M. Tech. in
PRODUCT DESIGN AND DEVELOPMENT

(Effective from 2022-23)

DEPARTMENT OF MECHANICAL ENGINEERING
MOTILAL NEHRU NATIONAL INSTITUTE OF TECHNOLOGY ALLAHABAD

Vision and Mission of the Institute

VISION

To attain a distinct identity for the Institute through innovation, knowledge creation and dissemination for the benefit of the society.

MISSION

- To nurture an eco-system for continuous enhancement of value-based teaching and learning process in the emerging areas of technology.
- To train quality human and knowledge resources in the service of society.
- To develop sustainable products and technologies.

Vision and Mission of the Department

VISION

To be a centre of excellence in Mechanical, Production and Industrial Engineering education and research for the benefits of society and humanity.

MISSION

- To educate and develop competent human resources for contemporary industry, academia and research.
- To promote interdisciplinary research and innovation skills in the graduates.
- To enhance the efforts to develop sustainable products, processes and technologies by developing competent entrepreneurs for the benefit of the society.

Department of Mechanical Engineering:

Brief about the Department:

The Department of Mechanical Engineering is one of the oldest departments of the institute and was established in the year 1961. We are the largest community of excellent, energetic, and dynamic faculty, staff and students in the institute. The department is having highly qualified and experienced faculty (36 faculty members) in all streams of Mechanical Engineering. The department is broadly divided into three academic streams in which students receive outstanding education with a wide choice of specializations, electives and research areas. These three academic streams are: Design Engineering, Production and Industrial Engineering and Thermal Engineering.
The department offers eight semester (i.e. 4 year) Bachelor of Technology (B. Tech.) programmes in Mechanical Engineering and Production and Industrial Engineering. Every year 223 students are admitted through JEE (mains) and 15% of this intake is through Direct Admission to Students Abroad (DASA) scheme for the above two B. Tech. programmes. Some students are also through ICCR and MEA (Govt. of India) Schemes.

The department also offers four semester (i.e. 2 year) Master of Technology (M. Tech.) programmes in Computer Aided Design and Manufacturing, Design Engineering, Product Design and Development, Production Engineering and Thermal Engineering. Every year 125 students (25 in each specialization) are admitted through GATE in the above five M. Tech. programmes.

The department also offers Doctor of Philosophy (Ph.D.) programme in various areas of Mechanical Engineering as well as Production and Industrial Engineering. The strength of the department lies in its Ph.D. programme with more than 100 PhDs already been awarded till March, 2022. About 80 research scholars are presently pursuing their PhDs. Every year the department admits Ph.D. students equal to half of the number of faculty holding Ph.D. degree. The department is also a QIP centre for PhD and M. Tech programmes.

Today, the world of Mechanical Engineering changes under the influence of advanced computational tools, improved simulation and analysis, and entirely different manufacturing protocols. This has opened up new vistas of research in the department.

List of Programmes offered by the Department:

Program	Title of the Program
B. Tech.	Mechanical Engineering
	Production & Industrial Engineering
M. Tech.	Computer Aided Design and Manufacturing
	Design Engineering
	Product Design and Development
	Production Engineering
	Thermal Engineering
Ph.D.	Mechanical Engineering

M. Tech. — Product Design and Development

Program Outcomes

PO1	Able to independently carry out research /investigation and development work to solve practical problems in Engineering.
PO2	Able to write and present a substantial technical report/document.
PO3	AbletodemonstrateadegreeofmasteryoverProductDesignandDevelopmentat a level higher than the requirements in the appropriate bachelor program.
PO4	Abilitytodesignanddevelopinnovativeproductstofulfiltheneedsofthesociety.

SCHEME OF INSTRUCTION

M. Tech. Product Design and Development – Course Curriculum Structure

S. No.	Code	Course	Credit	L-T-P	Contact Hours
Semester-I					
1	ME21141	Product Design and Development	4	4-0-0	
2	ME21142	Computer Aided Geometric Design	4	4-0-0	
3		Elective I	4	4-0-0	
4		Elective II	4	4-0-0	
5		Elective III	4	4-0-0	
		Total	**20**		
Semester-II					
1	ME22143	Computer Aided Product Design	4	4-0-0	
2	ME22241	Product Design and Development Lab	4	0-0-6	
3		Elective IV	4	4-0-0	
4		Elective V	4	4-0-0	
5		Elective VI	4	4-0-0	
		Total	**20**		
Semester-III					
1	ME23691	State of the art Seminar / Special Study / Term Project	4		
2	ME23641	Thesis	16		
		Total	**20**		

Semester-IV					
1	ME24641	Thesis	20		
		Total	**20**		

Note: The distribution of thesis evaluation marks will be as follows.

1. Supervisor (s) evaluation component: 50%
2. Oral Board evaluation component: 50%

List of Electives and Minors: M. Tech. (Product Design and Development)

S. No.	Code	Name
1.	ME21398	Mechanical System Design
2.	ME21304	Mechatronic Product Design
3.	ME21422	Product Lifecycle Management
4.	ME21346	Logistics and Supply Chain Management
5.	ME21347	Total Quality Management
6.	ME21302	Ergonomics for Mechanical Design
7.	ME21423	Principles of Engineering Design
8.	ME21424	Robotics and Automation
9.	ME21399	Materials, Manufacturing and Design
10.	ME22301	Finite Element Analysis for Mechanical Design
11.	ME22335	Soft Computing Methods
12.	ME22427	Creativity Engineering
13.	ME22391	Concurrent Engineering
14.	ME22428	Forensic Engineering
15.	ME22318	Reverse Engineering
16.	ME22429	Automobile System-Designer's Approach
17.	ME22313	Optimization Methods for Mechanical Design
18.	ME22642	Product Design and Development Project
19.		Applications of Computer for Design and Manufacturing
20.		Safety features of Products

Course Code: ME22141	Product Design and Development	Credits: 3-1-0:4

Prerequisites: Basic knowledge of science and engineering

COURSE OUTCOME

S.N.	Outcomes	BT Level	BT Description
CO1	To learn basic concepts of product development process	1	Remember
CO2	To identify customer needs and corresponding design features in the product	2	Understand
CO3	To interpret the customer needs and propose concepts	3	Apply
CO4	To analyse the proposed concepts using preliminary prototypes, CAD models, simulations etc.	4	Analyse
CO5	To evaluate and justify the design scheme of the product	5	Evaluate
CO6	To design and make final prototype for the selected concepts	6	Create

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4
CO1	3	3	3	1
CO2	1	3	2	1
CO3	3	3	3	1
CO4	3	3	1	3
CO5	3	3	3	2
CO6	3	3	3	1

Unit	Details	Lectures
1	**Introduction**-Introduction to product design, Significance of product design, product design and development process, sequential Engineering design method, the challenges of product development, **Development Process and Organizations**-Generic Development Process, Concept Development, Adapting the generic PD process flows, AMF development Process, Product Development Organizations, The AMF Organization.	10
2	**Product Planning and Identifying Customer Needs**-Product Planning process, Interpret raw data in terms of customers need, organize needs in hierarchy and establish the relative importance of needs, review of the process. **Product Specifications:**-Establish target specifications, setting final specifications,	10
3	**Concept Generation**-Activities of concept generation, clarifying problem, search both internally and externally, explore the output, **Concept Selection:**-Overview, concept screening and concept scoring, methods of selection. **Concept Testing**-Elements of testing: qualitative and quantitative methods including survey, measurement of customers' response. **Product Architecture**-Modular and Integral architecture, implications, establishing the architecture, Delayed differentiation, Platform Planning. **Industrial Design**-Assessing need for industrial design, Impact of industrial	10

	Design, industrial design process, management of industrial design process, assessing quality of industrial design.	
4	**Embodiment Design:** Design for Manufacturing, prototyping. Robust Design, Design for Environment **Intellectual Property and Environmental Guidelines-**Intellectual Property: Elements and outline, patenting procedures, claim procedure, Environmental regulations from government, ISO system.	10

Text /References Books:

1	Product Design and Development	Ulrich K. T, and Eppinger S. D	McGraw Hill
2	Product Design	Otto K, and Wood K	Pearson
3	Engineering of creativity: introduction to TRIZ methodology of inventive Problem Solving	Semyon D. Savransky	CRC Press
4	Mechanical Design Process	David G Ullman	McGraw Hill

Course Code: ME22142	Computer Aided Geometric Design	Credits: 4-0-0:4

Pre-requisites: PH-1101 Physics-I and MA-1101 Mathematics-I

COURSE OUTCOME

S.N.	Outcomes
CO1	Model the objects geometrically with curves, surfaces and solids by their mathematical representations.
CO2	Apply geometrical transformations to an available geometric model.
CO3	Create different projections of an available geometric model.
CO4	Analyse the applications of solid modelling in different fields.

CO-PO Mapping

	PO1	PO2	PO3	PO4
CO1	2	-	2	3
CO2	2	-	2	3
CO3	2	-	2	3
CO4	2	-	2	3

Unit	Details	Lectures
1	**Introduction:** Coordinate Systems, Representation of points, Explicit and Implicit equations, Intrinsic equations, Parametric equations	2
2	**Design of curves:** Algebraic and Geometric forms, Parametric space of a curve, Blending functions, Parametric cubic curve, Reparametrization, Truncation, Extension and Subdivision, Spline Curves, Bezier Curves, B-Spline Curves, Rational curves, introduction to NURBS.	10
3	**Fundamental of surface design:** Parametric space of a surface, Tangent and Twist vectors, Normal, Blending functions, Bicubic hermite surfaces, Reparametrization of a surface patch, Subdivision, Sixteen point form, Four curve form, Plane surface, Cylindrical surface, Ruled surface, Surfaces of revolution, Bezier surface, B-Spline surface and NURBS surface, Blending of surfaces.	6
4	**Solid modelling representation schemes:** Desired properties, Set theory, Boolean operators, Regularized set operations, Set-membership classification, Half-spaces, Boundary representation, Constructive Solid Geometry, Sweep representation, Analytical solid modelling, Instances and Parameterized shapes, Cell decomposition and Spatial-occupancy enumeration.	8

5	**Geometric transformations:** Rotation, Scaling, Reflection, Translation and Homogeneous coordinates, Combined transformations.	4
6	**Projections:** Orthographic projections, Axonometric projections, Oblique projections, Perspective transformation.	4
7	Data exchange formats, Application in Reverse Engineering, Applications in product development.	6

Text/Reference Books

1	Geometric Modelling	Mortenson, M. E.	McGraw Hill Education
2	Mathematical Elements for Computer Graphics	Rogers, D.F. and Adams, J.A.	Tata McGraw Hill
3	CAD/CAM: Theory and Practice	Zeid, I.	Tata McGraw Hill
4	Computer-Aided Engineering Design	Sahay, B. and Saxena, A.	Springer

Course Code: ME22143	Computer Aided Product Design	Credits: 4-0-0:4

Prerequisites: None

Course Outcomes

CO1	Students will be able to analyse the product development process and the importance of prototypes and their rapid production in aiding it.
CO2	Students will be able to apply the solid modelling fundamentals and make models in a solid modelling software.
CO3	Students will be able to evaluate the features required in a prototype and make effective recommendations about the appropriate additive manufacturing process to build it.
CO4	Students will be able to select the appropriate process parameters for an additive manufacturing process.

Course Articulation Matrix

	PO1	PO2	PO3	PO4
CO1	2	1	2	3
CO2	2	1	2	3
CO3	3	1	3	3
CO4	3	1	3	3

Unit	Details	Lectures
1	Product Development: Product definition, Generic product development process, Phased product development process, Stage Gate product development process, Spiral product development process. Prototyping: Prototype, Prototype Classifications, Roles of prototype.	4
2	Solid Modelling fundamentals: Graph Based methods, Instances and Parameterized Shapes, Cell Decomposition and Spatial-Occupancy Enumeration, Sweep Representation, Constructive Solid Geometry, Boundary Representation, Modelling practice on Solid Modelling software.	8
3	Additive Manufacturing: Generalized Additive Manufacturing Process Chain, Process parameters. Vat photopolymerization based processes: Process Principle, Photopolymerization, Vat Photopolymerization Materials, Scan patterns, Vat Photopolymerization based systems.	6
4	Extrusion-based processes: Process Principle, Materials, Process Parameters, Extrusion-based systems. Sheet Lamination processes: Process Principle, Materials, Process Parameters, layer bonding mechanisms, Sheet Lamination based systems.	6
5	Powder Bed Fusion processes: Process Principle, Materials, Powder Fusion Mechanisms, Process Parameters, Powder Handling, Powder Bed Fusion based systems Directed Energy Deposition processes: Process Principle, Materials, Process Parameters, Powder Feeding and Wire Feeding, Directed Energy Deposition based systems.	10
6	Material Jetting processes: Process Principle, Materials, Process Parameters, Droplet Formation Technologies, Material Jetting based systems.	6

Binder Jetting processes: Process Principle, Materials, Process Parameters, Binder Jetting based systems.

Reference Books:

1	Product Design and Development	K. T. Ulrich, S. D. Eppinger and A. Goyal	McGraw Hill
2	CAD/CAM Theory and Practice	I. Zeid	McGraw Hill
3	Rapid Prototyping: Principles and Applications	C.K. Chua, K.F. Leong and C.S. Lim	Cambridge University Press
4	Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping and Direct Digital Manufacturing	by I. Gibson, D. Rosen and B. Stucker	Springer

Course Code: ME22241	Product Design and Development Lab	Credits: 0-0-6:4

Prerequisites: Product Design and Development

Course Outcomes

CO1	Students will be able to identify the needs of the society and provide the solutions through products
CO2	Students will be able use CAD modeling, design standards etc.
CO3	Students will be able to make prototypes of the developed concepts
CO4	Students will learn the team work, report writing and presentation skills

Course Articulation Matrix

	PO1	PO2	PO3	PO4
CO1	2	2	3	3
CO2	2	2	3	3
CO3	3	2	3	3
CO4	2	3	3	3

Unit	Details
1	**Part A:** Selection of a suitable problem with a specific need in mind that can be taken up as a project. Brief description of the selected problem along with desired objective to be achieved. Discuss technological progress in the selected field & state of art, nationally & internationally. Design and development of the product based on the selected concept.
2	**Part B:** **i. Extending capabilities of machine drawing with pencil/ pixel** – Develop capabilities on Basics of sketching- should be able to sketch a specific change in an existing product on perspective view. The broad area to select any one from –automobile, pressure vessel, pump, compressor, pipeline, domestic appliances etc. etc. Preparing production drawing compete tolerance etc for a selected task. Familiarization with ASTM and BIS standards for a specific case selected earlier while learning production drawing. Learn BIS standards for items of everyday use such as Bicycle/ ceiling fan, Cooler fan, exhaust fan, domestic water heater, etc. Learn ASTM standards SAE standards for automobile components- two wheelers- brake/ clutch/ tyre etc.
3	**ii. Take a group project on any of the following:** Materials, manufacturing & cost difference on any selected product available in an a) Indian kitchen b) Hardware used in buildings such as door hinges, slides etc. c) Furniture's available in class rooms of MNNIT.
4	**iii. Following problems are open for selection. Consult BIS and ASTM standards wherever necessary.** Each student has to work on an individual problem and should submit a report/ working model. 1. Suggest an experimental test rig for finding out the Effort required vs. speed characteristics curve of (i) A Bicycle (ii) A Tricycle 2. Suggest an experimental set up for finding out the spring index of spring have the load range of 20 to 100 kg (i) helical compression spring (ii) helical tension spring 3. Suggest an experimental setup for finding out the power required in ploughing a field through a tractor

4. Suggest a method which allows accurate checking of fuel taken in your vehicle from your fuel filling stations. The device should be cheap, handy & practicable
5. Suggest a pressure gauge arrangement which allows only the predetermined quantity of air in your motorcycle tube.
6. Suggest a test setup which can be used for checking the performance of domestic centrifugal pumps.
7. Suggest a test setup which can be used for checking the performance of domestic pressure cookers.
8. Suggest a test setup which can be used for checking the performance of domestic desert cooler fans.

References:

1	Product Design and Development	Karl T. Ulrich, Steven D. Eppinger, and Anita Goyal	McGraw Hill Publication
2	Machine Design An Integrated Approach	R. L. Norton	Pearson Prentice Hall
3	Machine Component Design	Juvinall R. C. and Marshek, K. M.,	John Wiley, 5th Edition,
4	Mechanical Engineering Design (in SI Units)	Joseph E. Shigley and Charles R. Mischke	TATA McGraw Hill
5	Mechanical Design Process	David G Ullman	McGraw Hill Publication
6	Engineering of creativity: introduction to TRIZ methodology of inventive Problem Solving	Semyon D. Savransky	CRC Press
7	Human Factors in Engineering Design	Mark S sanders & Ernst J. Mc Cornick	McGraw Hill Publishers.

Course Code: ME21422	Product Lifecycle Management	Credits: 4-0-0:4

Prerequisites: Production Process, Production and Operation Management, Product Design and Development

Course Outcomes

S. No.	Outcomes	BT Level	BT Description
CO1	Understand the appreciation of the product lifecycle and its importance of product management through different stages of product lifecycle management.	2	Understand
CO2	Develop an understanding of the principles of Design Thinking, Lean Mindset, and Agile Principles and aligning them with the outcomes of Value, Flow, and Quality in PLM.	3	Apply
CO3	Apply the necessary skills, knowledge, and perspective to participate in or independently devise an effective product strategy for the Organisation.	3	Apply
CO4	Develop the understanding of how to create a customer-oriented product mindset and culture.	2	Understand
CO5	Apply the Product Lifecycle practices and tools required to take an idea through the entire product lifecycle.	3	Apply

Course Articulation Matrix

	PO1	PO2	PO3	PO4
CO1	3	2	2	3
CO2	2	1	2	1
CO3	2	2	3	3
CO4	2	2	3	2
CO5	2	2	3	2

Unit	Details	Lectures	CO mapping
1	**Introduction:** Background, Overview, Need, Benefits, Concept of Product Life Cycle. Components/Elements of PLM, Emergence of PLM, Significance of PLM, Customer Involvement.	4	CO1
2	**Product Life Cycle Environment:** Product Data and Product Work flow, Company's PLM vision, The PLM Strategy, Principles for PLM strategy, Preparing for the PLM strategy, Developing a PLM strategy, Strategy identification and selection, Change Management for PLM.	4	CO1
3	**Product Development Process & Methodologies:** Integrated Product development process - Conceive – Specification, Concept design, Design - Detailed design, Validation and analysis (simulation), Tool design, realize– Plan manufacturing, Manufacture, Build/Assemble, Test (quality check), Service - Sell	4	CO2

	and Deliver, Use, Maintain and Support, Dispose. Bottom-up design, Top-down design, Front loading design workflow, Design in context, Modular design. Concurrent engineering - work structuring and team Deployment - Product and process systemization-problem, identification and solving methodologies. Product Reliability, Mortality Curve. Design for Manufacturing, Design for Assembly. Design for Six Sigma.		
4	**Product Modelling:** Product Modeling - Definition of concepts - Fundamental issues - Role of Process chains and product models - Types of product models - model standardization efforts-types of process chains - Industrial demands.	4	CO2, CO3
5	**Types of Analysis Tools:** Design for manufacturing - machining - casting and metal forming -optimum design - Design for assembly and disassembly - probabilistic design concepts - FMEA – QFD - Taguchi Method for design of experiments -Design for product life cycle. Estimation of Manufacturing costs, Reducing the component costs and assembly costs, Minimize system complexity.	4	CO3
6	**Product Data Management Technology:** Product Data Management – An Introduction to Concepts, Benefits and Terminology, CIM Data. PDM functions, definition and architectures of PDM systems, product data interchange, portal integration, PDM acquisition and implementation.	4	CO3, CO4
7	**Recent Advances:** Intelligent Information Systems - Knowledge based product and process models - Applications of soft computing in product development process - Advanced database design for integrated manufacturing.	4	CO5

Text Books:

1	Product Life Cycle Management	Antti Saaksvuori, Anselmi Immonen	Springer

References:

1	Product Lifecycle Management	Grieves, Michael	TMH Publication
2	Product Lifecycle Management: Paradigm for 21st Century Product Realisation	Stark John	Springer
3	Product Design & Development	Kari Ulrich and Steven D. Eppinger	TMH Publication
4	Effective Product Design and Development	Stephen Rosenthol	Business One Orwin, Homewood
5	PDM: Product Data Management	Burden, Rodger	Resource Publication
6	Manufacturing Data Structures	Clement, Jerry; Coldrick, Andy; & Sari, John	John Wiley Sons
7	Bills of Materials for a Lean Enterprise	Garwood, Dave	Dogwood Publishing Co.

Course Code: ME 21346	Logistics and Supply Chain Management	Credits: 4-0-0:4

Prerequisites: Industrial Engineering

Course Outcomes

S. No.	Outcomes	BT Level	BT Description
CO1	Understand how each functional component and its processes become one integrated operation to satisfy customer's needs.	2	Understand
CO2	Develop an understanding of how to manage the interaction of business functions across companies in the supply chain.	3	Apply
CO3	Develop an understanding of how to manage the impact of demand on the supply chain and the considerable competitive advantages that can result from managing demand across companies	2	Understand
CO4	Effectively manage the flow of resources and information among the various partners of the supply chain.	2	Understand
CO5	Develop an understanding of how logistics and supply chain strategies can create value generation and utilise IT applications.	2	Understand

Course Articulation Matrix

	PO1	PO2	PO3	PO4
CO1	3	3	1	2
CO2	2	1	2	1
CO3	2	2	2	3
CO4	2	2	2	2
CO5	1	1	2	2

Unit	Details	Lectures	CO mapping
1	Introduction to Supply Chain Management, Understanding the Supply Chain, Macro processes in supply chain, Supply chain view: push/pull view and cyclic view, Supply chain phases and case studies.	4	CO1
2	Supply Chain Performance: Competitive and Supply Chain Strategies, achieving Strategic Fit and Scope of Strategic Fit	4	CO1
3	Supply Chain Drivers and Metrics: Drivers of Supply Chain Performance, Framework for structuring Drivers, Facilities, Inventory, Transportation, Information, Sourcing and Pricing, Case Study:: Seven-Eleven Japan Company	4	CO2
4	Planning Demand and Supply in a Supply Chain: Demand Forecasting in a Supply Chain, Aggregate Planning in a Supply Chain	4	CO3
5	Designing Distribution Networks and Application to E-Business- Role of distribution, factors influencing distribution network design, design options for a distribution network, E-Business and the distribution network.	4	CO4
6	Network Design in the Supply Chain- Role of network design in the	4	CO4

	supply chain, factors influencing network design decisions, framework for network design decisions		
7	Role of Information Technology in supply chain, coordination in a supply chain, Bullwhip Effect, Effect on performance due to lack of coordination, obstacles to coordination in a supply chain	4	CO5
8	Factors influencing logistics and decisions: introduction to logistics, logistical mission and strategic issues, operational objectives, components of logistics management, functions of logistics management	4	CO5
9	Benchmarking and performance measurement: Dimensions of performance measurement, internal performance measurement, external performance measurement, comprehensive supply chain measurement, characteristics of ideal measurement system	4	CO2

Text Books:

1	Supply Chain Management: Strategy, Planning & Operation	Sunil Chopra & Peter Meindle	Pearson Prentice Hall Publication.

References:

1	Logistical Management: The integrated Supply Chain Process	Donald J. Bowersox & David J. Closs	TMH Publication
2	Logistics and Supply Chain Management	Maretin Christopher	FT Publications
3	World Class Supply Management: The key to Supply Chain Management	Burt, Dobler and Straling	TMH Publication
4	Logistics and Supply Management	D K Agarwal	MacMillan Publication
5	Supply Chain Management in the 21st Century	B. S. Sahay	MacMillan Publication
6	Supply Chain Management: Theories & Practices	R P Mohanty and S. G. Deshmukh	Biztantra Publication
7	e-Procurement: From Strategy to Implementation	Dale Neef	Prentice Hall Publication

Course Code: ME21302	Ergonomics for Mechanical Design	Credits: 3-1-0:4

Prerequisites: Product Design and Development

Course Outcomes

CO1	Students will be able to apply the physical ergonomics concepts for the product improvement.
CO2	Students will be able to apply ergonomics concepts for the design of work space and work environments.
CO3	Students will be able to understand the human information processing and apply these principles for the product interface design.
CO4	Students will be able to apply human factors in product design for enhanced safety.

Course Articulation Matrix

	PO1	PO2	PO3	PO4
CO1	2	1	3	3
CO2	2	2	3	3
CO3	3	2	3	3
CO4	3	2	3	3

Unit	Details	Lectures
1	Introduction to ergonomics and relevance to design, Anthropometric measures and use of anthropometric data.	4
2	Physiology, Biomechanics, Kinesiology, Work-related musculoskeletal disorders.	7
3	Workspace Design: Postural triangle, design for standing operator, design for sitting operator, design for hand use, design for foot operation.	8
4	Manual material handling, Hand tool design.	6
5	Human information processing, Design of controls and displays, Graphic-user interface, Tactile interface.	6
6	Human Error, Accidents, and Safety, Human Factors in Systems Design.	4

Text Books:

1	Human Factors in Engineering and Design	S M Sanders and E J McCormick	McGraw Hill Publication
2	Introduction to Ergonomics	R S Bridger	McGraw Hill Publication
3	Ergonomics - How to design for ease and efficiency	K Kroemer, H Kroemer, and K E Kroemer-Elbert	Prentice Hall

References:

1	Human – Computer Interaction	A Dix, J Finlay, G D Abowd and R Beale	Pearson Education
2	Ergonomics and safety in hand tool design	C A Cacha	Lewis Publishers
3	The Design of Everyday Things	D Norman	Basic Books
4	Ergonomics for beginners: Industrial design perspective	https://nptel.ac.in/courses/107103004	

5	Applied Ergonomics	https://nptel.ac.in/courses/112104222

Course Code: ME21424	Robotics and Automation	Credits: 3-1-0:4

Prerequisites: Basic knowledge of Kinematics, Automation and Control Systems

Course Outcomes:

CO1	Students will be able to understand the concepts of robotics and automation systems. Basic components robot manipulator and their working principles.
CO2	Students will be able to Identify and Classify the types of industrial robots based on kinematic structure, DOF, control system and actuation.
CO3	Students will be able to Analyse and evaluate the motion analysis such as Robot kinematics, Motion dynamics, trajectory planning & Robot work envelopes etc. Identify and Classify the types of sensors and actuators.
CO4	Students will be able to Apply and analyse the acquired knowledge for designing the robot, Robot Programming methods for motion planning, gripper force analysis for specific applications. To get familiar with the latest improvements in robotics technology.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4
CO1	1	1	2	3
CO2	2	2	3	3
CO3	3	3	3	2
CO4	3	3	3	3
CO5	3	3	3	3

Unit	Details	No. Hrs
1	**Introduction:** Past, Present & Future; Robot Terminology; Applications, Components and Subsystems; Classification of Robot etc.	4
2	**End Effectors:** Different types of grippers and their design concepts etc.	4
3	**Motion Analysis:** Homogeneous transformations as applicable to rotation and translation – problems.	4
4	**Robot Kinematics:** Specifications of matrices, D-H notation joint coordinates and world coordinates, Forward and inverse kinematics – problems. Differential transformation and manipulators, Jacobians – problems	6
5	**Dynamics:** Lagrange – Euler and Newton – Euler formations – Problems.	4
6	**Trajectory Planning:** Trajectory planning and avoidance of obstacles, path planning, Skew motion, joint integrated motion, straight line motion–Robot programming, languages and software packages. Robot actuators: Pneumatic, Hydraulic actuators, electric & stepper motors. Feedback components: position sensors – potentiometers, resolvers, encoders – Velocity sensors etc.	8
7	**Automation :** Introduction, Types of systems - mechanical, electrical, electronics, fluidics; Hydraulics Systems and components; Pneumatic Systems Control; Applications of relays/switches; Measuring systems, Transducers; Programmable controllers; Automatic orientation and assembly; Design of components for assembly. Cost considerations and case studies. design and operation of automatic	8

systems-Pneumatic Controls, Electropneumatic Controls, Programmable Logic Controller (PLC) etc.

References

1	Robotics and Control	R.K Mittal and I.J. Nagrath	TMH
2	Introduction to Robotics, Analysis, Systems, Applications	Saeed B. Niku	PHI Publications
3	CAM and Automation	M.P. Groover	PHI Learning
4	Robotics –Control, sensing		TMH
5	Robotics Fundamental concepts and analysis	Ghosal Ashitava	Oxford
6	Robotics Technology and Flexible Automation	S.R. Deb and S. Deb	Tata McGraw Hill Education Pvt. Ltd
7	Introduction to Robotics	John J. Craig	Pearson
8	Industrial Robots: Technology, Programming and Applications	M.P. Groover et. al.	McGraw Hill, New York
9	Fluid Power with Applications	Anthony Esposito	Prentice Hall

Course Code: ME-22301	Finite Element Analysis for Mechanical Design	Credits: 4-0-0:4

Course Outcome

CO1	Understand the concept of FEA for solving mechanical design problems.
CO2	Understand FEA of 1-D elasticity problems such as bars, thin disc, plane trusses and beam bending problems and using it for mechanical design.
CO3	Understand the discretization and interpolation with mapping concept involving 2-D triangular and quadrilateral elements. FEA of Torsion mechanics and plane and axisymmetric elasticity problems and using solution for mechanical design.
CO4	Understand FEA for vibration problems and using it for mechanical design. Learn and apply the development of algorithms and write FE code for solving simple elasticity problems as well as trained about use of commercial software packages for complex problems.

Course Articulation Matrix

	PO1	PO2	PO3	PO4
CO1	3	2	1	1
CO2	3	2	1	2
CO3	3	2	1	2
CO4	3	1	2	1

Unit	Details	Lectures
1	Stress analysis in mechanical design problems; Capabilities and approaches of FEA; Step by Step procedure for FEA; **FEA of 1-D and 1dof Problems:** Basic procedure of Discretization of 1D domain and Interpolation with mapping concept, Development and evaluation of elemental integrals, Assembly and Imposition of boundary conditions; Solution procedure for system equations; FEA of axial deformation of bar problems and radial deformation of thin disc problems.	12
2	**FEA of 1-D and 2dof Problems:** Development of element equation and assembly procedure; FEA of plane trusses and beam bending problems	06
3	**FEA of 2-D Torsion Problems:** Basic procedure of Discretization of domain and Interpolation, Development of element equation and Assembly, Imposition of boundary condition and Solution; FEA of torsion of shaft problems	06
4	**FEA of 2-D Elasticity Problems:** Basic procedure of Interpolation with mapping concept, Development and evaluation of element equation, Imposition of boundary condition; FEA of plane and axisymmetric elasticity problems	08
5	**FEA of Dynamic Problems:** FEA of transient vibrational analysis; **Algorithmic approach and Software applications:** FEA with MATLAB programming and software packages like ANSYS etc.	04

Text Books:

1	The Finite Element Method in Engineering	S.S. Rao	Butterworth-Heinemann, Elsevier
2	Introduction to Finite Elements in Engineering	Chandrupatla and Belegundu	Pearson

Reference Book:

1	An Introduction to Finite Element Method	J.N. Reddy	Oxford University Press

Programming Books:

1	The Finite Element Method and Applications in Engineering using ANSYS	Madenci and Guven	Springer
2	The Finite Element Method Using MATLAB	Kwon and Bang	CRC Press

Course Code: ME-22318	Reverse Engineering	Credits: 4-0-0:4

Pre-requisites: PH-1101 Physics-I and MA-1101 Mathematics-I

COURSE OUTCOME

S.N.	Outcomes
CO1	Understand the various techniques for acquiring 3D coordinates of the points lying on the physical object and pre-process it
CO2	Construct the first order approximation surface with data point (triangular mesh modelling) for the computation of various topological and geometrical properties
CO3	Segment the data points for exact fitting of surfaces
CO4	Construct Surface model so as to be used for various engineering applications like analysis, modification, manufacturing etc.

CO-PO Mapping

	PO1	PO2	PO3	PO4
CO1	2	-	1	3
CO2	2	-	2	3
CO3	2	-	1	3
CO4	2	-	2	3

Unit	Details	Lectures
1	**Introduction:** Need of Reverse Engineering, definition, application	2
2	**Data acquisition technique:** Contact method, coordinate measurement machine and robotic arms Non-contact methods, triangulation, Structured Light etc.	8
3	**Pre - processing technique:** Need of pre-processing, import of the point cloud data, registration, data reduction and filtering	5
4	**Triangular mesh modelling:** Need of triangular mesh model and its definition, topological characteristics, Euler formula for triangular mesh model, various methods of construction of triangular mesh model	8
5	**Segmentation**: Definition and need of segmentation, various methods used for segmentation like edge based and face-based method of segmentation	8
6	**Curve and Surface modelling**: Parametric form of curves and surfaces, Hermite curve and surface, Bezier curve and Surface, B-spline curve and Surface, Introduction of NURBS	8
7	**B-Rep model creation:** Need of consistent and contiguous model, Blending curves and surfaces	3

Text/Reference Books:

1	Reverse Engineering and Industrial Prospective	Raja, Vinesh, Fernandes, Kiran	Springer Series in advanced

		J.	Manufacturing
2	Reverse Engineering- Recent Advances and Applications	Alexander C Telea	Intech Janeza trotline
3	Smart Product Engineering	Michael Abramovici, Rainer Stark	Springer Berlin Heidelberg

Course Code: ME-22301	Optimization Methods for Mechanical Design	Credits: 3-0-0:3

Prerequisites: Operational research & Mathematics

Course Outcomes

S. No.	Outcomes	BT Level	BT description
CO1	Student will be able to understand the formulation of optimization problems	2	Understand
CO2	Student will be able to solve the single and multi-variable optimization problems	3	Apply
CO3	Student will be able to solve the constrained and specialized optimization problems	3	Apply
CO4	Student will be able to solve the non-traditional optimization problems.	3	Apply

Course Articulation Matrix

	PO1	PO2	PO3	PO4
CO1	3	2	2	2
CO2	3	2	2	1
CO3	3	3	3	3
CO4	3	3	3	2

Unit	Details	Lectures
1	**Introduction**- Terminology, Design Variables, Constraints, Objective Function, Variable Bounds, Problem Formulation, Engineering Optimization Problems, Calculus Method, Linear Programming- Simplex Method, Concept of Dualit.	6
2	**Single Variable Optimization Problems:** Optimality Criterion, Bracketing Methods: Exhaustive Search Method, Bounding Phase Method, Region Elimination Methods: Interval Halving Method, Fibonacci Search Method, Golden Section Method, Successive Quadratic Estimation Method. Gradient Based Methods: Newton-Raphson Method, Bisection Method, Secant Method, Application to Root finding	5
3	**Multivariable Optimization Algorithms:** Optimality Criteria, Unidirectional Search, Direct Search Methods: Box Method, Hooke-Jeeves Pattern Search Method/ Powell's Conjugate Direction Method. Gradient Based Methods: Any two of the following: Cauchy's Steepest Descent Method, Newton's method, Marquardt's Method, Powell's Conjugate Gradient Method, Variable-metric (DFP) Method .	6
4	**Constrained Optimization Algorithms:** Kuhn Tucker Conditions, Transformation Methods: Penalty Function Method, Method of Multipliers (MOM), Sensitivity Analysis.	6
5	**Specialized Algorithms:** Integer Programming: Penalty Function Method, Branch and Bound Method, Geometric Programming, Applications.	6
6	**Non-Traditional Optimization Algorithms:** Genetic Algorithms: Basic Theory, Operators, Working, Differences between GAs and Traditional Methods, GAs for Constrained Optimization, Simulated Annealing, Elementary Idea of Neural	4

Networks and Fuzzy Logic, Ant Colony Optimization, Particle Swarm Optimization.

Text Books:

1	Optimization for engineering design: algorithms and examples	Kalyanmoy Deb	Prentice-Hall of India Private Limited, New Delhi
2	Engineering optimization: theory and practice	Singiresu S Rao	Fourth Edition, New Age International (P) Limited Publishers, New Delhi.

References:

1.	Engineering optimization - methods and applications.	A. M. Natarajan, P. Balasubramani, A. Tamilarasi	Pearson Education, 2013.
2.	Optimization in Operations research	Rardin, Ronald L.	Pearson Education
3.	Operations Research	Sulabha K. Kulkarni	Springer
4.	Operations Research Theory and Applications	J K Sharma,	MacMillan India Ltd.

5. https://www.youtube.com/watch?v=aJKuM4U-eYg
6. http://www.digimat.in/nptel/courses/video/111105039/L31.html

Course Code: ME21398	Mechanical System Design	Credits: X-0-0:X

Engineering Process and systems Approach: Fundamentals of Technical System: System, plant, Equipment, machines, Assemblies and components, Systems approach: structure and steps during life phases of the system, Application of Systems concepts in Engineering. General approach to design, Identification of Engineering functions, Conversion of energy, material and signals, Functional relationship, Working interrelationship: physical effects, Design phases, Engineering Activity Matrix, Defining the proposed effort, Role of Engineer, Engineering Problem Solving Concurrent Engineering, A case study.

Problem Formulation: Defining and formulating a design problem Nature of Engineering Problems, Needs Statement: customer requirements and company requirements, engineering characteristics, Constraints, Quality function deployment/ house of quality, Engineering design specification. System Theories General methodology of problem solving, Functional description of system, System analysis view points, black box approach, state theory approach, Function structure, function variants, relocating functions, subdividing functions, combining and eliminating functions, Concept evaluation: absolute and relative, Decision Process Approach, Case study.

System Modelling and linear graph modelling: Need for modelling, Modelling types and purposes, Linear graph modelling concepts, relating LGT to lumped element models of physical systems. Graph Modelling and Analysis Process, manipulation of graph theory rules, Path problem, Network flow problem. Case Study; Mathematical Modelling Concepts: Bondgraph approach. Case Study

Optimization Concepts: Optimisation process, Motivation and freedom of Choice, goals and objectives- Criteria, calculus method of optimization: Lagrange multiplier, Methods of optimisation-analytical: nonlinear optimization. System Evaluation: Feasibility Assessment, planning horizon, time value of money, financial analysis. A case study Decision Analysis: Elements of a decision problem, Decision model, probability, Expected monetary value, Utility value, Baye's theorem. Case Study.

System Simulation:- Simulation Concepts, simulation models, Iconic, Analog, Analytical, Simulation Process Problem definition, input model construction, Waiting line simulation, Solution process, limitations of simulation approach: A case study. Axiomatic Approach of Suh: Problem definition and FRs, Hierarchy of FRs and DPs Suh's Axioms and corollary, Decomposition of Design process, Design for manufacture.

References:

1. Systematic Mechanical Designing: A Cost and Management Perspective by M.S. Hundal, New York, ASME Press
2. Engineering Design: A Materials and Processing Approach by GE Dieter, McGraw Hill.
3. Design Engineering and design for manufacture by J. R. Dixon, Field Stone Pub.
4. The Mechanical Design Process, David G. Ullman, McGraw Hill
5. Engineering Design by R. J. Eggert, Pearson/Prentice Hall.
6. Elements of Engineering Design, Martin S Ray, Prentice Hall
7. Principles of Design by Nam P Suh, McGraw Hill 1999
8. Total Design by Stuart Pugh, Pearson Education
9. Optimisation Techniques by S. S. Rao
10. System analysis and Project Management by Cleland, Willium and King, McGraw Hill

11. Modelling and Simulation of Mechanical Systems using Bondgraph by Amalendu Mukherjee, Ranjit Karmakar

Course Code: ME21304	Mechatronic Product Design	Credits: X-0-0:X

Introduction to key elements of Mechatronic products; Principles of basic electronics - Digital logic, number system logic gates, Sequence logic flip flop systems; Sensors and Actuators, Signals and Systems, Computers and Logic Systems, Software and Data Acquisition; Mechatronic Design Approach, System Interfacing, Instrumentation and Control Systems; Microprocessor-Based Controllers and Microelectronics; Product functional block diagram; PCB Design, Product enclosure design, Microcontroller interfacing and programming, Interfacing with sensors and actuators, driver circuits and motion control, Stepper and servo motion control. Software and hardware tools to build mechatronic systems. Design and selection of mechatronic elements namely sensors like encoders and resolvers; stepper and servomotors, ball screws, solenoid like actuators, and controllers with applications to CNC systems, robotics, and consumer electronic products;

References:

1. Mechatronics by W. Bolton, published by Addison Worley Longman Pvt. Ltd.,
2. Mechatronics System Design by Devdas Shetty and Richard A. Kolk

Course Code: ME21347	Total Quality Management	Credits: X-0-0:X

Introduction:- Definition of Quality, Dimensions of Quality, Quality Planning, Quality costs - Analysis Techniques for Quality Costs, Basic concepts of Total Quality Management, Historical Review, Principles of TQM, Leadership – Concepts, Role of Senior Management, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation.
TQM Principles: Customer satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement – Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits, Continuous Process Improvement – Juran Trilogy, PDSA Cycle, 5S, Kaizen, Supplier Partnership – Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures – Basic Concepts, Strategy, Performance Measure. method. Theories as presened by quality gurus.
Performance measures: basic concepts and strategies , cost of quality, improvement action and plan, Quality awards: Malcolm Baldridge, Deming, etc., balanced score card method.
TQM tools: Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) – Concept, Improvement Needs.
Statistical analysis for quality and experimental design: The seven tools of quality, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Concept of six sigma, factor mode and effect analysis and identification of stages, t-test and F -test, orthogonal design, Taguchi's quality function, orthogonal design.
Quality system: Need for ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, TS 16949, ISO 14000 – Concept, Requirements and Benefits.
Case studies and discussion of practical industrial and service problems.

References:

1. Total Quality Management by Dale H.Besterfiled, et at.,, Pearson Education Asia,3rd Edition
2. Introduction to Total Quality: Quality Management for Production by D.L. Goetsch and S. Davis
3. Total Quality Management, L. Suganthi and A. Samuel, PHI
4. The Management and Control of Quality by James R. Evans and William M. Lindsay
5. Juran's quality handbook by Joseph M. Juran,McGraw Hill, 6th edition 2010

Course Code: ME21423	Principles of Engineering Design	Credits: X-0-0:X

The objective of this course is to introduce the concepts of system engineering to the students and to utilize these concepts in the design of complex engineering systems.

It focuses on defining customer needs and required functionality early in the development cycle, documenting the requirements, then proceeding with design synthesis and system validation while considering the complete problem.

Modeling of complex engineering systems and failure analysis of system.

At least two case studies to be solved.

References:

1. The engineering Design of System: Models and Methods by Dennis M Beude, Wiley India
2. System Engineering: Principles and Practice by A. Kossaikoff and William N Sweet,Wiley India
3. Formal Engineering Design Synthesis, Cambridge University press, NY, 2001
4. The Engineering Design Process by A Ertas& J C Jones, John Wiley and sons
5. Engineering Design A Synthesis by A Chakrabarti (ED), Springer

Course Code: ME21399	Materials, Manufacturing and Design	Credits: X-0-0:X

Why study design process- Understanding Mechanical design – Designer's and Design team.
Materials in Design –Evolution of Engineering materials –Metals- Plastics -composites Applications – Automotive Industry- Consumer Goods- Construction & Civil StructureIndustrial Applications.
Introducing modelling and synthesis for structural integrity- Modeling and Simulation -the Role of Models in Engineering -case studies--Similitude and Scale Models -Simulation -Geometric Modeling on the Computer -Finite-Element Analysis -Computer Visualization-Rapid Prototyping – case studies.
Materials Selection -Performance Characteristics of Materials -The Materials Selection Process - Sources of Information on Materials Properties-Economics of Materials - Design Example--Materials Substitution, Recycling and Materials Selection.
Embodiment design- Product architecture- Industrial design- Human factors design –design for environment. 6. Design Against Failure- fatigue -corrosion -wear etc.
Manufacturing processes & process selection Classifying processes -Shaping- joining- finishetc.
Plastics –different types- manufacturing Processes -case studies.
Materials & the environment Life cycle – packaging material –case studies.
Economic Decision Making -Cost Comparison - Materials and energy consuming systems – Eco selection -case studies. Methods of Developing Cost Estimates, Life Cycle Costing –case studies.
The Origin of Laws -Contracts - Liability -Product Liability -Protecting Intellectual Property - The Legal and Ethical Domains concern for the environment and for individual Case studies.

References:-

1. Engineering Design: A Materials and Processing Approach by George E. Dieter
2. Materials Selection in Mechanical Design by M.F Ashby, Butterworth- Heinmann
3. Handbook of Product Design for Manufacturing by James G Bralla
4. Manufacturing Engineering and Technology by S. Kalpakjian, Prentice Hall
5. Practical Engineering Failure Analysis by HaniMTawancy, Anwar ul- Hamid, Abbas – Marcel Dekker –New York.
6. Introduction to Engineering design-Modeling, Synthesis & Problem solving strategies- by Andrew Samuel & John Weir.
7. Mechanical Design Process by David G Ullman
8. Composites Manufacturing- Materials Products and process manufacturing.
9. Fatigue Design Handbook by Society of Automotive Engineers, Inc.

Course Code: ME22335	Soft Computing Methods	Credits: X-0-0:X

Introduction to soft computing; Neurons and neural networks, Single layer perceptron's, Multi-layer feed-forward neural networks; Learning processes, Radial basis function networks; Recurrent neural networks, Principal component analysis, Applications of neural networks. Introduction to Fuzzy logic, Operations on fuzzy sets, Fuzzy relations, Fuzzy implications, Introduction to fuzzy logic controllers (FLC), Construction of data base and rule base of FLC, Inference mechanisms, Defuzzification methods, Applications of fuzzy systems; Genetic algorithms and its applications.

References:

1. Neural Networks: A comprehensive Foundation by Haykin, Pearson Education.
2. Introduction to artificial neural systems by J. M. Zurada, Jaico Publishing House.
3. An Introduction to Fuzzy Logic for Practical Applications by Tanaka and Niimura, Springer.
4. Fuzzy logic with engineering applications by T. J. Ross, Wiley India Pvt. Ltd.
5. Multi-Objective Optimization using Evolutionary Algorithms by K. Deb, Wiley India Pvt. Ltd.
6. An Introduction to Genetic Algorithms by T M. Mitchell, MIT Press.
7. Practical Genetic Algorithms by Haupt and Haupt, Wiley.

Course Code: ME22427	Creativity Engineering	Credits: X-0-0:X

Introduction and overview: Innovation and creativity, Creative activity, Theory of the Mechanics of Mind Heuristics and Models: Attitudes, Approaches, and Actions That Support Creative Thinking, Human.

Processing-Brains and conscious mind: The subconscious mind-dreams, eureka, subconscious action, subconscious learning, solving a problem in the subconscious mind; Two sides of human thinking-use of presentiment, loading the subconscious mind; Intuitive creative work- tension, heuristic points examples; Incubation; Routine and Inventive Problems, difficulty of a problem, psychological Inertia, The Directed Creativity Cycle of PlsekA Synthesis Model of the Creative Process, Four phases of Preparation, Imagination, Development, and Action to organize the tools of directed creativity in other working.

Methods and Tools for Creativity: Basic principles behind the tools of creativity, Tools that prepare the mind for creative thought, Tools that stimulate the Imagination to come up with new ideas development and action: The bridge between mere creativity and the rewards of innovation, Intuitive methods of creative work: Intuitive solution, intuitive method- Penetrative analysis, Penetrative analysis of one's own work. TRIZ and Axiom based tools.

Creativity and current design practices:- Axioms and development of science and technology, a historic perspective, Creative process in design, Problem definition and FRs, Hierarchy of FRs and DPs. Decomposition of Design process, FRs: Definitions and characteristics. Introduction to TRIZ, standard structured problem solving, Cause effect chain analysis, Ideality, Scurve Analysis and trends of evolution, Nine windows, the anti-system and DTC analysis. Functionality, Functional modeling and trimming. Scientific effects, Inventive standards and Su-field modeling.

Contradictions and ARIZ tools:- Basic contradiction problem solving, AZIZ tools for Advanced contradiction problem solving, Subversion analysis, Root cause analysis. Case studies: for inventive problem solving.

References:

1. The principles of Design by Nam P. Suh, Oxford Univ Press
2. Axiomatic Design by Nam P. Suh, Oxford Univ Press, 2001.
3. Design engineering: a manual for enhanced creativity, Volume 10 by W. Ernst Eder
4. Inventive thinking through TRIZ: a practical guide, By Michael A. Orloff, Springer.
5. Systematic innovation: an introduction to TRIZ; (theory of inventive Problem Solving) by John Terninko, AllaZusman, CRC Press.
6. Engineering of creativity: Introduction to TRIZ methodology of inventive Problem Solving by Semyon D. Savransky, CRC Press.

Course Code: ME22391	Concurrent Engineering	Credits: X-0-0:X

Introduction- Basic concepts, sequential Engineering, sequential engineering Vs CE, why CE, mathematical model for understanding interactions between design and manufacturing, examples, benefits of CE, characterization of CE environment, difficulties associated with performing CE, framework for integration of life-cycle phases in a CE environment, CE techniques.

Design for Manufacturing and Assembly- DFA Guidelines- system guidelines, handling guidelines, insertion guidelines, and joining guidelines, theoretical minimum number of parts, design for piece part production, potential conflicts between DFA and DFM, manufacturing cost analysis, basic DFM part cost method, basic assembly method (adapted Xerox producibility index), Boothroyd DFA analysis.

Design for Manufacturing- Estimation of the manufacturing costs, reduction of costs of components, reduction of costs of assembly, reduction of the costs of supporting production; consider the impact of DFM Decisions on other factors.

Product Development Economics- Elements of Economic analysis, Build a Base-Case Financial Model, Perform Sensitivity Analysis, Use Sensitivity analysis to understand project Trade-Offs, Consider the influence of the Qualitative factors on project success.

CE Techniques - Quality Function Deployment, The Taguchi Method for Robust Design, Failure Modes and Effects Analysis (FMEA).

Design for reliability, design for maintainability, design for serviceability and their implementation.

References:

1. Systems Approach to Computer Integrated Design and Manufacturing by Nanua Singh, Wiley India.
2. Concurrent Engineering by Andrew Kusiak - John Wiley & Sons
3. Concurrent Engineering by Chanan S. Syan and Unny Menon - Chapman & Hall
4. Product Design and Development by Karl T. Ulrich, Steven D. Eppinger, and Anita Goyal, McGraw Hill Publication.
5. Product Design for Manufacture and Assembly by G. Boothroyd, P. Dewhurst and W. A. Knight, CRC Press.
6. Product Design: Techniques in Reverse Engineering and New Product Development by Kevin Otto and Kristin Wood, Pearson Publication.

Course Code: ME22428	Forensic Engineering	Credits: X-0-0:X

Introduction to forensic engineering uses -case studies to develop the skills you need for the analysis of product failure.
Failure of products and processes provides a 'toolbox' of techniques: observations, scientific and engineering tests that can be used to establish evidence of the causes of a failure in a metallic product or process.
Catastrophic failures – case studies - examines large-scale failures that have caused loss of life. The studies consider the roles of stress concentration in the design of critical components, poor manufacturing and poor design, material failures, and poor communications.
Intellectual property matters considers protection of new designs and inventive concepts. It concentrates on the arguments used for understanding particular patents, and the precedents that lawyers use for assessing construction, infringement and validity. Case studies include trials in which imitators were successfully sued by means of patents, and cases of new designs that were challenged unsuccessfully because the patents were weak or did not define the inventive concept widely enough to catch the alleged infringing product.

References:

1. Introduction to Forensic Engineering (The Forensic Library) by Randall K. Noon, CRC Press.
2. Forensic Engineering by Kenneth L. Carper
3. Forensic Engineering Investigation by Randall K Noon
4. Understanding How components Fail by Donald J Wulpi
5. The Winning Line: A Forensic Engineer's Casebook by Andrew E. Samuel

Course Code: ME22429	Automobile System-Designer's Approach	Credits: X-0-0:X

Introduction to auto vehicles, various systems of automobiles, Power transmission:, Road and aerodynamic, Transmission, systems- Layout. Alternative power sources, electric vehicles, hybrid vehicles.
Vehicle body engineering – General Information- classification of coachwork- models and architecture of a vehicle body- overall criterion for vehicle comparison- comfort diagram- strength of the vehicle body elements.
Suspension systems: type of chassis, dependent and independent suspension, coil and leaf spring suspension, shock absorbers, Steering systems, Power steering – options 4. Braking system – comparison- complexity -merits Tires & Wheels requirements
Vehicle Dynamics – Road- vehicle interaction
Testing Automobile components –component failure investigations
Road safety, Influence of vehicle characteristics on accidents, alternative design, safety factors, designs for uncertainty, crash testing
Introduction of traffic engineering – Highway Engineering –accident cause-analysis. Accident analysis – Case studies.

References:

1. The Automotive Chassis by J. Reimpell, H Stoll – SAE International
2. The Motor Vehicle: by Newton and Steed
3. Automotive vehicle safety by George A Peters & Barbara J Peters
4. Automotive Engineering Fundamentals by Richard Stone and J K Ball
5. Vehicle Body Engineering by J. Pawlowski

Course Code: ME22642	Product Design and Development Project	Credits: X-0-0:X

Students are required to carry out different projects related to Product Design and Development.

Course Code: MEXXXXX	Applications of Computer for design and Manufacturing	Credits: X-0-0:X

Course Code: MEXXXXX	Safety features of Products	Credits: X-0-0:X