Form: **MP 06 (i)**
(Clause 9.5.1)

Motilal Nehru National Institute of Technology Allahabad

1. Course Structure of M. Tech. Mechanical Engineering(Product Design and Development).

I Semester:

S. No.	Subject Name	Code	L	T	P	Cr
1.	Product Design and Development	ME21141	4	0	0	4
2.	Computer Aided Geometric Design	ME21142	4	0	0	4
3.	Elective I		4	0	0	4
4.	Elective II		4	0	0	4
5.	Elective III		4	0	0	4

Total Credits = 20

II Semester:

S. No.	Subject Name	Code	L	T	P	Cr
1.	Computer Aided Product Design	ME22143	4	0	0	4
2.	Product Design and Development Lab	ME22241	0	0	6	4
3.	Elective IV		4	0	0	4
4.	Elective V		4	0	0	4
5.	Elective VI		4	0	0	4

Total Credits = 20

III Semester:

S. No.	Subject Name	Code	Credits
1.	State of the art Seminar / Special Study / Term Project	ME23691	4
2.	Thesis	ME23641	16

IV Semester:

S. No.	Subject Name	Code	Credits
1.	Thesis	ME24641	20

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

1. Supervisor (s) evaluation component: 60%
2. Oral Board evaluation component: 40%

List of Electives for M. Tech Mechanical Engineering (Product Design and Development)

Elective-I		
Sl. No.	**Subject Code**	**Subject Name**
1	ME21398	Mechanical System Design
2	ME21304	Mechatronic Product Design
3	ME21422	Product Lifecycle Management

Elective-II		
Sl. No.	**Subject Code**	**Subject Name**
1	ME21346	Logistics and Supply Chain Management
2	ME21347	Total Quality Management
3	ME21302	Ergonomics for Mechanical Design

Elective-III		
Sl. No.	**Subject Code**	**Subject Name**
1	ME21423	Principles of Engineering Design
2	ME21424	Robotics and Automation
3	ME21399	Materials, Manufacturing and Design

Elective-IV		
Sl. No.	**Subject Code**	**Subject Name**
1	ME22301	Finite Element Analysis for Mechanical Design
2	ME22335	Soft Computing Methods
3	ME22427	Creativity Engineering

Elective-V		
Sl. No.	**Subject Code**	**Subject Name**
1	ME22391	Concurrent Engineering
2	ME22428	Forensic Engineering
3	ME22318	Reverse Engineering

Elective-VI		
Sl. No.	**Subject Code**	**Subject Name**
1	ME22429	Automobile System-Designer’s Approach
2	ME22313	Optimization Methods for Mechanical Design
3	ME22642	Product Design and Development Project

Mechanical Engineering Department

Course Code:**ME21141**
Course Name: **Product Design and Development**

1. Introduction to Product Design: Characteristics of successful product Development.
2. Who designs & develops products- Industrial & Practical Examples.
3. Creative thinking- Invention- innovation & inventiveness in a society.
4. Development Process & Organization.
5. A Generic Development Process & Concept Development.
6. Identifying Customer Needs.
7. Concept Generation, Concept Selection
8. Product Architecture, Industrial Design.
9. Human Factors & System Information Input- Text graphics, symbols and codes,
10. Work Place Design- case studies.
11. Human Factors Application – case studies.
12. Human Errors – accidents and safety. Techno legal issues
13. Intellectual Property Rights.

References:

1. Product Design & Development- Karl T. Ulrich, Steven D Eppinger, McGraw Hill Publishers.
2. The Mechanical Design Process – by David G. Ullman
3. Human Factors in Engineering Design- Mark S sanders & Ernst J. Mc Cornick McGraw Hill Publishers.
4. Product Design & Process Engineering – Benjamin W Nishel& Alan B Draker- McGraw Hill Publishers.
5. Any other reference discussed in class for specific topics

Mechanical Engineering Department

Course Code: **ME21142**
Course Name: **Computer Aided Geometric Design**

Introduction, Coordinate Systems, Representation of points, Geometric transformations: Rotation, Scaling, Reflection, Translation and Homogeneous coordinates, Combined transformations. Projections: Orthographic projections, Axonometric projections, Oblique projections, Perspective transformation.

Explicit and Implicit equations, Intrinsic equations, Parametric equations, 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.

Fundamental of surface design, Parametric space of a surface, Tangent and Twist vectors, Normal, Blending functions, Bicubichermite 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.

Solid modeling 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.

Data exchange formats, Triangular mesh modeling, Applications in product development.

References:

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

Mechanical Engineering Department

Course Code:**ME22143**
Course Name: **Computer Aided Product Design**

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

References:

1. CAD/CAM Theory and Practice by I. Zeid, McGraw Hill.
2. Rapid Prototyping: Principles and Applications byC.K. Chua, K.F. LeongandC.S. Lim, Cambridge University Press.
3. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping and Direct Digital Manufacturing by I. Gibson, D. Rosen and B. Stucker, Springer.

Mechanical Engineering Department

Course Code: **ME22241**
Course Name: **Product Design and Development Lab**

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.

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.

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.
Work on the **Annexure A** sheet. Select at least four problems and submit the worksheet.

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.

Mechanical Engineering Department

Course Code: **ME21398**
Course Name: **Mechanical System Design**

1 **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.

2 **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.

3 **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

4 **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.

5 **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, RanjitKarmakar

Mechanical Engineering Department

Course Code: **ME21304**

Course Name: **Mechatronic Product Design**

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

Mechanical Engineering Department

Course Code: **ME21422**
Course Name: **Product Lifecycle Management**

1. **Introduction:**Background, Overview, Need, Benefits, Concept of Product Life Cycle. Components / Elements of PLM, Emergence of PLM, Significance of PLM, Customer Involvement.

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.

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 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.

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.

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.

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.

References:

1. Product Lifecycle Management by Grieves, Michael, McGraw-Hill
2. Product Life Cycle Management by Antti Saaksvuori, AnselmiImmonen, Springer
3. Product Lifecycle Management: Paradigm for 21st Century Product Realisation byStark John, Springer-Verlag
4. Product Design & Development by Kari Ulrich and Steven D. Eppinger, McGraw Hill
5. Effective Product Design and Development by Stephen Rosenthol, Business One Orwin, Homewood
6. PDM: Product Data Management byBurden, Rodger, Resource Pub.
7. Manufacturing Data Structures by Clement, Jerry; Coldrick, Andy; & Sari, John, John Wiley Sons
8. Bills of Materials for a Lean Enterprise by Garwood, Dave,Dogwood Publishing Co.

Mechanical Engineering Department

Course Code: **ME21346**
Course Name: **Logistics and Supply Chain Management**

Introduction to Logistics and Supply Chain Management; Concepts, Drivers and obstacles; Planning Demand and supply in a supply chain-Demand forecasting; Aggregate Planning; Management of Inventory in global supply Chain; Role of Information Technology in supply chain; E-Business and the Supply chain; Factors influencing logistics and decision; Bench making and performance measurement; Supply chain risk and Reverse logistics and Green Supply Chain

References:

1. Supply Chain Management by John T. Mentzer, SAGE Publication.
2. Supply Chain Management: Strategy, Planning, and Operation by Chopra, Meindl and Kalra,
3. Business Logistics/Supply Chain Management by Ballou &Srivastava, Pearson Education.
4. Supply Chain Logistics Management by Bowersox,Closs, Cooper, Tata McGraw-Hill
5. Logistics and Supply Chain Management by Martin Christopher, Financial Times Prentice
6. Supply Chain Management: Text and Cases by Janat Shah, Pearson Education
7. Textbook of Logistics & Supply Chain management by D.K. Agrawal,Macmillan.

Mechanical Engineering Department

Course Code: **ME21347**
Course Name: **Total Quality Management**

1 **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.

2 **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

3 **Performance measures**, basic concepts and strategies , cost of quality, improvement action and plan, Quality awards: Malcolm Baldridge, Deming, etc., balanced score card method

4 **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,

5 **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

6 **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.

7 **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

Mechanical Engineering Department

Course Code: **ME21302**
Course Name: **Ergonomics for Mechanical Design**

Introduction to ergonomics and relevance to mechanical design, Anthropometric measures and use of anthropometric data.

Physiology, Anatomy, Biomechanics, Kinesiology, Work-related musculoskeletal disorders.

Design of workspace, Manual material handling, Hand tool design.

Human information processing, Design of controls and displays. Graphic-user interface. Tactile interface and Haptic interface. Kansei engineering.

Design process involving ergonomics check and ergonomic design evaluation.

References:

1. Sanders, S. M. and McCormick, E. J., Human Factors in Engineering and Design, McGraw Hill.
2. Bridger, R. S., Introduction to Ergonomics, McGraw Hill.
3. Kroemer, K., Kroemer, H., and Kroemer-Elbert, K. E., Ergonomics - How to design for ease and efficiency, Prentice Hall.
4. Dix, A., Finlay, J., Abowd, G. D. and Beale, R., Human – Computer Interaction, Pearson Education.
5. Cacha, C. A., Ergonomics and safety in hand tool design, Lewis Publishers.

Mechanical Engineering Department

Course Code: **ME21423**
Course Name: **Principles of Engineering Design**

1 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.
2 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.

3 Modeling of complex engineering systems and failure analysis of system.
4 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

Mechanical Engineering Department

Course Code: **ME21424**
Course Name: **Robotics and Automation**

1. **Introduction:** Past, Present & Future; Robot Terminology; Applications, Components and Subsystems; Classification of Robot etc.
2. End Effectors, Different types of grippers and their design concepts etc.
3. **Motion Analysis:** Homogeneous transformations as applicable to rotation and translation – problems.
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
5. **Dynamics:** Lagrange – Euler and Newton – Euler formations – Problems.
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.
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 systems-Pneumatic Controls, Electropneumatic Controls, Programmable Logic Controller (PLC) etc.

References:

1. Robotics and Control by Mittal R.K Mittal and I.J. Nagrath,TMH
2. Introduction to Robotics, Analysis, Systems, Applications by Saeed B. Niku, PHI Publications.
3. CAM and Automation by 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 by S.R. Deb and S. Deb S., " Tata McGraw Hill Education Pvt. Ltd, 2010.
7. Introduction to Robotics by 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

Mechanical Engineering Department

Course Code: **ME21399**
Course Name: **Materials, Manufacturing and Design**

1. Why study design process- Understanding Mechanical design – Designer's and Design team.
2. Materials in Design –Evolution of Engineering materials –Metals- Plastics -composites Applications – Automotive Industry- Consumer Goods- Construction & Civil Structure- Industrial Applications.
3. 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.
4. 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.
5. Embodiment design- Product architecture- Industrial design- Human factors design –design for environment.
6. Design Against Failure- fatigue -corrosion -wear etc.
7. Manufacturing processes & process selection Classifying processes -Shaping- joining- finish- etc.
8. Plastics –different types- manufacturing Processes -case studies.
9. Materials & the environment Life cycle – packaging material –case studies.
10. Economic Decision Making -Cost Comparison - Materials and energy consuming systems – Eco selection -case studies. Methods of Developing Cost Estimates, Life Cycle Costing –case studies.
11. 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.

Mechanical Engineering Department

Course Code: **ME22301**
Course Name: **Finite Element Analysis for Mechanical Design**

Concept, History, Packages and Range of applications and Steps of FEA; Approaches of FEA
*Direct Approach FEA:*Elemental Equations for simple Discrete systems: Spring Network, Plane Trusses and Plane Frames; Assembly Procedure; Imposition of Boundary Conditions and Solver Technology for linear equations

Mathematical Approach FEA:Galerkin's and Raleigh-Ritz Approaches for stress determination
1D FE Stress Analysis: Governing Equation and Boundary Conditions for 1D FEA of Bar extension and Beam bending Problems; Weak Formulation and Functional; Polynomial Approximation, Standard 1-D Shape Functions of C^0 and C^1 Continuity Elements; Derivation of Element Matrices and Vectors; Assembly, Imposition of Boundary Conditions and Nodal Solution; Co-ordinate Transformation and Numerical Integration; Eigen value bar vibration problem;

Plane 2D and Axisymmetric FE Stress Analysis: Governing Equation and Boundary Conditions for Torsion of Rod problem; Plane Stress and Plane Strain Problems, Weak Formulation and Functional; Polynomial Approximation, Standard 2-D Shape Functions of C^0 Continuity Elements; Derivation of Element Matrices and Vectors; Assembly, Imposition of Boundary Conditions and Nodal Solution; Mapping and Numerical Integration;

*3D FE Stress Analysis:*Governing equation and Boundary conditions 3D Stress Analysis Problems, Weak Formulation and Functional, Polynomial Approximation, Standard 3-D Shape Functions of C^0 Continuity Elements, Derivation of Element Matrices and Vectors, Assembly, Imposition of boundary conditions and Nodal Solution; Mapping and Numerical Integration FE

ANSYS Software Applications: Introduction; general solid modeling using 2D and 3D primitives available in ANSYS;Basic concepts of finite elements, with applications to problems confronted by mechanical designers; Application in analyzing design problems. Issues: solution methods, modeling techniques, basic problem definition. Individual projects focus on the interplay of analysis and testing in product design/development.

References:

1. An Introduction to Finite Element Method by J.N. Reddy, TMH, New Delhi
2. The Finite Element Method in Engineering by S.S. Rao, Butterworth Heinemann, Boston
3. Introduction to Finite Elements in Engineering by Chandrupatla, and Belegundu, PHI Pvt. Ltd., New Delhi
4. The Finite Element Method for Engineers by Huebner, Dewhirst, Smith, and Byrom, John Wiley and Sons (Asia) Pte Ltd, Singapore
5. The Finite Element Method Using MATLAB by Kwon and Bang**,** CRC Press, NY 1999

Mechanical Engineering Department

Course Code: **ME22335**
Course Name: **Soft Computing Methods**

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.

Mechanical Engineering Department

Course Code: **ME22427**
Course Name: **Creativity Engineering**

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, S-curve 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.

Mechanical Engineering Department

Course Code: **ME22391**
Course Name: **Concurrent Engineering**

1 **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.

2 **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.

3 **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.

4 **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

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

6 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.

Mechanical Engineering Department

Course Code: **ME22428**
Course Name: **Forensic Engineering**

1. Introduction to forensic engineering uses -case studies. to develop the skills you need for the analysis of product failure.
2. 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.
3. 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.
4. 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

Mechanical Engineering Department

Course Code: **ME22318**
Course Name: **Reverse Engineering**

1 Introduction: Need of Reverse Engineering, definition, application

2 Data acquisition technique- contact method, coordinate measurement machine and robotic arms

Non-contact methods, triangulation , Structured Light etc.

3 Pre- processing technique – need of pre-processing, import of the point cloud data, registration , data reduction and filtering

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

5 Segmentation- Definition and need of segmentation , various methods used for segmentation like edge based and face based method of segmentation

6 Curve and Surface modelling- Parametric form of curves and a surfaces , Hermite curve and surface, Bezier curve and Surface, B-spline curve and Surface, Introduction of NURBS

References:

1. Reverse Engineering and Industrial Prospective by Raja, Vinesh , Fernandes, Kiran J., Springer Series in advanced Manufacturing
2. Reverse Engineering- Recent Advances and Applications by Alexander C Telea, Intech Janeza trotline
3. Smart Product Engineering by Michael Abramovici , Rainer Stark, Springer Berlin Heidelberg

Mechanical Engineering Department

Course Code: **ME22429**
Course Name: **Automobile System-Designer's Approach**

1. Introduction to auto vehicles, various systems of automobiles, Power transmission:, Road and aerodynamic, Transmission, systems- Layout. Alternative power sources, electric vehicles, hybrid vehicles.
2. 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.
3. 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
5. Vehicle Dynamics – Road- vehicle interaction
6. Testing Automobile components –component failure investigations
7. Road safety, Influence of vehicle characteristics on accidents, alternative design, safety factors, designs for uncertainty, crash testing
8. 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
5. Automotive Engineering Fundamentals by Richard Stone and J K Ball
6.Vehicle Body Engineering by J. Pawlowski

Mechanical Engineering Department

Course Code: **ME22313**

Course Name: **Optimization Methods for Mechanical Design**

Introduction to Optimal Design: feasibility and boundedness, topography of search space, classification of methods. Single variable optimization problems, Gradient and Direct search based methods. Constrained and unconstrained problems, problems with non-linear constraints. (With emphasis on applications to Machine Design/Product Design, Vibration control). Nontraditional optimization methods. Optimization with parameter uncertainties; Robust Optimization, formulation, algorithms, applications. Methods of Multi-Disciplinary Optimization (MDO) with case studies in automotive engineering. Optimization for modular design.

References

1. Engineering Optimization by S. S. Rao
2. Optimization for Engineering Design by Kalyanmoy Deb

Mechanical Engineering Department

Course Code: **ME22642**

Course Name: **Product Design and Development Project**

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