Program Articulation Matrix

S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7
1	ESC	23MT5102 - CTEO	CO1	Understand the fundamental concepts of optimization, including types of problems, mathematical formulation, and programming implementation.	3	3					
2	ESC	23MT5102 - CTEO	CO2	Apply mathematical optimization techniques, both unconstrained and constrained, to solve engineering problems using programming languages like Matlab/Python/R.	3				3		
3	ESC	23MT5102 - CTEO	CO3	Analyze and solve multi-objective optimization problems, considering trade-offs and conflicting objectives, using appropriate algorithms and methodologies.	3				3		
4	ESC	23MT5102 - CTEO	CO4	Apply optimization techniques to solve application-specific problems in Machine Design and Thermal Engineering domains, demonstrating domain-specific knowledge and skills.	3				3		
5	PCC	23MD5102 - RMDA	CO1	Apply homogeneous transformations and DH parameters	2		2	2			
6	PCC	23MD5102 - RMDA	CO2	Apply forward and inverse kinematics to Robots		2	2	2			
7	PCC	23MD5102 - RMDA	CO3	Apply rigid body dynamics and dynamic modelling to Robots		2	2	2			
8	PCC	23MD5102 - RMDA	CO4	Design mechanical systems for robot manipulators		3	2	2			
9	PCC	23MD5102 - RMDA	CO5	Apply configuration space and motion planning		2	2	2			
10	PCC	23MD5103 - MBM	CO1	Analyze the structural deformation of solid bodies in multi-axial stress state to assess the safety factor against yielding	2		1				

S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7
11	PCC	23MD5103 - MBM	CO2	Solve 2-D elasticity problems in Cartesian and Polar coordinate systems		2	1				
12	PCC	23MD5103 - MBM	CO3	Analyze the bending of cantilever beams having rectangular and circular cross-sections; Axisymmetric stress and deformation in a solid of revolution ; and simple 3-D stress analysis problems	2		1				
13	PCC	23MD5103 - MBM	CO4	Analyze the plastic deformation of solid bodies using the method of characteristics and engineering methods	2		1				
14	PCC	23MD5103 - MBM	CO5	Analyze the complex structural deformation problems relevant to CO1, CO2, CO3 and CO4		2	1				
15	PCC	23MD5106 - MAME	CO1	Understand various CAD tools and peripherals required to create models.	2	2		2			
16	PCC	23MD5106 - MAME	CO2	Represent different curves and surfaces of geometric models.	2	2		2			
17	PCC	23MD5106 - MAME	CO3	Represent solid models using different solid represent schemes	2	2		2			
18	PCC	23MD5106 - MAME	CO4	Apply various data exchange formats in geometric modeling and also will be able to apply finite element modeling and mechanical assembly concepts in design applications	2	2		2			
19	PCC	23MD5106 - MAME	CO5	Analyze various mechanical elements models using modeling software	2	2		2			
20	PCC	23MD5106 - MAME	CO6	Design and develop mechanical components for selected applications	2	2		2			
21	PCC	23MD5204 - ASM	CO1	Analyze the stresses and deflections in the beams under unsymmetrical bending and determination of shear centre.		2					

S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7
22	PCC	23MD5204 - ASM	CO2	Analyze the stresses induced in curved beams subjected to loading.	2	2					
23	PCC	23MD5204 - ASM	CO3	Analyze the torsional stresses in beams and determine the contact stresses.	2	2					
24	PCC	23MD5204 - ASM	CO4	Apply principles of elasticity to determine stresses in two dimensional and three dimensional problems.		2					
25	PCC	23MD5204 - ASM	CO5	Simulate the structural members using ANSYS software and validate the results with analytical methods	2	2					
26	PCC	23MD5205 - MV	CO1	Analyse free vibrations of single degree freedom systems	3		3	3			
27	PCC	23MD5205 - MV	CO2	Analyse harmonically excited vibrations of single degree freedom systems	3		3	3			
28	PCC	23MD5205 - MV	CO3	Analyse the mode shapes of two degree and multi degree vibration systems	3		3	3			
29	PCC	23MD5205 - MV	CO4	Identify the means to control and measure the vibration response of the system	3		3	3			
30	PCC	23MD5205 - MV	CO5	Analyse the vibrations of the system using analysis software	3		3	3			
31	PRI	23IE5149 - TP	CO1	Understand Literature Review and Problem Identification	1	2		2			
32	PRI	23IE5149 - TP	CO2	Understand Methodology and Implementation	1	2		2			
33	PRI	23IE5201 - ERD	CO1	Analyze existing research to identify a focused and answerable research question or develop a well-defined hypothesis	2	3					
34	PRI	23IE5201 - ERD	CO2	Evaluate different research designs based on their strengths and weaknesses in relation to the chosen research question and data needs.		3					3

S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7
35	PRI	23IE5201 - ERD	CO3	Apply appropriate data collection methods considering the chosen research design and data characteristics.	2		2				
36	PRI	23IE5201 - ERD	CO4	Analyze and interpret data using relevant data analysis methods to address the research question			3				2
37	PRI	23IE6150 - DIS	CO1	Identify and articulate research problems within their field of study, demonstrating an understanding of current research gaps.	2		2				
38	PRI	23IE6150 - DIS	CO2	Design and execute research methodologies, employing relevant techniques for data collection, analysis, and interpretation.				2		2	
39	PRI	23IE6150 - DIS	CO3	Demonstrate advanced critical thinking skills, analyzing research findings within the context of existing literature to draw meaningful conclusions.	2		2				
40	PRI	23IE6250 - DIS	CO1	Demonstrate a comprehensive understanding of a chosen research topic and its significance in the broader field.	2					2	
41	PRI	23IE6250 - DIS	CO2	Apply appropriate research methodologies to address research questions		2			2		
42	PRI	23IE6250 - DIS	CO3	Analyze and interpret data effectively, drawing meaningful conclusions	2					2	
					2.2	2.2	2.1	2.3	2.8	2	2.5

23MT5102 - COMPUTATIONAL TECHNIQUES IN ENGINEERING OPTIMIZATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MT5102	COMPUTATIONAL TECHNIQUES IN ENGINEERING OPTIMIZATION	CTEO	R	2	2	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental concepts of optimization, including types of problems, mathematical formulation, and programming implementation.	2	PO1, PO2
CO2	Apply mathematical optimization techniques, both unconstrained and constrained, to solve engineering problems using programming languages like Matlab/Python/R.	3	PO1, PO5
CO3	Analyze and solve multi-objective optimization problems, considering trade-offs and conflicting objectives, using appropriate algorithms and methodologies.	4	PO1, PO5
CO4	Apply optimization techniques to solve application-specific problems in Machine Design and Thermal Engineering domains, demonstrating domain-specific knowledge and skills.	3	PO1, PO5

Syllabus

Introduction to Engineering Optimization: Basics of optimization, mathematical formulations, and algorithms. Applications in mechanical and machine design.

Unconstrained Optimization Techniques: Newton\'s method, gradient descent, conjugate gradient. Implementation in MATLAB/Python.

Constrained Optimization Techniques: Linear and nonlinear constraints, Lagrange multipliers, penalty and barrier methods. Application in mechanical design.

Multi-objective Optimization: Pareto optimality, weighted sum, epsilon-constraint methods. Implementing multi-objective optimization using Python.

Reference Books

1. "Engineering Optimization: Methods and Applications", Ravindran, R., Ragsdell, K. M., & Reklaitis, G. V., 2006, Wiley.
2. "Introduction to Optimization", Chong, E. K. P., & Zak, S. H., 2013, Wiley.
3. "Optimization Concepts and Applications in Engineering", Belegundu, A. D., & Chandrupatla, T. R., 2011, Pearson.
4. "Optimization in Practice with MATLAB?: For Engineering Students and Professionals", Achanta, S., & Darby-Dowman, K., 2015, Cambridge University Press.
5. "Applied Optimization: Formulation and Algorithms for Engineering Systems", Ross, I. J., 1999, Cambridge University Press.

23MD5102 - ROBOTICS MANIPULATOR DESIGN AND ANALYSIS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MD5102	ROBOTICS MANIPULATOR DESIGN AND ANALYSIS	RMDA	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply homogeneous transformations and DH parameters	3	PO1, PO3, PO4
CO2	Apply forward and inverse kinematics to Robots	3	PO2, PO3, PO4
CO3	Apply rigid body dynamics and dynamic modelling to Robots	3	PO2, PO3, PO4
CO4	Design mechanical systems for robot manipulators	4	PO2, PO3, PO4
CO5	Apply configuration space and motion planning	3	PO2, PO3, PO4

Syllabus

Introduction to Robotics: Definition of Robotics, Classification of Robots, Robot Components and Architecture :Robot Kinematics - Homogeneous Transformations, Denavit-Hartenberg (DH) Parameters

Forward Kinematics, Inverse Kinematics: Robot Dynamics - Rigid Body Dynamics, Lagrange\'s Equation, Newton-Euler Equations,

Dynamic Modeling of Manipulators; Robot Motion Planning - Configuration Space, Path Planning, Motion Planning Algorithms; Robot Control -Proportional-Integral-Derivative (PID) Control, Computed-Torque Control

Robot Manipulator Design- Mechanical Design Considerations, Actuators and Drive Systems; Robot Sensors and Perception -Sensor Types and Selection, Sensing Techniques for Robotics

Reference Books

1. Robotics: Modelling, Planning and Control, Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo, 1, 2010, Springer.
2. Introduction to Robotics: Mechanics and Control, John J. Craig, 1, 2017, Pearson.
3. Robot Dynamics and Control, Mark W. Spong, Seth Hutchinson, M. Vidyasagar , 2, 2020, Wiley.
4. Mechanical Vibrations and Noise Engineering, A. G. Ambekar, 1st Edition, 2011, Pearson.

23MD5103 - MECHANICAL BEHAVIOUR OF MATERIALS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MD5103	MECHANICAL BEHAVIOUR OF MATERIALS	MBM	R	3	1	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze the structural deformation of solid bodies in multi-axial stress state to assess the safety factor against yielding	4	PO1, PO3
CO2	Solve 2-D elasticity problems in Cartesian and Polar coordinate systems	4	PO2, PO3
CO3	Analyze the bending of cantilever beams having rectangular and circular cross-sections; Axisymmetric stress and deformation in a solid of revolution ; and simple 3-D stress analysis problems	4	PO1, PO3
CO4	Analyze the plastic deformation of solid bodies using the method of characteristics and engineering methods	4	PO1, PO3
CO5	Analyze the complex structural deformation problems relevant to CO1, CO2, CO3 and CO4	4	PO2, PO3

Syllabus

ELASTICITY: Two dimensional stress analysis - Plane stress - Plane strain Equations of compatibility Stress function Boundary conditions. PROBLEMS IN RECTANGULAR COORDINATES Solution by polynomials Saint Venents principles Determination of displacement Simple beam problems.

PROBLEMS IN POLAR COORDINATES General equations in polar coordinates Stress distribution symmetrical about axis Strain components in polar coordinates Simple and symmetric problems.

ANALYSIS OF STRESS AND STRAIN IN THREE DIMENSIONS: Principle stresses Homogeneous deformations Strain spherical and deviatoric stress Hydrostatic strain. General theorems Differential equations of equilibrium and compatibility Displacement Uniqueness of solution Reciprocal theorem.

BENDING OF PRISMATIC BARS Stress function Bending of cantilever beam Beam of rectangular cross section Beams of circular cross section. PLASTICITY Plastic deformation of metals Structure of metals Deformation Creep stress relaxation of deformation Strain rate condition of constant maximum shear stress Condition of constant strain energy Approximate equation of plasticity. METHODS OF SOLVING PRACTICAL PROBLEMS The characteristic method Engineering method Compression of metal under press Theoretical and experimental data drawing.

Solving problems relevant to modules 1 to 4

Reference Books

1 Theory of Elasticity, Timoshenko S.P. and Goodier J.N., 1970, McGraw-Hill Education.

2 An Engineering Theory of Plasticity, E.P. Unksov, 1961, Butterworths.

3 Applied Elasticity, C.T. Wang, 1953, McGraw-Hill.

4 Theory of Plasticity for Engineers, Hoffman and Sacks, 1953, McGraw-Hill.

5 Theory of Elasticity and Plasticity, Sadhu Singh, 1988, Khanna Publishers.

6 Theory of Elasticity and Plasticity, Harold Malcolm Westergaard, 1964, Dover Publications.

23MD5106 - MODELLING AND ANALYSIS OF MECHANICAL ELEMENTS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MD5106	MODELLING AND ANALYSIS OF MECHANICAL ELEMENTS	MAME	R	2	0	2	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand various CAD tools and peripherals required to create models.	2	PO1, PO2, PO4
CO2	Represent different curves and surfaces of geometric models.	3	PO1, PO2, PO4
CO3	Represent solid models using different solid represent schemes	3	PO1, PO2, PO4
CO4	Apply various data exchange formats in geometric modeling and also will be able to apply finite element modeling and mechanical assembly concepts in design applications	3	PO1, PO2, PO4
CO5	Analyze various mechanical elements models using modeling software	4	PO1, PO2, PO4
CO6	Design and develop mechanical components for selected applications	5	PO1, PO2, PO4

Syllabus

CADTOOLS:Definition of CAD Tools, Types of System, CAD/CAM system evaluation criteria, brief treatment of input an output devices. Graphics standards, functional areas of CAD, Modeling and Viewing, Software documentation efficient use of CAD Software.GEOMETRIC MODELING:Types of Mathematical representation of curves, wire frame models, wire frame entities, parametric representation of synthetic curves hermit cubic splines, Bezier curves, B-Splines rational curves.

SURFACE MODELING:Mathematical representation surfaces, surface model, surface entities, surface representation,parametric representation of surfaces,plane surface,rule surface, surface of revolution,tabular cylinder.PARAMETRIC REPRESENTATION OF SYNTHETICSURFACES:Hermit Bi Cubic surface, Bezier curve surface, B-Spline surface, COONs, Blending Surface,Sculptured surface, Surface Manipulation- Displaying, segmentation, trimming, intersection, Transformations (2D and3D).

GEOMETRIC MODELING 3D:Solid modeling, solid representation, Boundary Representation (B-Rep), Constructive Solid Geometry. CAD/CAM DATA EXCHANGE: Evaluation of data Exchange format, IGES Data representation sand structure, STEP Architecture, Implementation, ACIS and DXF.

DESIGN APPLICATIONS: Finite Element Modeling and Analysis and Mechanical Assembly. COLLABORATIVE ENGINEERING: Collaborative Design, Principles, Approaches, tools, designs system.

Reference Books

1. CAD/CAM: Principles and Applications, P.N.Rao, 3rd Edition, Tata Mc Graw hill.
2. CAD/CAM: Theory and Practice, Ibrahim Zeid, 2nd Edition, Tata Mc Graw hill.
3. CAD/CAM: Computer Aided Design and Manufacturing, M.Groover, E.Gimmers, 3rd Edition, Pearson.
4. CAD/CAM: Concepts and Applications, Chennakeava R. Alavala, 3rd Edition, Prentice Hall India Learning Private Limited.

23MD5204 - ADVANCED STRENGTH OF MATERIALS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MD5204	ADVANCED STRENGTH OF MATERIALS	ASM	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze the stresses and deflections in the beams under unsymmetrical bending and determination of shear centre.	4	PO2
CO2	Analyze the stresses induced in curved beams subjected to loading.	4	PO1, PO2
CO3	Analyze the torsional stresses in beams and determine the contact stresses.	4	PO1, PO2
CO4	Apply principles of elasticity to determine stresses in two dimensional and three dimensional problems.	3	PO2
CO5	Simulate the structural members using ANSYS software and validate the results with analytical methods	4	PO1, PO2

Syllabus

UNSYMMETRICAL BENDING: Bending stress in beams subjected to non-symmetrical bending, deflection of straight beams due to non symmetrical bending. SHEARCENTER: Bending axis and shear center-shear center of axisymmetric and unsymmetrical sections.

CURVED BEAM THEORY: Winkler Bach formula, correct factors, radial stress in curved beams, closed ring subjected to concentrated and uniform loads, stress in chain links. Torsion: Linear elastic solution, Pradtl elastic membrane (Soap-Film) Analogue, Narrow rectangular cross-section, Hollow thin wall torsion members, multiply connected cross-section.

CONTACT STRESS: Introduction, problem of determining contact stresses, assumptions on which a solution for contact stresses is based, expression for principle stresses, method of computing contact stresses, deflections of bodies in point contact, stresses for two bodies in contact over narrow rectangular area (Line of contact). Loads normal to area, stressed for two bodies in line contact normal and tangent to contacts area.

TWO DIMENSIONAL ELASTICITY PROBLEMS: Plane stress and plain strain, problems in rectangular Coordinates bending of cantilever beam loaded at the end, bending of a beam by uniform load. In polar coordinates, general equations in polar coordinates, stress distribution symmetrical about the axis, pure bending of curved bars, and displacements for symmetrical stress distributions, rotating discs. INTRODUCTION TO THREE DIMENSIONAL PROBLEMS: Uniform stress stretching of a prismatic bar by its own weight, twist of circular shafts of constant cross section, pure bending of plates.

Reference Books

1 Advanced Mechanics of materials, A.P.Boresi and O.M.Side bottom, 4th Edition, Wiely International.

2 Theory of Elasticity, Timoschenko S.P. and Goodier J.N, 2nd Edition, Mc Graw hill Publishers.

3 Advanced strength of materials, Den Hortog J.P., 3rd Edition, Dover Publications.

4 Theory of plates and shells, S.Timoshenko, 3rd Edition, McGraw Hill.

5 Strength of Materials and Theory of Structures, B.C Punmai, 2nd Edition, Laxmi Publications Pvt Ltd.

23MD5205 - MECHANICAL VIBRATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MD5205	MECHANICAL VIBRATIONS	MV	R	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyse free vibrations of single degree freedom systems	4	PO1, PO3, PO4
CO2	Analyse harmonically excited vibrations of single degree freedom systems	4	PO1, PO3, PO4
CO3	Analyse the mode shapes of two degree and multi degree vibration systems	4	PO1, PO3, PO4
CO4	Identify the means to control and measure the vibration response of the system	4	PO1, PO3, PO4
CO5	Analyse the vibrations of the system using analysis software	5	PO1, PO3, PO4

Syllabus

Classification of vibrations, Vibration analysis procedure, spring elements, damping elements, Inertia elements, harmonic motion and analysis, free vibration of undamped and damped translational and torsional systems.

Response of an undamped and damped systems under harmonic excitation, Response of damped system under harmonic force of the base, Response of damped system under rotating unbalance, Transfer function approach, solution using frequency transfer function.

Free vibration analysis of undamped 2DOF systems, coordinate coupling and Principal coordinates, forced vibration analysis, semidefinite system, solutions using Laplace Transform, Modelling of continuous system as multi degree of freedom systems

Vibration control and Isolation, Vibration measurement: Transducers, Vibration pickups, frequency measuring instruments, vibration exciters, signal analysis, dynamic testing of machinery and structures, machine condition monitoring and diagnosis.

Reference Books

1 Mechanical vibrations, S.S.Rao, 6th edition 2018, Pearson.

2 Vibration Analysis and Control in Mechanical Systems, C. M. Harris, 2nd Edition, 2001, CRC Press.

3 Mechanical Vibrations: Theory and Applications, S. Graham Kelly, 1st Edition, 2012, Cengage Learning.

4 Mechanical Vibrations and Noise Engineering, A. G. Ambekar, 1st Edition, 2011, Pearson.

23MD51A1 - LEAN MANUFACTURING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MD51A1	LEAN MANUFACTURING	LM	R	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Lean principles and tools for waste reduction, enhancing efficiency, and fostering a culture of continuous improvement in manufacturing environments.	2	PO1, PO2
CO2	Understand Lean methodologies like 5S, Kaizen, and Value Stream Mapping to optimize processes, reduce lead times, and improve overall productivity.	2	PO3, PO5
CO3	Understand leadership skills to champion Lean initiatives, cultivate a culture of employee engagement, and drive sustainable organizational improvement.	2	PO6
CO4	Apply practical knowledge of Lean implementation strategies to streamline operations, minimize costs, and maximize value for stakeholders and customers.	3	PO2
CO5	Apply practical skills in applying lean manufacturing principles and tools to improve efficiency, reduce waste, and optimize processes through hands-on lab activities.	3	PO1, PO2

Syllabus

An overview of Lean principles and philosophy, highlighting key concepts like waste reduction, value stream mapping, and continuous improvement. It covers strategies for boosting efficiency, optimizing processes, and fostering a culture of ongoing improvement.

Explore 5S methodology, Kaizen events, and Poka-yoke techniques. Understand Kanban systems for effective inventory management, focusing on organizational practices, continuous improvement, error-proofing processes, and visual workflow management to enhance operational efficiency.

Examine process flow, compare current and future state mapping, and apply VSM. Focus on improving process efficiency and eliminating waste through detailed analysis and strategic implementation of value stream mapping techniques.

Explore the essential role of leadership in implementing Lean methodologies, emphasizing the cultivation of a culture centered on continual improvement and the empowerment of employees to actively participate and contribute to Lean initiatives.

Reference Books

1. Lean Thinking: Banish Waste and Create Wealth in Your Corporation, James P. Womack, Daniel T. Jones , 2003, Free Press.
2. The Machine That Changed the World: The Story of Lean Production, Daniel T. Jones, Daniel Roos , 1990, Free Press.
3. Lean Production Simplified: A Plain-Language Guide to the World's Most Powerful Production System, Pascal Dennis , 2015, Productivity Press.
4. Lean Thinking: Banish Waste and Create Wealth in Your Corporation, James P. Womack and Daniel T. Jones , 2003, Free Press.

23MD51A2 - PRECISION AND QUALITY ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MD51A2	PRECISION AND QUALITY ENGINEERING	PQE	R	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and apply the measuring tools to machines and instruments.	2	PO3
CO2	Understand the different methods and solve the problems of Quality control.	2	PO3
CO3	Relate the Quality and Reliability and its associated failure modes.	2	PO3
CO4	Understand and implement the ISO 9000 series of total quality management.	2	PO3
CO5	Applying Precision Engineering concepts, Statistical Quality Control, and TQM principles for effective manufacturing processes.	3	PO3

Syllabus

INTRODUCTION: Importance of Precision Engineering, Tolerance and Technology, Definition of Tolerance, Impact of specifying Tolerance. MEASUREMENT OF PRECISION: Application of displacement transducers to machines and instruments, introduction to Precision Machine Design, Principles of Precision of Machine Design, Principle of Accuracy, Repeatability and resolution.

INTRODUCTION TO QUALITY: Quality of design, Quality of Conformance to Design, Quality of Performance, Growth of Quality Control, Process Monitoring, Acceptance Sampling, Quality of Performance Reliability, Management of Quality, Quality and Productivity.FUNDAMENTALS OF STATISTICS AND PROBABILITY IN QUALITY CONTROL

STATISTICAL QUALITY CONTROL: Variability in Materials, Machines and people, Statistical Understanding of Variability, Basic form of control chart, use of Control charts, Development of a Control Chart, Control charts for Variable and attributes. BASIC CONCEPT OF RELIABILITY: Introduction, Reliability and Quality, Failures and Failure Modes, Causes of Failures and Unreliability, maintainability and Availability, History of Reliability, Reliability literature.

TOTAL QUALITY MANAGEMENT: Objectives of TQM, Management in TQM, Implementation of TQM. I.S.O.9000 Series. Introduction Characteristics, Area covered in ISO 9000

Reference Books

1 Precision Engineering in Manufacturing, Murthy R. L., 1996, New Age International (P) limited.

2 Geometric Dimensioning and Tolerancing, James D. Meadows, 1995, Marcel Dekker inc..

3 Precision Engineering, VC Venkatesh& S Izman, --, TMH.

4 Introduction to Statistical Quality Control, Douglas C Montgomery, 2012, John Wiley.

5 Statistical Quality Control, Grant E.L. and Leavensworth, 2000, TMH.

23MD51A3 - BEHAVIOUR OF COMPOSITE MATERIALS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MD51A3	BEHAVIOUR OF COMPOSITE MATERIALS	BCM	R	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concept of Composite materials, Classifications and Manufacturing Processes	2	PO1, PO7
CO2	Apply the micro-mechanics concept to study the structural behavior of composite Lamina	3	PO1, PO2, PO7
CO3	Apply the macro-mechanics concept to study the structural behavior of composite Lamina	3	PO1, PO2, PO7
CO4	Apply Failure theories to calculate stresses in composite materials	3	PO1, PO2, PO7
CO5	Apply and analyze the theoretical concepts to conduct various experiments on composite materials through modeling.	4	PO2, PO7

Syllabus

Introduction to composite materials, Geometric definitions, Classification of composites, Types of fibers, Types of the matrix, Hybrid composite, Scale of analysismicro and macro mechanics approaches, Degree of Anisotropy. Manufacturing methods of the composites, Autoclave molding, Filament winding, and Resin transfer molding.

Elastic behavior of composite lamina (Micro-mechanics), Micro-mechanics methods, Geometric aspects and elastic symmetry, Longitudinal elastic properties (Continuous fibers), Transverse elastic properties, In-plane shear properties (Continuous fibers), Longitudinal properties (short fibers)

Elastic behavior of composite lamina (Macro mechanics approach), Stress-Strain relations: General anisotropic material, Specially orthotropic material, Transversely isotropic material, Orthotropic material under plane stress, Isotropic material.

Standard sizes of the specimen for tensile and compressive, Fatigue tests, and Impact tests of uni-directional composites. Experimental methods for characterization and testing of composite materials. Failure of the composite materials: fiber failures, matrix failure, interface failure. Failure Theories: Tsai-Wu, Tsai-Hill, Puck criterion, Maximum stress, maximum strain.

Reference Books

1 Engineering Mechanics of Composite Materials , Issac Daniel & Ori Ishai, 2nd; 2005, OU Publisher, USA.

2 Mechanics of Composite Materials , Autar K. Kaw , 2nd; 2005, Taylor & Francis.

3 Mechanics of Composite Materials , R.M.Jones , 2nd; 1998, Taylor & Francis .

4 Composite Materials , N. Chawla and K.K. Chawla, 3rd; 2006, Springer .

5 Mechanics of Composite Materials & Structures, Madhujit Mukhopadhyay, 1st; 2022, University Press.

23MD52B1 - DESIGN FOR MANUFACTURING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MD52B1	DESIGN FOR MANUFACTURING	DFM	R	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Identify the principles and methodologies of Design for Manufacturing (DFM) and its impact on manufacturing processes	3	PO1, PO2, PO3
CO2	Apply design techniques for optimizing part geometry, tolerances, and surface finish to improve manufacturability in machining processes	3	PO2, PO3, PO4
CO3	Develop and incorporate design considerations for casting, forging and sheet metal forming processes	3	PO2, PO3, PO4
CO4	Make use of the design constraints and opportunities of Additive Manufacturing (AM) techniques in product development	3	PO1, PO2, PO3
CO5	Apply DFM principles through case studies, hands-on exercises and software simulations to optimize manufacturing processes	3	PO2, PO4, PO5

Syllabus

Introduction to Design for Manufacturing (DFM) principles and methodologies. Understanding the impact of design decisions on manufacturing processes

Design for Machining: Optimizing part geometry, tolerances, and surface finish requirements to improve manufacturability using machining processes

Design for Casting and Forming: Considerations for designing parts for casting, forging, and sheet metal forming processes

Design for Additive Manufacturing (AM): Exploring the design constraints and opportunities for utilizing AM techniques in product development

Practical Component: Application of DFM principles through case studies, hands-on exercises, and software simulations for manufacturing process optimization

Reference Books

1 Design for Manufacturability Handbook , James G. Bralla , Revised, McGraw-Hill Education.

2 Design for Manufacturability and Statistical Design , Scott K. Johnson, 2019, CRC Press .

3 Design for Manufacturing and Assembly, Geoffrey Boothroyd, Peter Dewhurst, Winston A. Knight, Revised, Marcel Dekker Inc. .

4 Design for Manufacturing: A Structured Approach, Corrado Poli , Revised, Springer.

5 Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Ian Gibson, David W. Rosen, Brent Stucker, 2014, Springer.

23MD52B2 - DESIGN FOR SUSTAINABILITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MD52B2	DESIGN FOR SUSTAINABILITY	DFS	R	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding the Principles and Importance of Sustainability	2	PO5, PO6
CO2	Applying Life Cycle Assessment and Environmental Impact Assessment in Design	3	PO1, PO2
CO3	Implementing Sustainable Design Strategies and Principles	3	PO1, PO2
CO4	apply Sustainable Manufacturing, Supply Chain, and Assessment Tools	3	PO5, PO6, PO7
CO5	apply principles of sustainability in engineering design and develop sustainable solutions	3	PO5, PO6, PO7

Syllabus

Introduction to Sustainability: Definition and Principles of Sustainability, Importance of Sustainable Design, Environmental, Social, and Economic Dimensions Life Cycle Assessment: Introduction to Life Cycle Assessment (LCA), Life Cycle Thinking and Stages of LCA, Environmental Impact Assessment in Design, Interpretation and Limitations of LCA Results.

Sustainable Design Strategies: Design for Disassembly and End-of-Life Management, Material Selection and Substitution, Energy Efficiency and Renewable Energy Integration, Water Conservation and Waste Reduction, Design for Recyclability and Upcycling Sustainable Product Design: Design Principles for Sustainable Products, Eco-design and Design Guidelines, Cradle-to-Cradle Design Concepts, Sustainable Packaging Design.

Sustainable Manufacturing and Supply Chain Lean Manufacturing and Waste Reduction, Green Supply Chain Management, Closed-Loop Systems and Circular Economy, Social and Ethical Considerations in Manufacturing

Sustainable Design Assessment Tools Sustainable Design Standards and Certifications (e.g., LEED, BREEAM), Environmental Product Declarations (EPDs), Carbon Footprint Analysis, Social Life Cycle Assessment

Reference Books

1. Sustainable Design: A Critical Guide, David Bergman, 1, Bloomsbury.
2. Cradle to Cradle: Remaking the Way We Make Things, William McDonough, Michael Braungart, 2022, North Point Press.
3. Sustainability in Engineering Design, Ramachandran S., 2019, CRC Press.
4. Design for Sustainable Change, Stephen Lehmann, Roberta Tassi, 2019, Bloomsbury.

23MD52B3 - CONCURRENT MANUFACTURING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MD52B3	CONCURRENT MANUFACTURING	CM	R	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the integration of design and production activities to streamline workflows, enhance collaboration, and reduce time-to-market for products.	2	PO1, PO5
CO2	Apply concurrent engineering techniques in the product development process by engaging cross-functional teams to work simultaneously on design and production aspects.	3	PO1, PO5
CO3	Analyze the benefits of concurrent manufacturing, such as improved efficiency and reduced time-to-market, while also identifying potential challenges like increased complexity .	4	PO1, PO5
CO4	Analyze and optimize Implement strategies and techniques to optimize these processes, enhancing productivity, reducing costs, and improving overall operational efficiency..	4	PO1, PO5
CO5	Demonstrate and show a high level of skill and competence in utilizing concurrent engineering tools, including software and methodologies designed to integrate and streamline the design and production processes.	4	PO1, PO5

Syllabus

Introduction to concurrent manufacturing: principles and concepts - Overview of concurrent engineering and its importance in product development - Role of concurrent manufacturing in reducing time-to-market and enhancing product quality - Integration of design, manufacturing, and other functions for concurrent manufacturing

- Concurrent engineering techniques in product development - Simultaneous engineering and its application in concurrent manufacturing - Design for manufacturability and design for assembly principles - Use of computer-aided design (CAD) and computer-aided engineering (CAE) tools for concurrent design

Collaboration in cross-functional teams for concurrent manufacturing - Team dynamics and communication strategies for effective collaboration - Cross-functional team roles and responsibilities in concurrent manufacturing - Conflict resolution techniques and decision-making in cross-functional teams

Analysis of manufacturing processes for efficiency - Value stream mapping and process flow analysis - Identification of bottlenecks and waste in manufacturing processes - Lean manufacturing principles and their application in concurrent manufacturing

- Concurrent engineering tools and software - Overview of concurrent engineering software tools and their functionalities - CAD/CAM integration and data exchange for concurrent manufacturing - Simulation tools for process optimization and validation - Hands-on practice with concurrent engineering software tools

Reference Books

1. Concurrent Engineering: Contemporary Issues and Modern Design, Fathi, Madjid, 2nd Edition, 2021, CRC Press.
2. Concurrent Engineering: Automation, Tools, and Techniques, William D. Herrold, 1st Edition, 2018, Wiley-IEEE Press.
3. Design for Manufacturability and Concurrent Engineering, David M. Anderson, 1st Edition, 2014, CRC Press.
4. Collaboration Engineering: Designing Concurrent Systems, B. Sena, R. De Guio, et al., 1st Edition, 2013, Springer.
5. Lean Manufacturing: Tools, Techniques, and How to Use Them, William M. Feld, 2nd Edition, 2017, CRC Press.

23MD52C1 - ADVANCED FINITE ELEMENT ANALYSIS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MD52C1	ADVANCED FINITE ELEMENT ANALYSIS	AFEA	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply finite element method to solve two dimensional structural problems	3	PO3
CO2	Apply finite element method to solve problems in Bending of plates and shells and Conforming and Non-Conforming elements.	3	PO3, PO4
CO3	Formulate and solve the non linear problems in Elasto Plasticity.	4	PO3, PO4
CO4	Formulate the dynamic problems in free, transient and forced vibration	4	PO1
CO5	Gain hands on experience in converting a given structure into desired shape and size and to perform the suitable analysis using ANSYS software	4	PO3

Syllabus

Two Dimensional Problems: Basic concepts of plane stress and plane strain, stiffness matrix of CST element, finite element solution of plane stress problems

BENDING OF PLATES AND SHELLS: Review of Elasticity equation, Bending of plates and shells, Finite Element formulation of plates and shell elements, Conforming and Non-Conforming elements, C0 and C1 Continuity elements, application and examples.

NON-LINEAR PROBLEM: Introduction, Iterative Techniques, Material Non-Linearity, Elasto Plasticity, Plasticity, Viscos Plasticity, Geometric Non linearity, Large displacement formulation, application in metal forming process and contact problems.

DYNAMIC PROBLEMS: Direct formulation-free, transient and forced response, Solution procedures, Subspace iterative Techniques, Houbot, Wilson, Newmark, Methods, Examples.

Reference Books

1 The Finite Element Method, Zienkiewicz,O.C. and Taylor,R.L, 5th Edition, Mc Graw Hill International Edition.

2 Concept and Applications of Finite Element Analysis, Cook R.D, 3rd Edition, John Wiely and Sons Inc.

3 Finite Element Procedure in Engineering Analysis, Bathe K.J, 3rd Edition, Prentice Hall.

4 Introduction to Non Linear Finite Element Analysis, Nam-Ho Kin, 1st Edition, Springer.

23MD52C2 - FRACTURE MECHANICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MD52C2	FRACTURE MECHANICS	FM	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze the crack growth behavior in failed mechanical components	4	PO2, PO3
CO2	Analyze the stress field equations in flawed mechanical components	4	PO1, PO3
CO3	Determine the stress intensity factors of flawed mechanical components adopting different method of approaches	4	PO1, PO3
CO4	Evaluate the fracture toughness of the materials and develop the crack growth rate equations	4	PO2, PO3
CO5	Assess the fracture behavior of flawed mechanical components	4	PO2

Syllabus

ELEMENTS OF SOLID MECHANICS The geometry of stress and strain, elastic deformation, plastic and elastoplastic deformation limit analysis. STATIONARY CRACK UNDER STATIC LOADING Two dimensional elastic fields Analytical solutions yielding near a crack front Irwins approximation plastic zone size Dugdale model J integral and its relation to crack opening displacement.

ENERGY BALANCE AND CRACK GROWTH Griffith analysis Linear Fracture Mechanics Crack Opening displacement Dynamic energy balance crack arrest.

FATIGUE CRACK GROWTH CURVE Empirical Relation describing crack growth by fatigue Life calculations for a given load amplitude effects of changing the load spectrum Effects of Environment.

ELEMENTS OF APPLIED FRACTURE MECHANICS Examples of crackgrowth Analysis for cyclic loading leak before break crack Initiation under large scale yielding Thickness as a Design parameter crack instability in Thermal or Residual stress fields.

EVALUATION OF BEHAVIOUR OF FRACTURE Crack initiation, Crack growth, Fatigue lifecycle measurement.

Reference Books

1. Elementary Engineering Fracture Mechanics, David Broek, 1978, Fifthoff and Noerdhoff International Publisher.
2. Introduction of Fracture Mechanics, Kare Hellan, 1985, McGraw-Hill Book Company.
3. Elements of Fracture Mechanics, Preshant Kumar, 1999, Wheeler Publishing.
4. Mechanical Metallurgy , George E. Dieter , 1986, McGraw-Hill International.
5. Mechanical Behaviorof Materials , Norman E. Dowling, 2013, Prentice Hall .

23MD52C3 - TRIBOLOGICAL SYSTEM DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MD52C3	TRIBOLOGICAL SYSTEM DESIGN	TSD	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the surface wear and its treatment.	2	PO1, PO2
CO2	Apply the lubricant flow and delivery in different bearings	3	PO1, PO2
CO3	Apply the mechanism of rolling bearings and its failure criterion	3	PO1, PO2
CO4	Apply the tools to measure the bearing performance.	3	PO1, PO2
CO5	Analyze the tribological mechanism with experimental tools	4	PO2

Syllabus

Topography of surfaces, Surface features, interaction, theory of friction, sliding and rolling friction, Wear-mechanism of wear, wear resistant materials, surface treatment, Surface modification, coatings

Lubricants reduce friction, varying by composition and conditions. Standards guide usage across multiple lubrication regimes and dynamic effects.

Design and performance analysis of thrust and journal bearing, Hydrostatic journal bearing, Rolling element bearing, Bearing life capacity, ISO standard, Oil films and their effects, Rolling bearing failure

Tribomeasurement instruments assess surface topography via electron microscopy, friction, wear with lasers, adhering to international standards for bearing performance and vibration.

Reference Books

1 Tribology: Friction and Wear of Engineering Materials, Ian M. Hutchings, 2017, Butterworth-Heinemann.

2 Fundamentals of Tribology, Basim Al-Najjar, 2019, CRC Press.

3 Introduction to Tribology, J Halling, 2016, Wykeham Publications.

4 Introduction to Tribology, B.C. Majumdar, 2006, New Age .

5 Tribology: Principles and Design Applications, P Sahoo, 2012, PHI.

23MD52D1 - DESIGN OF PRESSURE VESSELS AND PLATES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MD52D1	DESIGN OF PRESSURE VESSELS AND PLATES	DPVP	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the methods to determine stresses in cylindrical shells	3	PO1, PO2
CO2	Analyze the stresses in pressure vessel with various closure heads	3	PO1, PO2
CO3	Formulate basic equations for bending of rectangular plate	3	PO1, PO2
CO4	Analyze bending stresses in circular plate	3	PO1, PO2

Syllabus

Methods for determining stresses, Factors affecting the design of vessels, Design approach, Terminology and ligament efficiency.Problems on strins,stresses and Ligament efficiency.

General theory of Membrane stresses in vessels under internal pressure, Torus under Internal pressure, Thick cylinder ,Thermal stresses and their significance, Graphical determination of thermal stress in a cylindrical vessel for any thermal gradient. Bending of a pate in one and two perpendicular directions.

Introduction-assumptions-slopes and curvatures of bent plate-strain curvature relations- moment curvature relations-equilibrium equations-rectangular plate, - rectangular plate, circular plate-summery of basic equations-basic equations in Cartesian coordinate system Method of superposition for the analysis of rectangular plates with arbitrary boundary conditions.

Basic equations in polar co-ordinate system. Pure bending and cylindrical bending of rectangular plates Navier solution for an all-round simply supported rectangular plate-levy solution for rectangular plates-. Circular plates subjected to an arbitrary load- Symmetric bending of circular plates, circular plate subjected to asymmetric load. circular plate-boundary conditions

Reference Books

1 Theory and Design of Pressure Vessels, John F. Harvey, 1987, CBS Publishers and Distributors.

2 Theory of plates, K Chandrashekara, 2001, University Press.

3 Approximate Methods in the Design and Analysis of Pressure Vessels and Piping, Stanley, M. Wales,, 1997, Pre ASME Pressure Vessels and Piping Conference.

4 Theory of elasticity, Timoshenko S.P. and Goodier J.N, 1987, McGraw-Hill Publishers.

23MD52D2 - ENGINEERING FAILURE ANALYSIS AND PREVENTION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MD52D2	ENGINEERING FAILURE ANALYSIS AND PREVENTION	EFAP	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles and importance of engineering failure analysis	2	PO1, PO2, PO6
CO2	Identify different failure modes and their associated mechanisms	3	PO1, PO2
CO3	Apply material selection techniques for failure prevention	3	PO1, PO2, PO3
CO4	Analyze failure cases, conduct risk assessment, and propose mitigation strategies	4	PO1, PO2, PO5

Syllabus

Introduction to Failure Analysis and Failure Modes - Introduction to Engineering Failure Analysis, Case studies of prominent engineering failures, Mechanical failure modes: fracture, fatigue, wear, corrosion, etc., Failure mechanisms: brittle fracture, ductile fracture, creep, etc.,Factors influencing failure modes and mechanisms

Material Selection and Design Considerations- Material properties and their impact on failure, Selection criteria for materials in different applications, Material testing and characterization techniques, Design principles for robustness and reliability, Stress analysis and failure prediction, Safety factors and design codes, Failure prevention in critical components

Non-Destructive Testing, Inspection, and Maintenance-Introduction to non-destructive testing (NDT) methods, Visual inspection, ultrasonic testing, radiography, etc., NDT applications in failure analysis and preventive maintenance, Preventive maintenance and condition monitoring, Failure data analysis and reliability-centered maintenance, Maintenance planning and scheduling

Case Studies, Risk Assessment, and Mitigation- Analysis of real-world failure cases, Root cause investigation and failure reconstruction, Lessons learned and recommendations for prevention, Risk assessment techniques: FMEA, FMECA, fault tree analysis, Risk management strategies and decision-making, Failure mitigation measures and their implementation

Reference Books

1. Failure Analysis of Engineering Structures: Methodology and Case Histories, V. Ramachandran and T. R. Chandrupatla, 1, 2005, CRC Press.
2. Introduction to the Design and Behavior of Bolted Joints, John H. Bickford, 5th, 2022, CRC Press.
3. Engineering Fracture Mechanics, David Broek , 1, 1986, CRC Press.
4. Mechanical Behavior of Materials , Marc Andre Meyers, Krishan Kumar Chawla, 2nd Edition, 2008, Cambridge University Press.

23MD52D3 - MODELING AND SIMULATION OF MECHATRONIC SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MD52D3	MODELING AND SIMULATION OF MECHATRONIC SYSTEMS	MSMS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Construct mathematical models for mechatronic systems including mechanical, electrical, fluid, and thermal, incorporating physical laws and system engineering concepts.	3	PO1, PO2
CO2	Construct and analyze mathematical models and differential-algebraic equations for electro-mechanical systems, evaluating responses of electrical, thermal, fluid, and mechanical rotational systems.	3	PO1, PO2
CO3	Apply state space approach and system identification techniques to solve and interpret model equations for various order systems using simulation	3	PO1, PO4
CO4	Analyze and assess time and frequency response of systems, incorporating design experiments, model structures, scaling, numerical methods, validation, and HIL simulation.	4	PO1, PO4

Syllabus

Physical Modelling: Mechanical and electrical systems, physical laws, continuity equations, compatibility equations, system engineering concept, system modelling with structured analysis, modelling paradigms for mechatronic system, block diagrams

mathematical models, systems of differential-algebraic equations, response analysis of electrical systems, thermal systems, fluid systems, mechanical rotational system, electrical-mechanical coupling.

Simulation Techniques: Solution of model equations and their interpretation, zeroth, first and second order system, solution of 2nd order electro-mechanical equation by finite element method, transfer function and frequency response, non-parametric methods, transient, correlation, frequency, Fourier and spectra analysis

design of identification experiments, choice of model structure, scaling, numeric methods, validation, methods of lumped element simulation, modelling of sensors and actuators, hardware in the loop simulation (HIL)

Rapid controller prototyping, coupling of simulation tools, simulation of systems in software (MATLAB, LabVIEW) environment.

Reference Books

1 Modeling of Dynamical Systems, L. Ljung, T. Glad , 2nd, 1994, Prentice Hall Inc.

2 System Dynamics: A Unified Approach, D.C. Karnopp, D.L. Margolis and R.C. Rosenberg , 3rd, 2000, Wiley-Interscience.

3 System Simulation , G. Gordon, 2nd, 1978, PHI Learning.

4 Micromechatronics, Modeling, Analysis, and Design with MATLAB , V. Giurgiutiu and S. E. Lyshevski , 1st, 2004, CRC Press.

23MD53E1 - DESIGN OF HYBRID VEHICLES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MD53E1	DESIGN OF HYBRID VEHICLES	DHV	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply theoretical knowledge and engineering principles to design and analyze hybrid vehicles.	4	PO1, PO2
CO2	Demonstrate proficiency in using industry-standard software for hybrid vehicle design and simulation.	5	PO2, PO5
CO3	Develop critical thinking and problem-solving skills related to hybrid vehicle design.	6	PO5
CO4	Apply engineering ethics and sustainability principles in the design of hybrid vehicles.	3	PO5

Syllabus

Introduction to Hybrid Vehicles: Hybridization principles, hybrid vehicle architectures, energy management strategies, and the role of hybridization in sustainable transportation.

Hybrid Powertrain Technologies: Study of internal combustion engines, electric motors, batteries, power electronics, and control systems used in hybrid vehicle propulsion systems.

Hybrid Vehicle Design: Design considerations for hybrid vehicle components, including powertrain, regenerative braking systems, energy storage, and system integration.

Hybrid Vehicle Control Systems: Control strategies for hybrid vehicles, optimization techniques, energy management algorithms, and vehicle performance analysis.

Reference Books

1. "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", Chris Mi, M. Abul Masrur, 2018, Wiley.
2. "Design of Alternative Energy Systems: Second Edition", Mohammad Rasul, 2016, McGraw-Hill Education.
3. "Fundamentals of Electric Vehicle Drives", Saeed Book Bank, 2017, CRC Press.
4. "Hybrid and Electric Vehicles: Principles and Applications", Chris Mi, 2013, CRC Press.
5. "Advanced Electric Drive Vehicles", Ali Emadi, 2014, CRC Press.

23MD53E2 - ENTERPRISE RESOURCE PLANNING FOR MECHANICAL ENGINEERS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MD53E2	ENTERPRISE RESOURCE PLANNING FOR MECHANICAL ENGINEERS	ERPME	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concept of Enterprise Resource Planning (ERP) and its significance in modern organizations	2	PO3
CO2	Understand the different modules of ERP systems, including Finance, Plant Maintenance, Quality Management, and Materials Management	2	PO3
CO3	Understand ERP Implementation Lifecycle and ERP Case studies	2	PO3
CO4	Understand E-Business Architecture and the role of ERP in e governance	2	PO3

Syllabus

Introduction to ERP: Enterprise An Overview, Integrated Management Information, Business Modeling, Integrated Data Model, ERP and Related Technologies. Business Processing Reengineering(BPR), Data Warehousing, Data Mining, Online Analytical Processing (OLAP), Supply Chain Management (SCM),Customer Relationship Management(CRM), Management Information System, Decision Support System, Executive Information System

ERP Manufacturing Prospective: Material Requirement Planning, Bill Of Material, Manufacturing Resource Planning, Distributed Requirement Planning, Product Data Management ERP Modules: Finance, Plant Maintenance, Quality Management, Materials Management, Benefits of ERP Reduction of Lead Time, On time Shipment, Reduction in Cycle Time, Improved Resource Utilization, Better Customer Satisfaction, Improved Supplier Performance, Increased Flexibility, Reduced Quality Costs, Improved Information Accuracy and Design making Capability

ERP Implementation Lifecycle: Pre evaluation Screening, Package Evaluation, Project Planning Phase, Gap Analysis, Reengineering, Configuration, Implementation Team Training, Testing, Going Live, End-user Training, Post implementation (Maintenance mode) ERP Case studies: E Commerce to E business, E Business structural transformation, Flexible Business Design, Customer Experience, Create the new techo enterprise, New generation e business leaders, memo to CEO, Empower your customer, Integrate Sales and Service, Integrated Enterprise applications

E Business Architecture Enterprise resource planning the E business Backbone Enterprise architecture planning, ERP usage in Real world, ERP implementation, Future of ERP applications ,memo to CEOE Procurement, E Governance, Developing the E Business Design, Introduction to ERP tools JDEdwards, Enterprise One, Microsoft Dynamic CRM module

Reference Books

1. Concepts in Enterprise Resource Planning, Ellen F. Monk, Bret J. Wagner , 4: 2013, Course Technology Cengage Learning.
2. Enterprise Resource Planning, Bret Wagner, Ellen Monk, 5: 2008, Cengage Learning.
3. Enterprise Resource Planning Fundamentals of Design and Implementation, K. Ganesh, Sanjay Mohapatra, S. P. Anbuudayasankar, P. Sivakumar , 2: 2014, Springer International Publishing.
4. Enterprise Resource Planning Systems, Daniel E. O'Leary, 2: 2002, Cambridge University Press.

23MD53E3 - INTERNET OF THINGS IN INDUSTRIES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MD53E3	INTERNET OF THINGS IN INDUSTRIES	ITOI	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand architecture of IIoT and IIoT Components	2	PO1, PO2
CO2	Understand communication Technologies of IIoT	2	PO1, PO2
CO3	Apply Visualization concepts of IIoT to design a IIoT system	3	PO1, PO2
CO4	Apply IIoT technology to design a robotic system	3	PO1, PO2

Syllabus

Introduction to IIoT, the difference between IoT and IIoT, Architecture of IIoT, IOT node, Challenges of IIOT. Fundamentals of Control System, introductions, components, closed loop and open loop system. Introduction to Sensors, Types of sensors, working principle of basic Sensors Ultrasonic Sensor, IR sensor, MQ2, Temperature and Humidity Sensors.

Communication Protocols: IEEE 802.15.4, ZigBee, Z Wave, Bluetooth, BLE, NFC, RFID. Industry standards communication technology LoRAWAN, OPC UA, MQTT, connecting into existing Modbus and Profibus technology, wireless network communication.

Front end EDGE devices, Enterprise data for IIoT, Emerging descriptive data standards for IIoT, Cloud data base, could computing, Fog or Edge computing. Extraction from Web Grabbing the content from a web page, Sending data on the web, Types of IoT interaction, Machine to Machine interaction M2M.

Programmable logic controller (PLC), Real-time control system, Supervisory Control & Data Acquisition (SCADA). HMI in an automation process, ERP & MES. Case study: Health monitoring, Iot smart city, Smart irrigation, Robot surveillance.

Reference Books

1 The Internet of Things in the Industrial Sector, Zaigham Mahmood, 1, 2019, Springer.

2 Industrial Internet of Things: Cybermanufacturing System, Sabina Jeschke, 1, 2016, Springer.

3 Industrial IoT: Challenges, Design Principles, Applications, and Security, Ismail Butun, 1, 2020, Springer.

4 INTRODUCTION TO INDUSTRIAL INTERNET OF THINGS AND INDUSTRY 4.0, Sudip Misra, 1, 2020, CRC Press.

5 Industrial Internet of Things (IIoT), R. Anandan, 1, 2022, Wiley-Scrivener.