VINOBA BHAVE UNIVERSITY HAZARIBAGH

SYLLABUS FOR B-TECH 6TH SEMESTER

Semester - VI
Branch: Mechanical Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	ME601	Solid Mechanics	3	1	0	4
2	PEC-III		3	0	0	3
3	PEC-IV		3	0	0	3
4	OEC II		3	0	0	3
5	OEC III		3	0	0	3
6	IC601	Entrepreneurship	2	0	0	2
7	ME651	Lab IV (Machine Design / CAD / SIEMENS)	0	0	3	1
8	ME652	Lab V (MOS)	0	0	3	1
9	ME653	Lab VI (Automobile Engg.)	0	0	3	1
					Total Credits	21

Code	**Professional Elective-III**	Code	**Professional Elective-IV**
ME611	Manufacturing Technology	ME621	Design of Transmission System
ME612	Mechatronics Systems	ME622	Computational Fluid Dynamics
ME613	Microprocessor in Automation	ME623	Machine Tool Design

Code	**Open Elective-II (Any One)**	Code	**Professional Elective-IV**
ME631	Industrial Robotics	ME641	Automobile Engineering
ME632	Computer Aided Design	ME642	Engineering Economics and Accountancy
ME633	Production Planning and Control	ME643	Reliability Engineering
ME634	Innovative Design	ME644	Theory of Constraints
ME635	Supply Chain Management	ME645	Environmental Impact Assessment

Mechanical Engineering			
ME601	**Solid Mechanics**	**L**	**T**
		3	**1**

Objectives:
The objective is to present the mathematical and physical principles in understanding the linear continuum behavior of solids.

Course Contents

Module-I
Introduction to Cartesian tensors, Strains: Concept of strain, derivation of small strain tensor and compatibility. (9)

Module-II
Derivation of Cauchy relations and equilibrium and symmetry equations, principal stresses and directions. (6)

Module-III
Constitutive equations: Generalized Hooke's law, Linear elasticity, Material symmetry; Boundary value problems: concepts of uniqueness and superposition. (6)

Module-IV
Plane stress and plane strain problems. (3)

Module-V
Introduction to governing equations in cylindrical and spherical coordinates, axisymmetric problems. (8)

Module-VI
Application to thick cylinders, rotating discs, torsion of non-circular cross-sections, stress concentration problems, thermo-elasticity, 2-d contact problems. (5)

Module-VII
Solutions using potentials energy methods, Introduction to plasticity. (3)

Course Outcomes:
Upon completion of this course, students will be able understand the deformation behavior of solids under different types of loading and obtain mathematical solutions for simple geometries.

Text Books:
[1] G. T. Mase, R. E. Smelser and G. E. Mase, Continuum Mechanics for Engineers, ThirdEdition, CRC Press, 2004.
[2] Y. C. Fung, Foundations of Solid Mechanics, Prentice Hall International, 1965.
[3] Lawrence. E. Malvern, Introduction to Mechanics of a Continuous Medium, Prentice Hallinternational, 1969.

Mechanical Engineering			
ME611	**Manufacturing Technology**	**L**	**T**
		3	**0**

Objectives:

(i) To provide knowledge on machines and related tools for manufacturing various components.
(ii) To understand the relationship between process and system in manufacturing domain.
(iii) To identify the techniques for the quality assurance of the products and the optimality ofthe process in terms of resources and time management.

Course Contents:

Module-I

Tooling for conventional and non-conventional machining processes: Mould and die design, Press tools, Cutting tools; Holding tool. (6)

Module-II

Jigs and fixtures, principles, applications and design; press tools – configuration, design of die and punch; principles of forging die design**.** (4)

Module-III

Metrology: Dimensions, forms and surface measurements, Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometry; Metrology in toolwear and part quality including surface integrity, alignment and testing methods; tolerance analysis in manufacturing and assembly. (8)

Module-IV

Process metrology for emerging machining processes such as micro-scale machining, Inspection and workpiece quality. (4)

Module-V

Assembly practices: Manufacturing and assembly, process planning, selective assembly, Material handling and devices. (6)

Module-VI

Linear programming, objective function and constraints, graphical method, Simplex andduplex algorithms, transportation assignment, Traveling Salesman problem; Network models: shortest route, minimal spanning tree,
maximum flow model- Project networks: CPM andPERT, critical path scheduling; Production planning &control: Forecasting models, aggregate production planning, materials requirement planning. (8)

Module-VII

Inventory Models: Economic Order Quantity, quantity discount models, stochastic inventory models, practical inventory controlmodels, JIT. Simple queuing theory models. (4)

Course Outcomes:

Upon completion of this course, students will be able to the tooling needed for manufacturing, the dimensional accuracy and tolerances of products, assembly of different components and the application of optimization methods in manufacturing.

Text Books:

(i) Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition) Pearson India, 2014.

(ii) Taha H. A., Operations Research, 6thEdition, Prentice Hall of India, 2003.

(iii) ShenoyG.V. and Shrivastava U.K., Operations Research for Management, WileyEastern, 1994.

Mechanical Engineering			
ME612	**Mechatronics Systems**	**L**	**T**
		3	**0**

Objectives:
(i) To understand the structure of microprocessors and their applications in mechanical devices
(ii) To understand the principle of automatic control and real time motion control systems, with the help of electrical drives and actuators
(iii) To understand the use of micro-sensors and their applications in various fields

Course Contents:

Module-I
Introduction: Definition of Mechanical Systems, Philosophy and approach; Systems and Design: Mechatronic approach, Integrated Product Design, Modeling, Analysis and Simulation, Man-Machine Interface. (8)

Module-II
Sensors and transducers: classification, Development in Transducer technology, Optoelectronics-Shaft encoders, CD Sensors, Vision System, etc.; (8)

Module-III
Drives and Actuators: Hydraulic and Pneumatic drives, Electrical Actuators such as servo motor and Stepper motor, Drive circuits, open and closed loop control. (5)

Module-I
Embedded Systems:Hardware Structure, Software Design and Communication, Programmable Logic Devices,Automatic Control and Real Time Control Systems. (6)

Module-IV
Smart materials: Shape Memory Alloy, Piezoelectric and Magnetostrictive Actuators: Materials, Static and dynamic characteristics, illustrative examples for positioning, vibration isolation, etc (4)

Module-V
Micromechatronic systems: Microsensors, Microactuators; Micro-fabrication techniques LIGA Process: Lithography, etching, Micro-joining etc. Application examples; (5)

Module-VI
Case studies Examples of Mechatronic Systems from Robotics Manufacturing, Machine Diagnostics, Road vehicles and Medical Technology. (4)

Course Outcomes:
Upon completion of this course, students will get an overview of mechatronics applications and the use of micro-sensors and microprocessors.

Text Books:

(i) Mechatronics System Design, Devdas Shetty & Richard A. Kolk, PWS Publishing Company (Thomson Learning Inc.)
(ii) Mechatronics: A Multidisciplinary Approach, William Bolton, Pearson Education
(iii) A Textbook of Mechatronics ,R.K.Rajput, S. Chand & Company Private Limited
(iv) Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, William Bolton, Prentice Hall.

Mechanical Engineering			
ME613	**Microprocessor in Automation**	**L**	**T**
		3	**0**

Objectives:
To introduce the basic concepts of Digital circuits, Microprocessor system and digital controller

Course Contents:

Module-I
Number Systems, codes, digital electronics: Logic Gates, combinational circuits design, Flip-flops, Sequential logic circuits design: Counters, Shift registers. (6)

Module-II
Introduction to 8085 Functional Block Diagram, Registers, ALU, Bus systems, Timing and control signals. (4)

Module-III
Machine cycles, instruction cycle and timing states, instruction timing diagrams, Memory interfacing. (3)

Module-IV
Assembly Language Programming: Addressing modes, Instruction set, simple programs in 8085; Concept of Interrupt, Need for Interrupts, Interrupt structure, Multiple Interruptrequests and their handling, Programmable interrupt controller; Interfacing peripherals: Programmable peripheral interface (8255). (10)

Module-V
Interfacing Analog to Digital Converter & Digital to Analog converter, Multiplexed seven segments LED display systems, Stepper Motor Control. (5)

Module-VI
Data Communication: Serial Data communication (8251), Programmable Timers (8253); 8086/8088 Microprocessor and its advanced features. (5)

Module-VII
Introduction to Digital Control: Sampling theorem, Signal conversion and Processing, Z-Transform, Digital Filters, Implementation of Digital Algorithm. (7)

Course Outcomes:
Students who have done this course will have a good idea of the use of microprocessors for automation.

Text Books:

(i) Digital Electronics: An Introduction to Theory and Practice, William H. Gothmann, PHI Learning Private Limited
(ii) Digital Computer Electronics: An Introduction to Microcomputers, Albert Paul Malvino, Tata McGraw-Hill Publishing Company Ltd.
(iii) Microprocessor Architecture, Programming, and Applications with the 8085, Ramesh Gaonkar, PENRAM International Publishers.
(iv) Digital Control Systems, Benjamin C. Kuo, Oxford University Press (2/e, Indian Edition, 2007).
(v) Microcomputer Experimentation with the Intel SDK-85, Lance A. Leventhal, Prentice Hall

Mechanical Engineering			
ME621	**Design of Transmission System**	**L**	**T**
		3	**0**

Objectives:
To learn about the design procedures for mechanical power transmission components

Contents:

Module-I
Flexible transmission elements- design of flat belts & pulleys, selection of V-belts and pulleys, selection of hoisting wire ropes and pulleys, design of chains and sprockets. (6)

Module-II
Gear transmission- speed ratios and number of teeth, force analysis, tooth stresses, dynamic effects, fatigue strength, factor safety, gear materials; Design of straight tooth spur gear and parallel axis helical gears based on strength and wear considerations, pressure angle in the normal and transverse plane; equivalent number of teeth and forces for helical gears. (6)

Module-III
Straight bevel gear- tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of a pair of straight bevel gears. (4)

Module-IV
Worm gear, merits & demerits, terminology, thermal capacity, materials, forces & stresses, efficiency, estimating the size of worm gear pair. Cross helical gears, terminology, helix angles, sizing of a pair of helical gears. (4)

Module-V
Gear box- geometric progression, standard step ratio; Ray diagram, kinematics layout; Design of sliding mesh gear box- Design of multi-seed gear box for machine too applications; constant mesh gear box, speed reducer unit; Variable speed gear box; Fluid couplings, Torque converters for automotive applications. (10)

Module-VI
Cam design, types: pressure angle and undercutting base circle determination, forces and surface stresses; Design of plate clutches, axial clutches, cone clutches, internal expandingrim clutches; Electromagnetic clutches; Band and Block brakes. (6)

Module-VII
External shoe brakes, internal expanding shoe brake. (4)

Course Outcomes:

Upon completing this course the students will be able to design transmission systems for engines and machines.

Text Books:

(i) Shigley J., Mischke C., Budynas R. and Nisbett K., Mechanical Engineering Design, 8th ed., Tata McGraw Hill, 2010.
(ii) Jindal U.C., Machine Design: Design of Transmission System, Dorling Kindersley, 2010.
(iii) Maitra G. and Prasad L., Handbook of Mechanical Design, 2nd ed., Tata McGraw Hill,2001.

Mechanical Engineering			
ME622	**Computational Fluid Dynamics**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the student will be able to:

1. Develop mathematical models for flow phenomena.
2. Analyze mathematical and computational methods for fluid flow and heat transfer simulations.
3. Solve computational problems related to fluid flows and heat transfer.
4. Evaluate the grid sensitivity and analyze the accuracy of a numerical solution.
5. Evaluate flow parameters in internal and external flows.
6. Develop flow simulation code for fluid flow and heat transfer problems.

Contents:

Module-I
Introduction: History and Philosophy of computational fluid dynamics, CFD as a design and research tool, Applications of CFD in engineering, Programming fundamentals, MATLAB programming, Numerical Methods (5)

Module-II
Governing Equations of Fluid Dynamics: Models of the flow, The substantial derivative, Physical meaning of the divergence of velocity, The continuity equation, The momentum equation, The energy equation, Navier-Stokes equations for viscous flow, Euler equations for inviscid flow, Physical boundary conditions, Forms of the governing equations suited for CFD, Conservation form of the equations, shock fitting and shock capturing, Time marching and space marching. (5)

Module-III
Mathematical Behavior of Partial Differential Equations: Classification of quasi-linear partial differential equations, Methods of determining the classification, General behavior of Hyperbolic, Parabolic and Elliptic equations. Basic Aspects of Discretization: Introduction to finite differences, Finite difference equations using Taylor series expansion and polynomials, Explicit and implicit approaches, Uniform and unequally spaced grid points. (6)

Module-IV
Grids With Appropriate Transformation: General transformation of the equations, Metrics and Jacobians, The transformed governing equations of the CFD, Boundary fitted coordinate systems, Algebraic and elliptic grid generation techniques, Adaptive grids. Parabolic Partial Differential Equations: Finite difference formulations, Explicit methods – FTCS, Richardson and DuFort-Frankel methods, Implicit methods – Laasonen, Crank-Nicolson and Beta formulation methods, Approximate factorization, Fractional step methods, Consistency analysis, Linearization. (8)

Module-V
Stability Analysis: Discrete Perturbation Stability analysis, von Neumann Stability analysis, Error analysis, Modified equations, Artificial dissipation and dispersion. Elliptic Equations: Finite difference formulation, solution algorithms: Jacobi-iteration method, Gauss-Siedel iteration method, point- and line-successive over-relaxation methods, alternative direction implicit methods. Hyperbolic Equations: Explicit and implicit finite difference formulations, splitting methods, multi-step methods, applications to linear and nonlinear problems, linear damping, flux corrected transport, monotone and total variation diminishing schemes, tvd formulations, entropy condition, first-order and second-order tvd schemes. (7)

Module-VI
Scalar Representation of Navier-Stokes Equations: Equations of fluid motion, numerical algorithms: ftcs explicit, ftbcs explicit, Dufort-Frankel explicit, Maccormack explicit and implicit, btcs and btbcs implicit algorithms, applications. Grid Generation: Algebraic Grid Generation, Elliptic Grid Generation, Hyperbolic Grid Generation, Parabolic Grid Generation.(4)

Module-VII
Finite Volume Method For Unstructured Grids: Advantages, Cell Centered and Nodal point Approaches, Solution of Generic Equation with tetra hedral Elements, 2-D Heat conduction with Triangular Elements. Numerical Solution of Quasi One Dimensionl Nozzle Flow: Subsonic-Supersonic isentropic flow, Governing equations for Quasi 1-D flow, Non-dimensionalizing the equations, MacCormack technique of discretization, Stability condition, Boundary conditions, Solution for shock flows. (5)

Text Books:
(i) Anderson, J.D.(Jr), Computational Fluid Dynamics, McGraw-Hill Book Company, 1995.

(ii) Hoffman, K.A., and Chiang, S.T., Computational Fluid Dynamics, Vol. I, II and III, Engineering Education System, Kansas, USA, 2000.

(iii) Chung, T.J., Computational Fluid Dynamics, Cambridge University Press, 2003.

(iv) Anderson, D.A., Tannehill, J.C., and Pletcher, R.H., Computational Fluid Mechanics and Heat Transfer, McGraw Hill Book Company, 2002.

Mechanical Engineering			
ME623	**Machine Tool Design**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the student will be able to:

1. Understand basic motions involved in a machine tool.
2. Design machine tool structures.
3. Design and analyze systems for specified speeds and feeds.
4. Select subsystems for achieving high accuracy in machining.
5. Understand control strategies for machine tool operations.
6. Apply appropriate quality tests for quality assurance.

Contents:

Module-I
Introduction to Machine Tool Drives and Mechanisms: Introduction to the course, Working and Auxiliary Motions in Machine Tools, Kinematics of Machine Tools, Motion Transmission (6)

Module-II
Regulation of Speeds and Feeds: Aim of Speed and Feed Regulation, Stepped Regulation of Speeds, Multiple Speed Motors, Ray Diagrams and Design Considerations, Design of Speed Gear Boxes, Feed Drives, Feed Box Design (10)

Module-III
Design of Machine Tool Structures: Functions of Machine Tool Structures and their Requirements, Design for Strength, Design for Rigidity, Materials for Machine Tool Structures, Machine Tool Constructional Features, Beds and Housings, Columns and Tables, Saddles and Carriages (10)

Module-IV
Design of Guideways, Power Screws and Spindles: Functions and Types of Guideways, Design of Guideways, Design of Aerostatic Slideways, Design of Anti-Friction Guideways, Combination Guideways, Design of Power Screws. (6)

Module-V
Design of Spindles and Spindle Supports: Functions of Spindles and Requirements, Effect of Machine Tool Compliance on Machining Accuracy, Design of Spindles, Antifriction Bearings(4)

Module-VI
Dynamics of Machine Tools: Machine Tool Elastic System, Static and Dynamic Stiffness (3)

Module-VII
Acceptance Tests (1)

Text Books:

(i) N.K. Mehta, Machine Tool Design and Numerical Control, TMH, New Delhi, 2010

(ii) G.C. Sen and A. Bhattacharya, Principles of Machine Tools, New Central Book Agency, 2009.

(iii) D. K Pal, S. K. Basu, "Design of Machine Tools", 5th Edition. Oxford IBH, 2008

(iv) N. S. Acherkhan, "Machine Tool Design", Vol. I, II, III and IV, MIR publications, 1968.

Mechanical Engineering			
ME631	**Industrial Robotics**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the student will be able to:

1. Understand the basic components of robots.
2. Differentiate types of robots and robot grippers.
3. Model forward and inverse kinematics of robot manipulators.
4. Analyze forces in links and joints of a robot.
5. Programme a robot to perform tasks in industrial applications.
6. Design intelligent robots using sensors.

Contents:

Module-I

Robotics-classification, Sensors-Position sensors, Velocity sensors, Proximity sensors, Touch and Slip Sensors, Force and Torque sensors. (6)

Module-II

Grippers and Manipulators-Gripper joints, Gripper force, Serial manipulator, Parallel Manipulator, selection of Robot-Selection based on the Application (8)

Module-III

Kinematics-Manipulators Kinematics, Rotation Matrix, Homogenous Transformation Matrix, Direct and Inverse Kinematics for industrial robots for Position and orientation. (8)

Module-IV

Differential Kinematics and static- Dynamics-Lagrangian Formulation, Newton-Euler Formulation for RR & RP Manipulators. (6)

Module-V

Trajectory planning-Motion Control- Interaction control, Rigid Body mechanics, Control architecture- position, path velocity and force control systems, computed torque control, adaptive control, and Servo system for robot control. (6)

Module-VI

Programming of Robots and Vision System- overview of various programming languages. (4)

Module-VII

Application of Robots in production systems- Application of robot in welding, machine tools, material handling, and assembly operations parts sorting and parts inspection. (2)

Text Books:

(i) Fu, K.S., Gonzalez, R.C., and Lee, C.S.G., Robotics control, Sensing, Vision and Intelligence, McGraw-Hill Publishing company, New Delhi, 2003.

(ii) Klafter, R.D., Chmielewski, T.A., and Negin. M, Robot Engineering-An Integrated Approach, Prentice Hall of India, New Delhi, 2002.

(iii) Craig, J.J., Introduction to Robotics Mechanics and Control, Addison Wesley, 1999.

Mechanical Engineering			
ME632	**Computer Aided Design**	**L**	**T**
		3	**0**

Objectives:
To provide an overview of how computers can be utilized in mechanical component design

Contents:

Module-I
Fundamentals of Computer Graphics- Product cycle, sequential and concurrent engineering, Computer Aided Design, CAD system architecture, computer graphics, Coordinate systems, 2D and 3D transformations, viewing transformation. (12)

Module-II
Geometric Modeling- representation of curves, Hermite curves, Bezier curves, B-spline curves, rational curves, Techniques of surface modelling, surface patch, Coons and bicubic patches, Bezier and B-spline surfaces, Solid modelling techniques, CSG and B-rep, Octra, Loxel, Mix representation. (8)

Module-III
Visual realism- hidden line-surface-solid removal algorithms, shading, colouring, computer animation Assembly of parts- assembly modelling, interferences of positions and orientation, tolerance analysis, mass property calculations. (4)

Module-IV
Mechanism simulation and interefence checking CAD standards- Graphical Kernel System (GKS), standards for vexchange images, Open Graphics Library (OpenGL), Data exchange standards- IGES, STEP, CALS etc. (10)

Module-V
Communication standards (6)

Course Outcomes:
Upon completion of this course, the students can use computer and CAD software for modelling mechanical components

Text Books:
(i) Ibrahim Zeid, Mastering CAD CAM, Tata McGraw Hill Publishing Co. 2007.
(ii) C. McMohan and J. Browne, CAD/CAM Principles, II edition, Pearson Education, 1999.
(iii) W. M. Neumann and R.F. Sproul, Principles of Computer Graphics, McGraw Hill, 1989.
(iv) D. Hearn and M.P. Baker, Computer Graphics, Prentice Hall Inc., 1992.

Mechanical Engineering			
ME633	**Production Planning and Control**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the student will be able to:

1. Understand production systems and their characteristics.
2. Evaluate MRP and JIT systems against traditional inventory control systems.
3. Understand basics of variability and its role in the performance of a production system.
4. Analyze aggregate planning strategies.
5. Apply forecasting and scheduling techniques to production systems.
6. Understand theory of constraints for effective management of production systems.

Contents:

Module-I
Introduction to Production Systems: Production Systems: Classification & Characterization, Overview of Production Planning and Control issues, Review of EOQ& inventory control systems. (8)

Module-II
Material Requirement Planning: Dependent Demand & Material Requirement Planning, Structure of MRP system, MRP Calculations, Planning Issues, Implementation Issues. (5)

Module-III
Just in Time Production Systems: Just-in-Time System: Evolution, Characteristics of JIT Systems, Continuous Improvement, The Kanban System, Strategic Implications of JIT System. Factory Physics: Basic factory dynamics, Variability basics, Push and pull production systems

(7)

Module-IV
Aggregate Planning: Aggregate Planning: Purpose & Methods, Reactive and Aggressive Alternatives, Planning Strategies, LP Formulation, Master Production Scheduling. (5)

Module-V
Scheduling: Scheduling in Manufacturing, Sequencing Operations for One Machine, Sequencing Operations for a two-station Flow Shop, Job Shop Dispatching. (5)

Module-VI
Forecasting Methods: Demand Forecasting: Principles and Methods, Judgment methods, Causal methods, Time-series methods. (5)

Module-VII
Issues in PPC: Special features in Planning & Control of Product-focused Systems and Process-focused Systems, Theory of Constraints. (5)

Text Books:

(i) KrajewskiL.J. and Ritzmen L.P., Operations Management: Strategy and Analysis, 9th Edition, Pearson Education, 2010.

(ii) Chase, R.B., Jacobs, F.R. and Aquilano, N.J., Operations Management for Competitive Advantage, 11th Edition, Tata McGraw Hill Book Company, New Delhi, 2010.

(iii) Hopp, WJ and Spearman, ML, Factory Physics: Foundations of Manufacturing Management, McGraw Hill International Edition, Third Edition, 2008.

Mechanical Engineering			
ME634	**Innovative Design**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the student will be able to:

1. Understand the conceptual development techniques to find solution for a critical design issue.
2. Apply embodiment principles to translate the conceptual ideas to engineering design.
3. Apply environmental, ethical and social issues during innovative design process.
4. Design and develop innovative engineering products for industrial needs using robust design philosophy.

Contents:

Module-I

Introduction: Innovations in Design, Engineering Design Process, Prescriptive and integrative models of design, Design Review and societal considerations. (8)

Module-II

Identification of Customer Need: Evaluating Customer requirements and survey on customer needs, Conversion of customer needs into technical Specifications, Information sources. (8)

Module-III

Concept Generation and Evaluation: Creativity and Problem solving, Brainstorming, Theory of Inventive Problem solving (TRIZ), Functional Decomposition of the problem for innovative concept development, Morphological design, Introduction to Axiomatic Design, Concept evaluation and decision making. (10)

Module-IV

Embodiment Design: Introduction, Product Architecture, Configuration and Parametric design Concepts, Industrial Design, Taguchi Methods. (7)

Module-V

Design for X: Design for Manufacturing, Design for Assembly, Design for Environment, Design for Reliability and Robustness, Introduction to FMEA and FMECA. (7)

Text Books:
(i) Nigel Cross, Engineering Design Methods, John Wiley, 2009.

(ii) George E. Dieter, Engineering Design, McGraw-Hill, 2009.

(iii) GenrichAltshuller, The Innovation Algorithm, Technical Innovation Centre, 2011.

Mechanical Engineering			
ME635	**Supply Chain Management**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the student will be able to:

1. Understand the decision phases and apply competitive & supply chain strategies.
2. Understand drivers of supply chain performance.
3. Analyze factors influencing network design.
4. Analyze the influence of forecasting in a supply chain.
5. Understand the role of aggregate planning, inventory, IT and coordination in a supply chain.

Contents:

Module-I
Strategic Framework: Introduction to Supply Chain Management, Decision phases in a supply chain, Process views of a supply chain: push/pull and cycle views, Achieving Strategic fit, Expanding strategic scope. (6)

Module-II
Supply Chain Drivers and Metrics: Drivers of supply chain performance, Framework for structuring Drivers, Obstacles to achieving strategic fit. (5)

Module-III
Designing Supply Chain Network: Factors influencing Distribution Network Design, Design options for a Distribution network, E-Business and Distribution network, Framework for Network Design Decisions, Models for Facility Location and Capacity Allocation. (10)

Module-IV
Forecasting in SC: Role of forecasting in a supply chain, Components of a forecast and forecasting methods, Risk management in forecasting. (5)

Module-V
Aggregate Planning and Inventories in SC: Aggregate planning problem in SC, Aggregate Planning Strategies, Planning Supply and Demand in a SC, Managing uncertainty in a SC: Safety Inventory. (8)

Module-VI
Coordination in SC: Modes of Transportation and their performance characteristics, Supply Chain IT framework, Coordination in a SC and Bullwhip Effect. (4)

Module-VII
Green Supply Chain Management: Introduction and Concept. (2)

Text Books:
(i) Sunil Chopra and Peter Meindl, Supply Chain Management - Strategy, Planning and Operation, 4th Edition, Pearson Education Asia, 2010.
(ii) David Simchi-Levi, Philp Kamintry and Edith Simchy Levy, Designing and Managing the Supply Chain - Concepts Strategies and Case Studies, 2nd Edition, Tata-McGraw Hill, 2000.

Mechanical Engineering			
ME641	**Automobile Engineering**	**L**	**T**
		3	**0**

Objectives:
To understand the construction and working principle of various parts of an automobile

Contents:

Module-I
Types of automobiles, vehicle construction and layouts, chassis, frame and body, vehicle aerodynamics, IC engines- components, function and materials, variable valve timing (VVT). (5)

Module-II
Engine auxiliary systems, electronic injection for SI and CI engines, unit injector system, rotary distributor type and common rail direct injection system, transistor based coil ignition& capacitive discharge ignition systems, turbo chargers (WGT, VGT), engine emission control by 3-way catalytic converter system, Emission norms (Euro & BS). (10)

Module-III
Transmission systems, clutch types & construction, gear boxes- manual and automatic gearshift mechanisms, over drive, transfer box, flywheel, torque converter, propeller shaft, slip joints, universal joints, differential and rear axle, Hotchkiss drive and Torque tube drive. (5)

Module-IV
Steering geometry and types of steering gear box, power steering, types of front axle, types of suspension systems. (5)

Module-V
Pneumatic and hydraulic braking systems, antilock braking system (ABS), electronic brake force distribution (EBD) and traction control. (5)

Module-VI
Alternative energy sources, natural gas, LPG, biodiesel, bio-ethanol, gasohol and hydrogen fuels in automobiles, modifications needed, performance, combustion & emission characteristics of alternative fuels in SI and CI engines. (7)

Module-VII
Electric and Hybrid vehicles, application of Fuel Cells. (3)

Course Outcomes:
Upon completion of this course, students will understand the function of each automobile component and also have a clear idea about the overall vehicle performance.

Text books:
(i) Kirpal Singh, Automobile Engineering, 7thed., Standard Publishers, New Delhi, 1997.
(ii) Jain K.K. and Asthana R.B., Automobile Engineering, Tata McGraw Hill, New Delhi,2002.
(iii) Heitner J., Automotive Mechanics, 2nd ed., East-West Press, 1999.
(iv) Heisler H., Advanced Engine Technology, SAE International Publ., USA, 1998.

Mechanical Engineering			
ME642	**Engineering Economics and Accountancy**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the student will be able to:

1. Prepare accounting records and summarize and interpret the accounting data for managerial decisions.
2. Understand the macro-economic environment of the business and its impact on enterprise.
3. Understand cost elements of the product and its effect on decision making.
4. Understand the concepts of financial management and smart investment.

Contents:

Module-I
Engineering Economics: Introduction to Engineering Economics – Fundamental concepts – Time value of money – Cash flow and Time Diagrams – Choosing between alternative investment proposals – Methods of Economic analysis. (8)

Module-II
The effect of borrowing on investment- Various concepts of National Income – Significance of National Income estimation and its limitations, Inflation –Definition – Process and Theories of Inflation and measures to control. (8)

Module-III
New Economic Policy 1991 – Impact on industry. (4)

Module-IV
Accountancy: Accounting Principles, Procedure – Double entry system – Journal – Ledger, Trail Balance – Cash Book – Preparation of Trading, Profit and Loss Account – Balance sheet. (10)

Module-V
Cost Accounting – Introduction – Classification of costs – Methods of costing – Techniques of costing – Cost sheet and preparation of cost sheet- Breakeven Analysis – Meaning and its application, Limitations. (10)

Text Books:
(i) Henry Malcom Stenar-Engineering Economic Principles, McGraw Hill Pub.

(ii) Dewett K.K., "Modern Economic Theory", Siltan Chand & Co.

(iii) Agrawal AN,"Indian Economy" Wiley Eastern Ltd, New Delhi

(iv) Jain and Narang "Accounting Part-I', Kalyani Publishers

(v) Arora, M.N. "Cost Accounting", Vikas Publications.

Mechanical Engineering			
ME643	**Reliability Engineering**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the student will be able to:

1. Understand the concepts of reliability, availability and maintainability
2. Develop hazard-rate models to know the behavior of components
3. Build system reliability models for different configurations
4. Asses reliability of components and systems using field and test data
5. Implement strategies for improving reliability of repairable and non-repairable systems

Contents:

Module-I

Introduction: Probabilistic reliability, failures and failure modes, repairable and non-repairable items, pattern of failures with time, reliability economics. (6)

Module-II

Component Reliability Models: Basics of probability & statistics, hazard rate & failure rate, constant hazard rate model, increasing hazard rate models, decreasing hazard rate model, time-dependent & stress-dependent hazard models, bath-tub curve. (10)

Module-III

System Reliability Models: Systems with components in series, systems with parallel components, combined series-parallel systems, k-out-of-m systems, standby models, load-sharing models, stress-strength models, reliability block diagram. (10)

Module-IV

Life Testing & Reliability Assessment: Censored and uncensored field data, burn-in testing, acceptance testing, accelerated testing, identifying failure distributions & estimation of parameters, reliability assessment of components and systems. (8)

Module-V

Reliability Analysis & Allocation: Reliability specification and allocation, failure modes and effects and criticality analysis (FMECA), fault tree analysis, cut sets & tie sets approaches; Maintainability Analysis: Repair time distribution, MTTF / MTBF, MTTR, availability, maintainability, preventive maintenance. (6)

Text Books:

(i) Ebeling CE, An Introduction to Reliability and Maintainability Engineering, TMH, New Delhi, 2004.

(ii) O'Connor P and Kleymer A, Practical Reliability Engineering, Wiley, 2012.

Mechanical Engineering			
ME644	**Theory of Constraints**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the student will be able to:

1. Understand the philosophy of TOC.
2. Assess the system performance using throughput accounting.
3. Apply DBR and OPT methodologies for manufacturing scheduling.
4. Implement critical chain methodology for project scheduling
5. Understand TOC thinking process tools including CRT, EC, FRT and PRT

Contents:

Module-I

Introduction: Basic philosophy, local and global optima, five focusing steps of TOC, comparison with TQM & JIT philosophies. (8)

Module-II

Throughput Accounting: Financial and operating measures, local and global performance measures, throughput, inventory, operating expenses, linking concepts of throughput accounting with financial accounting. (10)

Module-III

Manufacturing Scheduling: Line and job shop processes, make-to-stock and make-to-order environments, scheduling rules, DBR methodology for scheduling line processes, OPT methodology for scheduling job shops, buffering and types of buffers, buffer management. (10)

Module-IV

Project Scheduling: Critical chain methodology, developing single-project critical chain plan, developing multi-project critical chain plan, buffer and threshold sizing, project risk management. (5)

Module-V

TOC Thinking Process: Current reality tree, evaporating clouds, future reality tree, prerequisite tree, transition tree. (7)

Text Books:

(i) Dettmer H. W., Goldratt's Theory of Constraints: A Systems Approach to Continuous Improvement. ASQ Quality Press, Wiscousin, 1997.

(ii) Leach, L.P, Critical Chain Project Management, 2nd Edition, Artech House Inc, London, 2005.

Mechanical Engineering			
ME645	**Environmental Impact Assessment**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the student will be able to:

1. Identify the environmental attributes to be considered for the EIA study.
2. Formulate objectives of the EIA studies
3. Identify the suitable methodology and prepare Rapid EIA.
4. Prepare EIA reports and environmental management plans.
5. Plan the methodology to monitor and review the relief and rehabilitation works.

Contents:

Module-I

Introduction: The Need for EIA, Indian Policies Requiring EIA , The EIA Cycle and Procedures, Screening, Scoping, Baseline Data, Impact Prediction, Assessment of Alternatives, Delineation of Mitigation Measure and EIA Report, Public Hearing, Decision Making, Monitoring the Clearance Conditions, Components of EIA, Roles in the EIA Process. Government of India Ministry of Environment and Forest Notification (2000), List of projects requiring Environmental clearance, Application form, Composition of Expert Committee, Ecological sensitive places, International agreements. (10)

Module-II

Identifying the Key Issues: Key Elements of an Initial Project Description and Scoping, Project Location(s), Land Use Impacts, Consideration of Alternatives, Process selection: Construction Phase, Input Requirements, Wastes and Emissions, Air Emissions, Liquid Effluents, Solid Wastes, Risks to Environment and Human, Health, Socio-Economic Impacts, Ecological Impacts, Global Environmental Issues.

(8)

Module-III

EIA Methodologies: Criteria for the selection of EIA methodology, impact identification, impact measurement, impact interpretation & Evaluation, impact communication, Methods-Adhoc methods, Checklists methods, Matrices methods, Networks methods, Overlays methods. (4)

Module- IV

Environmental index using factor analysis, Cost/benefit analysis, Predictive or Simulation methods. Rapid assessment of Pollution sources method, predictive models for impact assessment, Applications for RS and GIS. (3)

Module-V

Reviewing the EIA Report: Scope, Baseline Conditions, Site and Process alternatives, Public hearing. Construction Stage Impacts, Project Resource Requirements and Related Impacts, Prediction of Environmental Media Quality, Socio-economic Impacts, Ecological Impacts, Occupational Health Impact, Major Hazard/ Risk Assessment, Impact on Transport System, Integrated Impact Assessment. (6)

Module-VI

Review of EMP and Monitoring: Environmental Management Plan, Identification of Significant or Unacceptable Impacts Requiring Mitigation, Mitigation Plans and Relief & Rehabilitation, Stipulating the Conditions, What should be monitored? Monitoring Methods, Who should monitor? Pre-Appraisal and Appraisal. (6)

Module-VII

Case Studies: Preparation of EIA for developmental projects- Factors to be considered in making assessment decisions, Water Resources Project, Pharmaceutical industry, thermal plant, Nuclear fuel complex, Highway project, Sewage treatment plant, Municipal Solid waste processing plant, Tannery industry. (7)

Text Books:

1. Jain, R.K., Urban, L.V., Stracy, G.S., Environmental Impact Analysis, Van Nostrand Reinhold Co., New York, 1991.
2. Barthwal, R. R., Environmental Impact Assessment, New Age International Publishers, 2002
3. Rau, J.G. and Wooten, D.C., Environmental Impact Assessment, McGraw Hill Pub. Co., New York, 1996.
4. Anjaneyulu.Y., and Manickam. V., Environmental Imapact Assessment Methodologies, B.S. Publications, Hyderabad, 2007.
5. Wathern.P., Environmental Impact Assessment- Theory and Practice, Routledge Publishers, London, 2004.

Mechanical Engineering			
IC601	**Entrepreneurship**	**L**	**T**
		2	**0**

Course objective:

1. To have Understanding of the dynamic role of entrepreneurship and small businesses
2. To know about Organizing and Managing a Business
3. To know about Financial Planning and Control
4. To know about Business Plan Creation
5. To know about Forms of Ownership for Small Business

Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** An Overview of Entrepreneurs and Entrepreneurship, Definition, Concept of Entrepreneurship & Intrapreneurship, Characteristics and skills of entrepreneurs	08
2.	**Entrepreneurial Development:** Entrepreneurship & Economic development, Contribution of Small and big enterprises to the economy, Entrepreneurial environment, Types of Entrepreneurs.	08
3.	**Developing the Business Plan :** Identification of Business idea, Elements of a Business Plan, Building Competitive Advantage, Conducting feasibility Analysis, Strategy and Planning for Starting Your Small Business, Developing Marketing Strategies, Managing Human Resources.	08
4.	**Sources of Finance:** Equity vs. Debt Capital, Sources of Equity Finance, Institutional finance, Venture Capital, Lease Finance,Obtaining the Right Financing.	06
5.	**Forms of Business Ownership:** Forms of Ownership, Becoming an Owner ,Sole Proprietorship, Partnership, Corporations and other forms of ownership.	04
6.	**Intellectual Property Management:** Importance of innovation, patents& trademarks in small businesses, introduction to laws relating to IPR in India.	04
7.	**Institutional support for small businesses in India:** Support in areas of technology, finance, inputs & infrastructure, marketing, entrepreneurship development .	04
	Total	**42**

Suggested Books:

[1]. Hisrich & Peters, "Entrepreneurship", Tata McGraw Hill

[2]. Roy, Rajeev, "Entrepreneurship", Oxford University Press

[3]. Norman M. Scarborough, "Essentials of Entrepreneurship & Small Business Management", 6th ed., Prentice Hal

[4]. Dutta, Bholanath, "Entrepreneurship management" ,Excel Books.