. Transducers for Position, speed,	08 Hours

vibration, sound, humidity, and moisture measurement, Hall effect Transducer.	
Data Acquisition and Signal Processing Systems for data acquisition and processing modules and computerized data system digitization rate, time and frequency domain representation of signals, and Nyquist criterion a brief description of elements of mechatronics modular approach to mechatronics and engineering design.	05 Hours
Advanced Flow Measurements Basic flow meters, magnetic, ultrasonic flow meters, Flow visualization, shadowgraph, Schlieren and interferometric techniques, Pitot static tubes; hot wire anemometers, flow measuring problems, Laser Doppler velocity meter, flow measurements using coriolis effect.	07 Hours
Temperature Measurements Modes of heat transfer, laws of conduction, convection and radiation, Temperature scales, classification of Temperature Sensors, Overview of Temperature Sensor Material, Expansion thermometers, filled system thermometers Thermoelectric sensors, electric resistance sensors; thermistors, Electrical temperature instruments, thermocouples, RTD, and thermistors, Pyrometers, IR temperature detectors, radiations pyrometers, Temperature measuring problems in flowing fluids, dynamic compensation	06 Hours

(Total Lecture Hours: 42)

Books Recommended

1.	E. O. Doeblin. *Measurements System Application and Design*, 5th Edition, McGraw Hill, 2004.
2.	J. P. Holman. *Experimental Methods for Engineers*, 8th Edition. New York: McGraw-Hill, 2012.
3.	T. G. Beckwith, R. D. Marangoni, J. H. Lienhard. *Mechanical Measurements*, 6th Edition, Prentice Hall of India, 2006.
4.	A. K. Gosh. *Introduction to Measurements and Instrumentation*, 4th Edition, PHL Learning Private limited, 2012.
5.	P. E. Donald. *Industrial Instrumentation,* CBS publishers, 2004.

MECC232	:	SMART MATERIALS AND MANUFACTURING	L	T	P	Credits
			3	0	0	03

Course Outcomes

At the end of the course the students will be able to

CO1	Understand the ideas about intelligent and smart materials.
CO2	Study the applications of electro-rheological fluids and Piezoelectric materials.
CO3	Apply the concept and use of shape memory materials and fibre optics in the modern applications.
CO4	Design the vibration absorption systems.
CO5	Evaluate the modelling of shells, beams and plates.
CO6	Modify the outcomes related the smart structure for a specific application.

Syllabus

Smart Materials and Structural Systems Introduction to Smart Materials and Structures, Actuator materials, sensing technologies, micro-sensors, intelligent systems, hybrid smart materials, passive sensory smart structures, reactive actuator-based smart structures, active sensing and reactive smart structures, smart skins.	06 Hours
Intelligent Materials Primitive functions of intelligent materials, intelligence inherent in materials, materials intelligently harmonizing with humanity, intelligent biological materials.	05 Hours
Electro–Rheological Fluids Suspensions and electro, rheological fluids; the electro-rheological phenomenon, charge migration mechanism for the dispersed phase, electro rheological fluid actuators	05 Hours
Piezoelectric Materials Background, Piezoelectricity, industrial piezoelectric materials, smart materials featuring piezoelectric elements	04 Hours
Shape Memory Materials Background on shape memory alloys, applications of shape memory alloys, Continuum applications: structures and machine systems, Discrete applications, impediments to applications of shape memory alloys, shape memory plastics.	04 Hours
Fiber Optics Overview, light propagation in an optical fiber, embedding optical fibers in fibrous	05 Hours

polymeric thermo-sets, fiber optic strain sensors	
The Piezoelectric Vibrations Absorber Systems Introduction, single mode absorber, theory, design solution, extension including viscous modal damping, the electromechanical coupling coefficient, inductance, experimental results, multimode absorber, derivation of transfer function, design solution, self-tuning absorber, performance function, control scheme.	07 Hours
Modelling of Shells, Plates and Beams Derivation of the basic shell equations, equation of motion, equations for specific geometries and cylindrical shell, Plate equations and beam equations.	06 Hours

(Total Lecture Hours: 42)

Books Recommended

1	M. V. Gandhi, B. D. Thompson, B. S. Thompson. *Smart Materials and Structures*, Springer Netherlands, 1992.
2	A. V. Srinivasan, D. Michael McFarland, *Smart Structures: Analysis and Design*, Cambridge, University Press, 2009.
3	P. L. Reece. *Smart Materials and Structures: New Research*, Nova Science Publishers, 2007.
4	A. Preumont. *Vibration Control of Active Structures: An Introduction*, Springer, 2011.
5	F. Y. Cheng, H. Jiang, K. Lou. *Smart Structures: Innovative Systems for Seismic Response Control*, CRC Press, 2008.

MECC233	:	COMPUTER AIDED TOOL DESIGN	L	T	P	Credits
			3	0	0	03

Course Outcomes

At the end of the course the students will be able to

CO1	Define properties of tool material and nomenclatures related to press tools and classifying different cutting tools
CO2	Explain different types of locaters, clams, bushes, gauges and moulds for designing jigs fixtures for and inspection aids for engineering components
CO3	Design jig, fixtures, and moulding dies of a given engineering component and use of computer for creating model
CO4	Evaluate the dimension of press tool components for a given configuration /types of shearing die
CO5	Apply thumb rules and empirical formulas to solve problem related to shearing operation dies and punches and other cutting tools
CO6	Analyse a different scheme of strip layouts for maximizing stock utilisation and use of computer design for a given case for examining feasibility of design

Syllabus

Tool Design Methods Introduction, Design procedure, Statement of the problem, Needs Analysis – Tentative design solutions, finished design, Drafting and design techniques in tooling drawings, Punch and die Manufacturing Techniques	06 Hours
Tooling Materials Introduction, Properties of tool materials, Metal cutting tools, Single-point cutting tools, milling cutters, Drills and Drilling, Reamer classification, Taps, tap classification, The selection of carbide cutting tools, Determining the insert thickness for carbide tools, Various heat treatments.	06 Hours
Gages and Gage Design Introduction, Fixed Gages, Gage Tolerances, the selection of material for Gages, Indicating Gages, and Automatic gages.	04 Hours
Design of Drill Jigs Principles of location, locating methods and devices, Principles of clamping, Drill jigs, Chip formation in drilling, General considerations in the design of drill jigs, Drill bushings, Methods of construction, Drill jigs and modern manufacturing, Computer aided Jig design.	10 Hours

Design of Fixtures Introduction, Fixtures and economics, Types of Fixtures, Vice Fixtures, Milling Fixtures, Boring Fixtures, Broaching Fixtures, Lathe Fixtures, Grinding Fixtures, Types of Die construction, Computer aided Fixture Design,	
Design of Press Tools Die-design fundamentals, Blanking and Piercing die construction, Pilots, Strippers and pressure pads, Presswork materials, Strip layout, Short -run tooling for Piercing, Bending dies, Forming dies, Drawing operations.	08 Hours
Design of Moulding Dies Introduction to Injection moulding process, Parting line selection, Requirement of Air vents, Ejection system, Computer aided die design for injection moulding, Compression molding.	08 Hours

Total Lecture Hours: 42

Books Recommended

1	C. Donaldson, H. L. George, V. C. Goold. *Tool Design*, Tata McGraw Hill Publishing Company Ltd., 36th Reprint 2006.
2	P. H. Joshi. *Tooling Data*, Wheeler Publishing, 2000.
3	P. C. Sharma. *Machine Tool and Tool Design*, S Chand Company. 2004.
4	J.Y.H. Fuh. *Computer aided Injection mold design and manufacture*, CRC Press 2018.
5	J. R. Paquin, R. E. Crowley. *Die design fundamentals*, Ind. Press Inc., New York, 1987.

MECC234	:	LASER BASED MICRO MANUFACTURING	L	T	P	Credits
			3	0	0	03

Course Outcomes

At the end of the course the students will be able to

CO1	Define various terms and properties related to laser radiations
CO2	Apply concept of laser material interaction for finding response parameters of materials having feasibility for ablation
CO3	Explain laser based machining processes for casting, forming, joining, and allied processes
CO4	Determine micromachining output responses considering given influencing parameters such as ablation properties, process, and techniques
CO5	Analyse quality of cut in laser drilling considering focus, assisting gases, and design of nozzle
CO6	Design a given engineering component part using laser forming processes

Syllabus

Basics of Laser Electromagnetic radiation – Laser operation mechanism - Stimulated Emission – Amplification - Properties of Laser Radiation – Types of Laser	03 Hours
Laser Material Interaction Absorption of Laser Radiation- Thermal Effects, Heating, melting and Vaporization – Thermal analysis – Moving source of heat - Vapor Expansion and Recoil Pressures - Plasma Formation – Material removal process Ablation	05 Hours
Laser machining Overview of Conventional machining processes and non-conventional processes – Laser in manufacturing – Laser casting – laser forming- Laser joining – Laser machining. -materials for Laser machining. – Economic aspect for conventional and Laser machining process.	05 Hours
Laser Drilling Laser Drilling Approaches-Melt Expulsion-Analysis of Laser Drilling Process- Quality of holes- Laser Parameters – Focusing – Assist gases and their pressure- Nozzle design	07 Hours
Laser cutting Evaporative Laser Cutting - Laser Fusion Cutting- Mass momentum Balance of molten material - Energy Balance for losses - Oxygen-Assistance- Controlled Fracture Technique – quality aspect –Striations effect- Dross- Heat-Affected Zone- Effect of	07 Hours

Laser Type Effect of Laser Type- Effect of Laser Type- Laser Power – optical system- Nozzle parameter- assist gas type- Feasible materials for laser cutting - Applications	
Laser Assisted Machining Laser-Assisted Machining LAM Process Surface Finish and Integrity Machining Using Single Laser Beam- Intersecting Laser Beams- Application of 3D Laser machining	03 Hours
Laser Micromachining Laser Micromachining mechanisms- Laser Ablation- Factors Influencing Ablation Rate- Ablation Damage- Laser-Assisted Chemical Etching- Micromachining Techniques- Direct Writing- Mask Projection- Interference- Combined Techniques- Laser Micromachining Applications -Laser Marking and Engraving	05 Hours
Laser Forming Laser Forming Processes- Bending- Buckling- Upsetting- Analysis of Laser Forming Processes- Laser forming applications- Laser-Based Rapid Prototyping – laser welding process- Laser Interference Processing- Laser Shock Processing and its applications- Laser Dressing of Grinding Wheels	07 Hours

Total Lecture Hours: 42

Books Recommended

1	J. Dowden. *The Theory of Laser Materials processing*, Springer, 2009.
2	N. B. Dahotre, S. P. Harimkar. *Laser fabrication and machining of materials*, Springer, 2008.
3	E. Fogarassy, D. Geohegan. *Laser Ablation*, Imprint North Holland Elsevier Publications, 1996.
4	J. Lawrence, D. G. Waugh. *Laser surface engineering Processes and application*, Wood Head Publishing Series, 2015.
5	K. Sugioka, M. Meunier, A. Piqué, *Laser Precision microfabrication*, Springer, 2010.

MECC235	:	QUALITY ENGINEERIN AND MANAGEMENT	L	T	P	Credits
			3	0	0	03

Course Outcomes

At the end of the course the students will be able to

CO1	Explain the different concepts of quality, system reliability & maintenance and its application to the design and manufacturing activities.
CO2	Understand and Apply statistical concepts and techniques for designing of products and process controls.
CO3	Describe and apply reliability analysis concepts to selected applications.
CO4	Describe and Apply the two level factor factorial design, general factorial design and surface response method for experimental design.
CO5	Formulate, analyze, design and synthesize open-ended quality engineering problems using the various statistical process control tools and quality management tool.
CO6	Select and apply newer concepts and initiatives for quality improvement.

Syllabus

Introduction Introduction to quality control and the quality system, some philosophies and their impact on quality, Cost of quality, Quality audit.	02 Hours
Statistical Quality Control Statistical Concepts and Data analysis: Fundamentals of statistical concepts and techniques in quality control and improvement, Data analysis and sampling; Control Charts: Statistical Process Control using control charts, Control charts for attributes and variables. Process capability analysis: Concepts and procedures of Process capability. Acceptance Sampling: Acceptance sampling for attributes and variables.	14 Hours
Reliability Analysis Reliability: Failure rate analysis, mean failure rate, mean time to failure, mean time between failure, Graphical representation of Fd, Z and R. Generalization in graphical form, integral form, Hazard models, systems reliability, availability, maintenance, overall equipment effectiveness, Total Productive Maintenance (TPM), Failure Mode and Effect Analysis (FMEA).	03 Hours
Experimental Design Experimental Design: Fundamentals of experimental Design, Single, Multi factor and 2k factor experiments, Two level fractional factorial design, Response surface method. Quality loss function. Taguchi method: Taguchi method, Design of experiments using orthogonal array, Data analysis from Taguchi and Multi level factor design.	08 Hours

New Quality Concepts and Initiatives New Quality Concepts and initiatives: Total Quality Management (TQM) and its techniques, New Seven Management Tools, and Industrial Case studies on Costs of Quality, Five S, kaizen, Quality Circles, Quality Function Deployment (QFD), Poka Yoke, Total Productive Maintenance (TPM), Lean Manufacturing, Six Sigma, Lean Six Sigma, etc. Quality Management through Software.	12 Hours
Quality Standards Quality Standards and Business Excellence Models: Quality System Standards, ISO 9000, ISO 14000, various Quality Awards and case studies.	02 Hours
World Class Manufacturing Manufacturing Excellence World Class Manufacturing (WCM) – Model and elements of WCM.	01 Hours

Total Lecture Hours: 42

Books Recommended

1	A. Mitra. *Fundamentals of Quality Control and Improvement*, 2nd Ed., Prentice Hall of India, 2011
2	K. Krishnaiah, P. Shahabudeen. *Applied Design of Experiments and Taguchi Methods*, Prentice Hall of India, 2012.
3	Dale H. Besterfield, Carol Besterfield-Michna, Mary Besterfield-Sacre, Glen H. Besterfield, Hemant Urdhwareshe, Rashmi Urdhwareshe, *Total Quality Management*, , Pearson Education, 2012.
4	G. W. Cobb. *Introduction to Design and Analysis of Experiments*, John Wiley & Sons, 2015.
5	D. C. Montogomery. *Introduction to Statistical Quality Control*, John Wiley & Sons, 8th Edition, 2013.

MECC240	:	OPTIMIZATION TECHNIQUES	L	T	P	Credits
			3	0	0	03

Course Outcomes

At the end of the course the students will be able to

CO1	Understand the concept of optimization, related terms and formulate mathematical models for practical problems based on the information provided.
CO2	Use linear programming to solve real life linear programming problems
CO3	Solve transportation and transhipment problems, travelling salesman problem and integer programming
CO4	Determine solutions that will be deployed in real world situations after conducting sensitivity and post optimality analysis
CO5	Apply classical methods to solve nonlinear programming problems
CO6	Use evolutionary algorithms to solve complex engineering problems where classical methods are not suitable.

Syllabus

Introduction Introduction to optimization, linear programming, formulation, graphical method, simplex method and special cases	04 Hours
Sensitivity and post optimality analysis Sensitivity analysis and post optimality analysis, changes in resources and objective function, changes affect feasibility and optimality, duality, dual simplex algorithm, generalize simplex algorithm	08 Hours
Special types of linear programming problems Transportation problems, Transshipment problems, Travelling salesman problems, Integer programming	06 Hours
Introduction to MATLAB and solving linear and nonlinear problems using MATLAB Introduction to MALAB, creating and manipulating vectors and matrix, user defined function, special built-in function to create special vectors and matrices, symbolic math, built-in function to solve linear programming problems	06 Hours
Nonlinear programming problems Graphical method, convex function and convex region, necessary and sufficient conditions, Lagrangian method, Karush-Kuhn-Tucker (KKT) conditions, solving nonlinear problems using MATLAB.	04 Hours

Evolutionary Algorithms Introduction to evolutionary algorithm, introduction to multi-objective optimization, genetic algorithms, differential evolution algorithm, Particle swarm optimization, tabu search, simulated Annealing technique, solving real life engineering problems using MATLAB	14 Hours

Total Lecture Hours: 42

Books Recommended

1	F. S. Hillier, G. J. Lieberman, B. Nag, P. Basu. *Introduction to operations research*, Tata McGraw-Hill Education, 2017.
2	H. A. Taha. *Operations research: an introduction*, Pearson Education India, 2017.
3	S. S. Rao. *Engineering optimization: theory and practice*, John Wiley & Sons, 2019.
4	A. Vasuki. *Nature-Inspired Optimization Algorithms*, CRC Press, 2020.
5	D. E. Goldberg. *Genetic algorithms: in search, optimization and machine learning*, Pearson Education India, 2006.

MECC241	:	THEORY OF ELASTICITY AND PLASTICITY	L	T	P	Credits
			3	0	0	03

Course Outcomes

At the end of the course the students will be able to

CO1	Explain the concept of equilibrium, torsion and bending of bars using theory of elasticity.
CO2	Apply plastic flow theory to predict the material deformation or fracture of selected mechanical component
CO3	Compute the numerical problems using flow rule, plastic work increment, work hardening and tensile instability
CO4	Develop analytical modelling and skills of engineering application related to plastic deformation
CO5	Explain the theory of local necking under uniaxial and biaxial tension in sheet metal forming applications
CO6	Apply plasticity concepts to analyse the stamping, bending and deep drawing process in metal strips

Syllabus

Theory of Elasticity Plane stress and plane strain, Stress and strain at a point. Equilibrium and compatibility equations. Two dimensional problems in rectangular and polar co –ordinates, Mohr's Circle of Stress in Two dimensions, three dimensional problems, Mohr's Circle of Stress in Three dimensions, Torsion and bending of bars.	10 Hours
Principles of Plastic Flow Theory Stress tensor, Hydrostatic and Deviator component of Stress, Plastic Stress & Strain relationship & Condition of initiation of plastic deformation, Failure Criterion, Plastic work increment, Plastic Anisotropy, Two-dimensional plastic flow theory- Slip line field theory, Introduction of large strains, Strain or work hardening, Experimental strain analysis	12 Hours
Tensile Instability Introduction, Uniaxial tension of a perfect & an imperfect strip, Uniaxial tension of a rate dependent material, necking in continuous bar, sheets, necking in biaxial tension, Effect of strain hardening, Effect of rate sensitivity, Ductile fracture & reduction of area, Determination of Forming Limit Strains for an Anisotropic material by Neck of growth. Methods for testing material properties	10 Hours

Stamping, Bending and Deep Drawing Analysis Two-dimensional stamping model, Stretch and draw ratio in stamping, three-dimensional stamping model, bending without tension, bending in Vee-die, Spring back, bending of small radius, Deep drawing of a sheet, Cup height, drawing with flange, wall ironing of deep drawn cup	10 Hours

Total Lecture Hours: 42

Books Recommended

1	E. G. Thomsen, C. T. Yang, S. Kobayashi. *Mechanics of Plastic Deformation in Metal Processing*, The MacMilan Co, 1965.
2	E. M. Mielnik. *Metal Working Science & Engineering*, 1st Edition, McGraw - Hill, Inc., New York, 1991.
3	Z. Marciniak, J. L. Dancan, S. J. Hu. *The Mechanics of Sheet Metal Forming*, Butterworth-Heinemann, 2002.
4	S. P. Timoshenko, J. Goodier. *Theory of Elasticity*, McGraw Hill, 1975.
5	V. Molotnikov, A. Molotnikov. *Theory of Elasticity and Plasticity: A Textbook of Solid Body Mechanics*, Springer, 2021

MECC242	:	INDUSTRIAL TRIBOLOGY	L	T	P	Credits
			3	0	0	03

Course Outcomes

At the end of the course the students will be able to

CO1	Understand and explain different laws of friction and topology of surfaces.
CO2	Differentiate between the types of lubricants, properties and its respective application area.
CO3	Appreciate the various modes of wear and the wear-mechanism maps.
CO4	Understand behaviour of bearing in different lubrication regimes and able to develop mathematical model.
CO5	Select the type of bearing for any given required engineering use and determine the load carrying capacity and other related parameters.
CO6	Decide on the tribological measurement techniques based on performance of machine components.

Syllabus

Introduction to the Concept of Tribo-Design Specific principles of tribo-design, tribological problems in machine elements.	04 Hours
Basic Principles of Tribology Sliding friction, relative motion in bodies, friction due to adhesion, deformation, energy dissipation during friction, types of wear and their mechanisms, wear in lubricated contacts and film lubrication.	08 Hours
Friction, Lubrication and Wear in Lower Kinematic Pairs Concept of friction angle, friction in screws with a square and triangular threads, plate, cone and centrifugal clutches, drives utilizing friction force, frictional aspects of brake design and tribo-design aspects of mechanical seals.	10 Hours
Friction, Lubrication and Wear in Higher Kinematic Pairs Loads acting on contact area, traction in contact zone, rolling friction and cam-follower systems.	05 Hours
Sliding-Element Bearings Derivation of Reynolds equation, hydrostatic and thrust bearings, journal bearings, gas bearings, steady-state analysis of fluid-film bearings, modern developments in journal bearing design, selection and design of thrust bearings	05 Hours

Rolling-Contact Bearings Analysis of friction in rolling contact bearings, deformations and kinematics of rolling element bearings, lubrication analysis of rolling contact bearings.	05 Hours
Lubrication and Efficiency of Involute Gears Generalities of gear design, lubrication regimes, gear failure due to scuffing, gear pitting, design aspects of gear lubrication and efficiency of gears.	05 Hours

Total Lecture Hours: 42

Books Recommended

1	D. Dowson, C.M. Taylor, M. Godet, D. Berthe. *Tribological Design of Machine Elements*, 1st Edition, Elsevier Science, 1989.
2	G. Stachowiak, A. Batchelor. *Engineering Tribology*, 3rd Edition, Elsevier Science, ISBN (978-0-12-397047-3), 2014.
3	A. Harnoy. *Bearing Design in Machinery: Engineering Tribology and Lubrication*, CRC Press, 2002.
4	S. Wen, P. Huang. *Principles of Tribology*, 2nd Edition, Wiley Publication, (ISBN: 978-1-119-21490-8), 2017.
5	R. Gohar, H. Rahnejat. *Fundamentals of Tribology*, 3rd Edition, World Scientific Publishing Company, 2018.

MECC243	:	MECHANICS OF COMPOSITE MATERIALS	L	T	P	Credits
			3	0	0	03

Course Outcomes

At the end of the course the students will be able to:

CO1	Explain the different types of composite materials.
CO2	Analyse the macro and micro mechanical behaviour of lamina.
CO3	Solve the problems of macro mechanical analysis of laminate
CO4	Evaluate the bending, buckling and vibration analysis of laminated plate.
CO5	Explain the design requirement of composite materials.
CO6	Analyse the nonlinear behaviour of composite materials.

Syllabus

Introduction Classification and characteristics of composite materials, Mechanical behaviour of composite materials, Terminology of laminated composite materials, Manufacture of laminated composite materials, Applications of composite materials	06 Hours
Macro-Mechanical Behaviour of a Lamina Stress-strain relationship for anisotropic materials, Stiffness, compliances and engineering constants for orthotropic materials, Relationship on engineering constants, Stress-strain relationship for plane stress in an orthotropic material, Strength of an orthotropic lamina	08 Hours
Micro-Mechanical Behaviour of a Lamina Mechanics of materials approach to stiffness, Elasticity approach to stiffness, Mechanics of materials approaches to strength.	06 Hours
Macro-Mechanics Behaviour of a Laminate Classical laminate theory, Special cases of laminate stiffness, Theoretical versus measured laminate stiffness, Strength of laminates, Inter laminar stresses	06 Hours
Bending, Buckling and Vibration of Laminated Plates Governing equations for bending, buckling and vibration of laminated plate, Deflection of simply supported laminated plates under distributed transverse load, Buckling of laminated plate, Vibration of laminated plate.	08 Hours
Introduction To Design of Composite Structures and Nonlinear Behaviour Introduction, Introduction to structural design, Material Selection, Configuration Selection, Laminate joints, Design requirements and design failure criteria, Definition	08 Hours

and types of non-linearity, Non-linear analysis of plates for bending, buckling and vibration, Inter laminar stresses of laminate.	

Total Lecture Hours: 42

Books Recommended

1	K. K. Autar. *Mechanics of composite materials*, 2^{nd} Edition, CRC Press, 2006.
2	R. M. Jones. *Mechanics of composite materials*, 2^{nd} Edition, Taylor and Fransis, 2018.
3	M. M. Kaminski. *Computational mechanics of composite materials*, Springer, 2005.
4	B. D. Agarwal. *Analysis and Performance of Fiber Composites*, 3rd Edition, John Wiley & Sons, 2006.
5	R.F. Gibson. *Principles of Composite Material Mechanics*, 4th Edition, CRC Press, 2016.

MECC244	:	SURFACE ENGINEERING	L	T	P	Credits
			3	0	0	03

Course Outcomes

At the end of the course the students will be able to

CO1	Decide the surface preparation methods suitable for different substrate materials.
CO2	Demonstrate the ability to use the core concepts of engineering application in material degradation by corrosion, wear and its prevention.
CO3	Describe the importance & role of surface modifications to achieve several technological properties.
CO4	Explain importance of specific coating technique ,characterization & its applications on specific engineering components.
CO5	Select surface engineering technique for specific wear mechanisms and corrosion control.
CO6	Propose suitable surface engineering technique to control material degradation.

Syllabus

Introduction Surface engineering: Introduction to surface engineering, Scope of surface engineering for different engineering materials, Surface Preparation methods such as Chemical, Electrochemical, Mechanical: Sand Blasting, Shot peening, Shot blasting, Hydro-blasting, Vapor Phase Degreasing etc., Coatings: Classification, Properties and applications of Various Coating	04 Hours
Wear Adhesive wear, Abrasive and erosive wear, Wear induced by mechanical fatigue of the worn surface, melting wear, fretting wear and diffusive wear, Analytical models of wear, Wear resistant materials, Fatigue, fracture and creep.	06 Hours
Corrosion Corrosion of metals in aqueous media: Electrochemistry and aqueous corrosion, Electrochemical corrosion of machinery and structures, Corrosion inhibitors, Materials factors in aqueous corrosion. Oxidative reactions of metals with oxygen, sulphur and other halogens.	06 Hours
Discrete Coatings Introduction, Coatings of organic compounds, Electrochemical coatings, Plasma and thermal spraying, plasma-transferred arc the D gun, Vacuum-based coating methods, Friction surfacing, weld overlays and explosive bonding, Advanced coating techniques.	06 Hours

Integral Coatings and Modified Surface Layers Introduction, Thermally or mechanically modified surface layers: Induction hardening, Laser and electron beam surface hardening, Shot-peening, Thermochemical methods of coating: Galvanization and hot-dipping, Carburizing, carbonitriding, nitriding, nitrocarburizing & boronizing, Advanced surface modification technologies: Plasma nitriding and plasma carburization, Surface alloying by laser and electron beam, Ion implantation.	08 Hours
Characterization of Surface Coatings Introduction, Measurement of surface roughness and coating thickness, Hardness and microhardness analysis, Adhesivity testing, Microstructural evaluation, Chemical analysis, Residual stress analysis, Corrosion testing.	06 Hours
Control of Materials Degradation Introduction, Methodology of analysing materials degradation, Selection of optimal surface engineering technology, Control of wear by surface engineering, Principles of coating selection for wear resistance, Selection of specific surface engineering techniques for specific wear mechanisms, Control of corrosion by surface engineering, Control of fatigue and fracture by surface engineering	06 Hours

Total Lecture Hours: 42

Books Recommended

1	T. Burakowski, T. Wierzchon. *Surface engineering of metals*, CRC Press, 2020.
2	A. W. Batchelor, L. N. Lam, M. Chandrasekaran. *Materials degradation and its control by surface engineering*, 3rd Edition, Imperial college press, 2011.
3	L. I. Tushinsky, I. Kovensky, A. Plokhov, V. Sindeyev, P. Reshedko. *Coated Metal: Structure and Properties of Metal-Coating Compositions*, Springer, Germany, 2002.
4	M. Ohring. *Materials Science of Thin Films*, 2nd Edition, Academic Press, 2002.
5	L. I. Tushinsky, I. Kovensky, A. Plokhov, V. Sindeyev, P. Reshedko. *Materials Degradation and Its Control by Surface Engineering*, 3Ed Hardcover – Illustrated, February 2011.

MECC210	:	EXTENDED FINITE ELEMENT METHODS	L	T	P	Credits
			3	0	0	03

Course Outcomes

At the end of the course the students will be able to

CO1	Explain the concept of XFEM.
CO2	Analyze different modes of fracture.
CO3	Utilized enrichment functions to solve simple fracture problems by XFEM.
CO4	Evaluate stress intensity factor (SIF) for isotropic and orthotropic materials by XFEM.
CO5	Solve the problems on Cohesive Cracks.
CO6	Evaluate the stresses and SIF near crack tip of dynamic fracture problems.

Syllabus

Introduction Structures, discontinuities in the materials, fracture mechanics, comparison between FEM and XFEM, general aspects of XFEM, Partition of unity, enrichment functions, local and non-local models, discrete cracked element, singular elements, enriched elements, Basics of elasticity, LEFEM, strong and weak discontinuities, cracks modeling, XFEM application.	08 Hours
XFEM for Isotropic Problems Basics of FEM, basics of fracture mechanics, partition of unity, enrichment, isotropic XFEM, modeling of strong and weak discontinuities, XFEM approximation, signed distance function, modeling of strong and weak discontinuous fields, modeling of crack, XFEM discretization and integration, tracking moving boundaries, level set method, numerical simulations: A tensile plate with a central crack, single and double edge cracks, edge and center crack in finite and infinite plate.	08 Hours
XFEM for Orthotropic Problems Anisotropic elasticity, elasticity solution, anisotropic stress functions, orthotropic mixed mode problems, energy release rate and stress intensity factor for anisotropic materials, analytical solutions for near crack tip, near crack tip displacement field, XFEM discritization and SIF calculations, numerical simulations: Plate with a crack parallel to material axis of orthotropy , orthotropic and isotropic materials with crack subjected to tensile tractions	08 Hours
XFEM for Cohesive Cracks Cohesive cracks, Numerical models for cohesive cracks, Crack propagation criteria, Griffith criterion for cohesive crack, Cohesive crack model, XFEM for cohesive cracks (enrichment functions, governing equation and XFEM discritization), numerical simulations: mixed mode bending beam, four point bending beam and double cantilever beam.	08 Hours

Static and Dynamic Fracture Analysis Analytical Solutions for Near Crack Tip, Mixed Mode Fracture, SIF Calculation by Interaction Integral, Anisotropic XFEM, Analytical Solutions for Near crack tips in dynamic states, analytical solution for near crack tip of a Propagating crack Material, dynamic stress intensity factor, numerical simulations: plate with stationary centre crack, mode I plate with edge crack, mixed mode edge crack in composite plate, composite plate with crack under impulsive loading.	10 Hours

Total Lecture Hours: 42

Books Recommended

1	S. Mohammadi. *Extended finite element method*, 1st edition, Blackwell, 2007.
2	*XFEM fracture mechanics of composites*, 1st edition, A John Wiley & Sons, Ltd., Publication 2012.
3	P Kumar. *Elements of fracture mechanics*, Tata McGraw Hill, New Delhi, 2017.
4	Anderson. *Fracture Mechanics-Fundamental and Application*, T. L. CRC press1998.
5	R. B. Charlie, A. Chaudhary. *Failure Analysis of Engineering Materials*, McGraw Hill, New York, 2001.

MECC211	:	COMPUTATIONAL FLUID DYNAMICS TECHNIQUES	L	T	P	Credits
			3	0	0	03

Course Outcomes

At the end of the course the students will be able to

CO1	Develop mathematical model for fluid flow through turbomachine passage.
CO2	Discretize the fundamental equations of flow and other transport processes.
CO3	Apply finite volume method for numerical modeling of flow.
CO4	Solve flow problems using semi-explicit and semi-implicit algorithms.
CO5	Generate mesh for flow domain in complex turbomachinery geometry.
CO6	Solve Navier-Stokes equations for flow through complex turbomachine passages.

Syllabus

Review of Governing Equations Fluid Flow and Heat Transfer Conservation of Mass, Newton's Second Law of Motion, Expanded Forms of Navier stokes equations, Conservation of Energy Principle, Special Forms of the Navier Stokes Equations, Classification of Second order Partial Differential Equation s, Initial and Boundary Conditions, Governing Equations in Generalized Coordinates.	06 Hours
Finite Difference, Discretization, Consistency, Stability and Fundamental of Fluid Flow Modeling Elementary Finite Difference Quotients, Basic Aspects of Finite Difference Equations, Errors and Stability Analysis, Some Nontrivial Problems with Discretized Equations, Applications to Heat Conduction and Convection.	08 Hours
Solution of Viscous Incompressible Flows by Stream Function -Vorticity Formulation Two-Dimensional Incompressible Viscous Flow, Incorporation of Upwind Scheme, Estimation of Discretization Error, Application to Curvilinear Geometries, Derivation of Surface Pressure and Drag.	08 Hours
Solution of Navier-Stokes Equations for Incompressible Flows Using MAC and SIMPLE Algorithms Staggered Grid, Solution of the Unsteady Navier -Stokes Equations, Solutions of Energy Equation, Formulation of the Flow Problems, SIMPLE Algorithm.	10 Hours
Introduction to FVM: Integral Approach, discretization & Higher order scheme, Finite Volume Solution of Unsteady Advection, Diffusion Problems with Source Term.	10 Hours

Total Lecture Hours: 42

Books Recommended

1	D. A. Anderson, J. C. Tannehill, R. H. Pletcher. *Computational Fluid Mechanics and Heat Transfer*, Hemisphere Publishing Corporation, New York, U.S.A, 1984.
2	K. Murlidhar, T. Sunderarajan. *Computational Fluid Flow and Heat Transfer*, Narosa Publishing House, New Delhi, 2003.
3	J. D. Anderson Jr. *Computational Fluid Dynamics*, McGraw Hill, Inc. New York, 1996.
4	S. V. Ankar. *Numerical Heat Transfer and Flow*, Hemisphere Publ., Corporation, 1985.
5	H. K. Versteag, W. Malalsekara. An Introduction to Computational Fluid Dynamics, Pearson, 2008

MECC203	**:**	**SOFTWARE PRACTICE 2**	**L**	**T**	**P**	**Credits**
			0	**0**	**4**	**02**

Course Outcomes

At the end of the course the students will be able to

CO1	Apply programming language to solve engineering problems.
CO2	Generate code for solving engineering problems using differential equations.
CO3	Develop FEA codes for 1D and 2D problems.
CO4	Develop FEA codes for thermal problems.

Exercises:

1. Exploring programming languages such as MATLAB / Python / Scilab.
2. Write code for 2nd order differential equation for given problems.
3. Write FEA code for solving a given problem of 1D spring and linear bar element.
4. Write FEA code for solving a given problem of 2D truss structure.
5. Write FEA code for solving a given problem of Plane stress and Plane strain.
6. Write FEA code for solving a given problem of thermal analysis.

MECC204	**:**	**LABORATORY PRACTICE 2**	**L**	**T**	**P**	**Credits**
			0	**0**	**4**	**02**

Course Outcomes

At the end of the course the students will be able to

CO1	Understand working of 3D printing technology.
CO2	Perform slicing exercise.
CO3	Demonstrate working of Arduino.
CO4	Practice controlling of motors used in Industrial robotics.

Practicals:

1. Demonstration of 3D printing technology.
2. Carry out slicing exercise of given objects.
3. Exploring system control through Arduino board.
4. Robotics-Controlling of servo motor.
5. Robotics-Controlling of DC motor.
6. Robotics-Controlling of stepper motor.