Mechanical Engineering

Course Structure
Academic Session 2020-21 onwards
SEMESTER V

S. No.	Course Code	Subject	L	T	P	Credit
		Theory				
1.	ME501	Heat Transfer	4	1	0	4
2.	ME502	Design of Machine Elements	3	1	0	3
3.	ME503	Internal Combustion Engines	3	1	0	3
4.*	ME504 ME505 ME506	Industrial Robotics Design for Manufacturing Energy System and Management	3	1	0	3
5.**	ME507 ME508 ME509	Project Management Principles of Management Total Quality Management	3	1	0	3
		Laboratory/Sessionals				
1.	ME501P	Heat Transfer	0	0	3	1
2.	ME502P	Design of Machine Elements	0	0	3	1
3.	ME503P	Internal Combustion Engines	0	0	3	1
4.	ME504P	Industrial Robotics Lab	0	0	3	1
5		General Proficiency/Seminar	0	0	2	2
Total Credit						**22**

***Professional Elective I**

**** Open Elective I**

HEAT TRANSFER

Course Code - ME501

Objectives :

- The aim of the course is to build a solid foundation in heat transfer exposing students tothe three basic modes namely conduction, convection and radiation.
- Rigorous treatment of governing equations and solution procedures for the three modeswill be provided, along with solution of practical problems using empirical correlations.
- The course will also briefly cover boiling and condensation heat transfer, and the analysisand design of heat exchangers.

Contents :

Module I
Introduction to three modes of heat transfer, Derivation of heat balance equation- Steady onedimensional solution for conduction heat transfer in Cartesian, cylindrical and sphericalgeometry, concept of conduction and film resistances, critical thickness of insulation, lumpedsystem approximation and Biot number, heat transfer through pin fins- Two dimensionalconduction solutions for both steady and unsteady heat transfer-approximate solution tounsteady conduction, heat transfer by the use of Heissler charts.**(12)**

Module II
Heat convection,basic equations, boundary layers- Forced convection, external and internalflows- Natural convective heat transfer- Dimensionless parameters for forced and freeconvection heat transfer-Correlations for forced and free convection- Approximate solutionsto laminar boundary layer equations (momentum and energy) for both internal and externalflow- Estimating heat transfer rates in laminar and turbulent flow situations using appropriatecorrelations for free and forced convection. **(10)**

Module III
Interaction of radiation with materials, definitions of radiative properties, Stefan Boltzmann'slaw, black and gray body radiation, Calculation of radiation heat transfer between surfacesusing radiative properties, view factors and the radiosity method.**(8)**

Module IV
Types of heat exchangers, Analysis and design of heat exchangers using bothLMTD and ε-NTU methods. Exposure of numerical technique of heat transfer. **(6)**

ModuleV
Boiling and Condensation heat transfer, Pool boiling curve **(3)**

ModuleVI

Introduction mass of transfer, Fick's law, Similarity between heat and mass transfer **(3)**

Course Outcomes:

1. After completing the course, the students will be able to formulate and analyze a heattransfer problem involving any of the three modes of heat transfer.
2. The students will be able to obtain exact solutions for the temperature variation usinganalytical methods where possible or employ approximate methods or empiricalcorrelations to evaluate the rate of heat transfer.
3. The students will be able to design devices such as heat exchangers and also estimate theinsulation needed to reduce heat losses where necessary.

Text Books:

1. P. K. Nag, Heat and Mass Transfer
2. Yunus A Cengel, Heat Transfer : A Practical Approach, McGraw Hill, 2002
3. Frank Kreith, Raj M. Manglik, Mark S. Bohn: Principles of Heat Transfer, Cengage Learning

References Books:

1. A. Bejan, Heat Transfer John Wiley, 1993
2. J.P.Holman, Heat Transfer, Eighth Edition, McGraw Hill, 1997.
3. F.P.Incropera, and D.P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley,Sixth Edition, 2007.
4. MassoudKaviany, Principles of Heat Transfer, John Wiley, 2002

DESIGN OF MACHINE ELEMENTS

Course Code - ME502

Objectives :

This course seeks to provide an introduction to the design of machine elements commonly encountered in mechanical engineering practice, through

- A strong background in mechanics of materials based failure criteria underpinning the safety-critical design of machine components
- An understanding of the origins, nature and applicability of empirical design principles, based on safety considerations
- An overview of codes, standards and design guidelines for different elements
- An appreciation of parameter optimization and design iteration
- An appreciation of the relationships between component level design and overall machine system design and performance

Contents :

Module I
Design considerations - limits, fits and standardization, Review of failure theories for static and dynamic loading (including fatigue failure), (6)

Module II
Design of shafts under static and fatigue loadings, Analysis and design of sliding and rolling contact bearings, (8)

Module III
Design of transmission elements: spur, helical, bevel and worm gears; belt and chain drives, (8)

Module IV
Design of springs: helical compression, tension, torsional and leaf springs, (6)

Module V
Design of joints: threaded fasteners, pre-loaded bolts and welded joints, (6)

Module VI
Analysis and applications of power screws and couplings, Analysis of clutches and brakes, Engine Components. (9)

Course Outcomes:
Upon completion of this course, students will get an overview of the design methodologies employed for the design of various machine components

Text Books:
[1] Shigley, J.E. and Mischke, C.R., Mechanical Engineering Design, Fifth Edition, McGraw-Hill International; 1989.

[2] Deutschman, D., Michels, W.J. and Wilson, C.E., Machine Design Theory and Practice, Macmillan, 1992.
[3] Juvinal, R.C., Fundamentals of Machine Component Design, John Wiley, 1994.
[4] Spottes, M.F., Design of Machine elements, Prentice-Hall India, 1994.
[5] R. L. Norton, Mechanical Design – An Integrated Approach, Prentice Hall, 1998

INTERNAL COMBUSTION ENGINES

Course Code - ME503

Objectives :

- To familiarize with the terminology associated with IC Engines.
- To understand the basics of IC Engines.
- To understand Combustion and various parameters and variables affecting it in various types of IC Engines.
- To learn about various systems used in IC Engine required for various applications.

Contents :

Module I
Review of ideal cycles; Details of fuel-air cycles. [6 hrs]

Module II
Combustion in SI and CI engines, combustion stages, combustion chamber and abnormal combustion. [8hrs]

Module III
Fuel supply systems in SI and CI engines, carburetor.[7hrs]

Module IV
Port fuel injection, direct injection and common rail injection. [7hrs]

Module V
Ignition system, lubrication systems and cooling Systems [7hrs]

Module VI
Testing of IC Engines, Engine emissions and control, advanced IC engine concepts [7hrs]

Course Outcomes:
1. Students who have done this course will have a good idea of the basics of IC engines.
2. They will have good knowledge of different parameters influence the operational characteristics of IC Engines.
3. Students will have good idea about different operational parts of IC Engines.
4. They will have understand the functions of fuel combustion of IC Engines.
5. They will have the good knowledge about designing and modifying the IC engines.

Text books:
1.Obert E. F. "Internal combustion engines and air pollution " Harper and Row Publication Inc. NY,1973.
2. Heisler H. " Advanced Engine technology " Edward Arnold 1995.
3. Heywood J.B. " Internal combustion Engine fundamentals ", McGraw Hill Book Co. NY, 1989.

4. Heldt P.M. " High combustion Engines ", Oxford &IBH Publishing Co.India, 1985.
5. Stockel M.W.,Stockel TS and Johnson C, " Auto Fundamentals ", The Goodheart, Wilcox Co.Inc. Illinois, 1996.

INDUSTRIAL ROBOTICS

Course code-ME504

Objective:

- To Gain knowledge of Robotics and automation.
- To Understand the working methodology of robotics and automation.
- Write the program for robot for various applications

Contents:

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

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

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

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

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. **(6hrs)**

Module-VI
Programming of Robots and Vision System- overview of various programming languages. **(4 hrs)**

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. **(2hrs)**

Course Outcomes:

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

Text Books:

1. Fu, K.S., Gonzalez, R.C., and Lee, C.S.G., *Robotics control, Sensing, Vision and Intelligence,* McGraw-Hill Publishing company, New Delhi, 2003.
2. Klafter, R.D., Chmielewski, T.A., and Negin. M, *Robot Engineering-An Integrated Approach,* Prentice Hall of India, New Delhi, 2002.
3. Craig, J.J., *Introduction to Robotics Mechanics and Control*, Addison Wesley, 1999.

DESIGN FOR MANUFACTURING

Course code-ME505

Objective:

- To educate students on factors to be considered in designing parts and components with focus on manufacturability.
  .
- To impart the knowledge on design considerations for designing components produced using various machining operations.

Contents:

Module-I

Introduction: Overview of the course, Design for manufacturing, Typical Case studies, Innovative product and service designs. **(4hrs)**

Module-II

Material Selection: Requirements for material selection, systematic selection of processes and materials, ASHBY charts **(4hrs**)

Module-III

Design for Casting: Basic characteristics and Mold preparation, Sand casting alloys, Design rules for sand castings, Example calculations, Investment casting overview, Cost estimation, Number of parts per cluster, Ready to pour liquid metal cost, Design guidelines for Investment casting, Die casting cycle, Determination of optimum number of cavities, appropriate machine size, Die cost estimation, Design principles. **(8hrs**)

Module-IV

Design for Injection molding: Injection molding systems, Molds, molding cycle time, mold cost estimation, estimation of optimum number of cavities, Assembly techniques, Design Guidelines. **(5hrs)**

Module-V

Design for Hot Forging: Characteristics of the forging process, forging allowances, flash removal, die cost estimation,Die life and tool replacement costs. **(5hrs)**

Module-VI

Design for Sheet metal working: Press selection, press brake operations, Design rules. **(2hrs)**

Module-VII

Design for Powder Metal processing: Powder metallurgy, tooling and presses for Compaction, Sintering, materials, heat treatments, Design guidelines. Design for machining: Machining using single point cutting tools, multipoint cutting tools, abrasive wheels, Assembly, cost estimation for machined components, Design guidelines. (10) Module 8: Design for Assembly: Design guidelines for manual assembly, large assemblies, analysis of an assembly, rules for product design for automation, design for robot assembly, Design for manufacture and Computer aided design. (4hrs)

Course Outcomes:

- Understand the design principles of design for manufacturing processes
- Estimates the cost of dies, molds and machined components based on die life.
- Understand the design for manual assembly and automated assembly.
- Design typical assemblies using principles of design for X concepts.
- Understand the design rules for machining with single point and multi point cutting tools.

Text Books:

1. Geoffrey Boothroyd, Dewhurst.P, Knight.W, *roduct design for manufacture and assembly*,
2. CRC press, 2002
3. George E Dieter, *Engineering Design- A material processing approach*, 5/E. Mc Graw hill international, 2003.
4. ASM Handbook, *Design for manufacture*, 2000.

ENERGY SYSTEM AND MANAGEMENT

Course code-ME506

Objectives:

- To understand the basics of Energy Resources.
- To understand the Energy Conversion Systems and Management.
- To learn about basic concept of Power Systems Engineering.

Contents:

Module- I

Energy Resources: Energy and Development, Units and Measurements, Conventional and Non-Conventional Sources of Energy, Fossil and Mineral Energy Resources, Details of Coal, Peat, Oil, Natural Gas and Nuclear Resources, Recovery of Fossil Fuels, Classification and Characterization of Fossil fuels, Basic of Solar, Wind, Bio, Hydro, Tidal, Ocean Thermal and other Renewable Energy Sources, Impact of Energy on Environment, Flow of Energy in Ecological System, Environmental Degradation due to energy, Control of Pollution from Energy. (**7hrs)**

Module- II

Energy Conversion Systems I: Energy, Conversion routes, Direct and indirect way of Energy Conversion, Principles of heat and mass transfer, Thermodynamics, Fluid static and dynamics, Electricity generation, distribution and use, Basic of Solar Thermal Conversion, Technology of Selective Coating, Fundamentals of Flat Plate Collector and Evacuated Collector, Basic of Wind Energy Conversion, Wind machine, Wind electric generator, Wind pump. (**7hrs)**

Module- III

Energy Conversion Systems II: Basics of Photovoltaic Conversion technology and PV systems, PV system design methodologies, Basics of Bio-energy conversion, biomethanation technology, Thermochemical Conversion through Pyrolysis, Gasification and Esterification, Bio Oil, Application of Ocean Thermal Gradient and Geothermal gradient for power generation, Basics of hydropower, Tidal and Wave power, Basics of Hydrogen fuel, Fundamentals of Fuel Cells, Basics of Fusion power, Energy Storage Technologies, Mechanical storage, Chemical storage and Electrical storage, Details of Pb-acid battery, Ni-Cd-alkaline battery, Ni-iron and Na-S batteries, battery maintenance and safety precautions. (**7hrs)**

Module- IV

Energy Management: Fundamental of Energy conservation, Energy Management and Audit, Basics of Energy Demand and Supply, Principles of Economic analysis in the Energy Management and Audit Programme, Supply side and demand side energy management, Boilers and Firing System, Steam, Condensation Systems, Energy Conservation and Management in power plant, Energy conservation in Buildings, Heating, Ventilation and Air Conditioning System, Degree day in energy use monitoring, Energy Conservation Opportunities, in chemical industries, Waste heat recovery, Co-generation, Energy Conservation in Agricultural Sector, Energy conservation in illumination engineering, Combustion stoichiometry, air-fuel ratio, optimum loading in boilers, etc (**7hrs)**

Module- V

Industrial Energy Analysis: Materials and energy balance in the industries, Products and the process, industrial demand and supply networking, Optimization techniques, efficiency analysis, methods, Energy monitoring and ongoing information dissertation in terms of energy consumption, production and cumulative sum of differences. Energy efficiency analysis in various conversion systems like boilers, furnaces, compression systems, controlling systems, etc. Case studies for large scale, medium scale and small scale industries, efficiency integration methodologies. (**7hrs)**

Module- VI

Power Systems Engineering Basic concept of power plants, types of power plants, thermal power stations, various components of thermal power stations, power plant cycles, fuel handling, combustion, waste disposal methodologies, economizers, turbo alternators, heat balance and efficiencies, hydroelectric power plant, various components, capacity calculation, design methodologies, operation and maintenance methodologies, elements of nuclear power stations, reactor design, fuel, moderator, coolant control and safety, waste disposal. (**7hrs)**

Course Outcomes:

Upon completion of this course, students will be able to understand Energy Resources, Energy Conversion Systems and Energy Management.

Text Books:

1. Albert Thumann, *Handbook of Energy Audits*, The Fairmont Press Inc., Atlanta gergia, 1979.
2. Murphy W.R and Mckay G, *Energy Management*, Butterworths, London, 1982.
3. Albert Thumann, *Plant Engineer and Management guide to Energy Conservation*, Van Nost and Reinhold Co., Newyork.
4. Energy Audits, E.E.O.-Book-lets, U.K. 1988.
5. Craig B.Smith, "*Energy Management Principles*", Pergamon Press.
6. The role of Energy Manager, E.E.O., U.K.

7. The Energy conservation Design Resource Hand Book-The Royal architectural Institute of Canada.
8. Non-Conventional Energy Resources by B.H . Khan, Tata McGraw Hill

Project Management

Course code- ME507

Objective:

- To facilitate the understanding of project management principles and processes

Contents:

Module- I

Introduction: Introduction to Project Management, definitions, History of Project Management, project identifications, establishing a project, Project Life Cycle. (**4 hrs)**

Module- II

Project Analysis: Facets of Project Analysis, Resource Allocation, Market Analysis, Technical Analysis, Economic and Ecological Analysis. (**7 hrs)**

Module- III

Financial Analysis: Financial Estimates and Projections, Investment Criteria, Financing of Projects. (**8 hrs)**

Module- IV

Network Methods in PM: Origin of Network Techniques, AON and AOA differentiation, CPM network, PERT network, Other network models. (**9 hrs)**

Module- V

Optimisation in PM: Time and Cost trade-off in CPM, Crashing procedure, Scheduling when resources are limited. (**6 hrs)**

Module- VI

Project Risk Management: Risk analysis, Work Breakdown Structure, Earned Value Management. (**8 hrs)**

Course Outcomes:

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

1. Understand the importance of projects and its phases.
2. Analyze projects from marketing, operational and financial perspectives.
3. Evaluate projects based on discount and non-discount methods.
4. Develop network diagrams for planning and execution of a given project.
5. Apply crashing procedures for time and cost optimization.

Text Books:

1. Prasanna Chandra, Project: A Planning Analysis, Tata McGraw Hill Book Company, New Delhi, 4th Edition, 2009.
2. Cleland, Gray and Laudon, Project Management, Tata McGraw Hill Book Company, New Delhi, 3rd Edition, 2007.
3. Jack R. Meredith., Samuel J. Jr. Mantel., Project Management - A Managerial Approach, John Wiley, 6th Edition, 2011.

Principles of Management

Course code- ME508

Objectives:

- To understand the principles of Management and their application to the functioning of organization

Contents:

Module- I

Definition of management, science or art, manager vs. entrepreneur; Types of managers-managerial roles and skills; Evolution of management-scientific human relations, system and contingency approaches. **(6 hrs)**

Module- II

Types of Business organizations, sole proprietorship, partnership, company, public and private enterprises; Organization culture and environment; current trends and issues in management, Nature and purpose of planning, types of planning, objectives, policies , Strategic Management, planning Tools and Techniques, Decision making steps & processes. **(8 hrs)**

Module- III

Nature and purpose of Organizing, formal and informal organization, organization structure, types, line and staff authority, departmentalization, delegation of authority, centralization and decentralization. Job design, human resource management, HR planning, Recruitment selection, Training & Development, Performance Management, carrier planning and Management. **(8 hrs)**

Module- IV

Directing, individual and group behavior,, motivation, motivation theories, motivational techniques, Job satisfaction, job enrichment, leadership, types and theories of leadership, effective communication. **(6 hrs)**

Module- V

Production planning and control: Forecasting models, aggregate production, and planning, scheduling, materials requirement planning; Controlling, system and process of controlling, budgetary and non-budgetary control techniques **(8 hrs)**

Module- VI

Inventory Control: Deterministic models, safety stock inventory control system Use of computers and IT in management control, productivity problems and management, control and performance, direct and preventive control, reporting. **(6 hrs)**

Course Outcomes:

Upon completion of this course, the students will

1. Get a clear understanding of management functions in an organization
2. Develop leadership quality to guide their work force to get done assigned jobs in time.
3. Maintain correct stock of spares and material for sustained production

4. Maintaining and hiring human resources of required skill and experience in time
5. Preparation of master budget and other budget to arrange required funds to carry out planned activities of organization

Text Books:

1. Robbins S.P. and Couiter M, Management, Prentice Hall India, 10th ed., 2009
2. Stoner JAF, Freeman RE and Gilbert DR, Management, 6th ed., Pearson Education 2004.
3. Tripathy PC & Reddy PN, Principles of Management, Tata Mcgraw Hill, 1999.
4. O.P.Khanna - Industrial Engineering and Management – Dhanpat Rai Publications O.P.Khanna

Total Quality Management

Course code- ME509

Objective:
To facilitate the understanding of total quality management principles and processes.

Contents:

Module-I
Introduction, evolution of quality control; Definitions of quality, Quality and productivity; Basic concepts of TQM, TQM framework, contributions of Deming, Juran and Crosby.; Quality conformance, customer need, customer orientation & satisfaction, customer complaints; Quality cost, product & service costing, measuring quality cost
8 Hrs.

Module-II
TQM principles; leadership, strategic quality planning; Quality councils- employee involvement, motivation; Empowerment;
6 Hrs.

Module-III
Team and Teamwork; Quality circles, recognition and reward, performance appraisal;
Continuous process improvement; PDCA cycle, 5S, Kaizen; Supplier partnership, Partnering, Supplier rating & selection**.**
8 Hrs.

Module-IV
The seven traditional tools of quality management; New management tools; Six sigma-concepts,methodology, applications to manufacturing, Bench marking process, evaluation; FMEA-stages, types**.**
6 Hrs.

Module-V
TQM tools and techniques, control charts, process capability, concepts of six sigma, Quality Function Development (QFD), Taguchi quality loss function; TPM- concepts, improvement needs, performance measures**.**
8 Hrs.

Module-VI
Quality systems, need for ISO 9000, ISO 9001-9008; Quality system- elements, documentation; Quality auditing, QS 9000, ISO 14000-concepts, requirements and benefits; TQM implementation in manufacturing and service sectors**.**
6 Hrs.

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

1.Understand the importance of quality and its assurance.
2.Analyze quality statements, customer focus and market plan.
3.Evaluate quality based products & methods.

4.Develop tools, methodology for the assurance of quality.
5.Apply & use the tools and techniques of TQM in manufacturing and service sector.

Text Books:

1. Besterfield D.H. et al., Total Quality Management, 3rd ed., Pearson Education Asia, 2006.
2. Evans J.R. and Lindsay W.M., The management and Control of Quality, 8th ed., first Indian edition, Cengage Learning, 2012.
3. Janaki raman B. and Gopal R.K., Total Quality Management, Prentice Hall India, 2006.
4. Suganthi L. and Samuel A., Total Quality Management, Prentice Hall India, 2006.

Mechanical Engineering

Course Structure
Academic Session 2020-21 onwards
SEMESTER VI

S. No.	Course Code	Subject	L	T	P	Credit
		Theory				
1.	ME601	Solid Mechanics	4	1	0	4
2.	ME602	Automobile Engineering	3	1	0	3
3.	ME603	Design of Transmission System	3	1	0	3
4.*	ME604 ME605 ME606	Computer Aided Design Mechatronic Systems Microprocessor in Automation	3	1	0	3
5.**	ME607 ME608 ME609	Operations Research Reliability Engineering Machine Tool Design	3	1	0	3
		Laboratory/Sessionals				
1.	ME601P	Solid Mechanics	0	0	3	1
2.	ME602P	Automobile Engineering	0	0	3	1
3.	ME604P	Manufacturing Lab	0	0	3	1
4.	ME607P	Computer Aided Design	0	0	3	1
5	IN601	Internship/Tour & Training/Industrial Training	0	0	2	2
Total Credit						**22**

***Professional Elective II**

**** Open Elective II**

SOLID MECHANICS

Course Code – ME601

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, strain gauges and rosettes. **(8hrs)**

Module-II

Stress: Derivation of Cauchy relations and equilibrium and symmetry equations, principal stresses and directions, octahedral shear stresses. **(8hrs)**

Module-III

Constitutive equations: Generalized Hooke's law, Linear elasticity, Material symmetry; Boundary Value Problems: concepts of uniqueness and superposition. **(6hrs)**

Module-IV

Plane stress and plane strain problems, introduction to governing equations in polar and cylindrical coordinates, axisymmetric problems. **(7hrs)**

Module-V

Application to thick cylinders, rotating discs, torsion of non-circular cross-sections, stress concentration, thermo-elasticity. **(8hrs)**

Module-VI

Solutions using potentials energy methods, Introduction to plasticity. **(5hrs)**

Course Outcomes:

Upon completion of this course, students will be able to:

1. Understand the deformation behavior of solids under different types of loading.
2. Find mathematical solutions for simple geometries under different types of loading.
3. Transform the state of stress from one set of co-ordinate axes to another set of co-ordinate axes.
4. Apply compatibility equation for different system of strain.
5. Find the mathematical solution for axisymmetric problem.
6. Understand the concept of elasticity and plasticity.

Text Books:

[1] G. T. Mase, R. E. Smelser and G. E. Mase, Continuum Mechanics for Engineers, Third Edition, 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 Hall international, 1969.

[4] S M A Kazimi, Solid Mechanics, Mc Graw Hill, 2016

AUTOMOBILE ENGINEERING

Course Code – ME602

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, (5)

Module-II
Engine auxiliary systems, fuel supply system, starting system, ignition system, electronic injection for SI and CI engines, engine lubrication and cooling system, engine emission control by 3-way catalytic converter system, Emission norms .(10)

Module-III
Transmission systems, AWD and 4WD transmission, clutch types & construction, gear boxes, Automatic transmission, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints, differential and rear axle, (6)

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

Module-V
General braking requirement, elementary theory of shoe brake, weight transfer, mean lining pressure and heat generation during braking, mechanical Pneumatic and hydraulic braking systems, power brake, antilock braking system(ABS), (6)

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. Electric and Hybrid vehicles, application of Fuel Cells, (10)

Module-VII

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.

DESIGN OF TRANSMISSION SYSTEM

Course Code – ME603

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 hrs)**

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 hrs)**

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 hrs)**

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 hrs)**

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 hrs)**

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 hrs)**

Module-VII

External shoe brakes, internal expanding shoe brake. **(4 hrs)**

Course Outcomes:

1. 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, 8thed., 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.

COMPUTER AIDED DESIGN

Course Code – ME604

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 **(8 hrs)**

Module- II

Geometric Modelling- straight line, representation of curves, Hermite curves, Bezier curves, B-spline curves, rational curves **(5 hrs)**

Module- III

Techniques of surface modelling, plane surface, cylindrical surface, surface of revolution, surface patch, Coons and bicubic patches, Bezier and B-spline surfaces **(6 hrs)**

Module- IV

Fundamental of solid design, parametric space of a solid, surface and curves in a solid, Solid modelling techniques, CSG and B-rep. **(6 hrs)**

Module- V

Visual realism- hidden line-surface-solid removal algorithms, shading, colouring, computer animation **(5 hrs)**

Module- VI

Assembly of parts- assembly modelling, interferences of positions and orientation, tolerance analysis, mass property calculations, 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., Communication standards **(12 hrs)**

Course Outcomes:

Upon completion of this course, the students will be able to:

1. Use computer and CAD software for modelling mechanical components
2. draw different types of curves in 2D
3. draw different types of surface
4. draw solid modelling
5. assembly of different part modelling

Text Books:

1. Ibrahim Zeid, Mastering CAD CAM, Tata McGraw Hill Publishing Co. 2007.
2. C. McMohan and J. Browne, CAD/CAM Principles, II edition, Pearson Education, 1999.
3. W. M. Neumann and R.F. Sproul, Principles of Computer Gra[hics, McGraw Hill, 1989.
4. D. Hearn and M.P Baker, Computer Graphics, Prentice Hall Inc., 1992.

MECHATRONIC SYSTEMS

Course Code – ME605

Objective:

- To provide an overview of mechatronics applications and the use of micro-sensors and microprocessors.

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. **(8hrs)**

Module-II

Sensors and transducers: classification, Development in Transducer technology, Opto-electronics- Shaft encoders, CD Sensors, Vision System, etc.**(5hrs)**

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**.(5hrs)**

Module-IV

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

Module-V

Smart materials: Shape Memory Alloy, Piezoelectric and Magnetostrictive Actuators: Materials, Static and dynamic characteristics, illustrative examples for positioning, vibration isolation, etc**.(8hrs)**

Module-VI

Micro mechatronic systems: Micro sensors, Micro actuators; Micro-fabrication techniques LIGA Process: Lithography, etching, Micro-joining etc. Application examples; Case studies Examples of Mechatronic Systems from Robotics Manufacturing, Machine Diagnostics, Road vehicles and Medical Technology. **(10hrs)**

Course Outcomes:

- To understand the structure of microprocessors and their applications in mechanical devices
- To know the use of various sensors and transducers
- To understand the principle of automatic control and real time motion control systems, with the help of electrical drives and actuators
- To know the static and dynamic characteristics of actuators
- To understand the use of micro-sensors and their applications in various fields

Text Books:

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

MICROPROCESSOR IN AUTOMATION

Course Code – ME606

Objectives:

- To introduce the basic concepts of Digital circuits, Microprocessor system and digital Controller.

Contents:

Module- I

Number Systems, codes, digital electronics: Logic Gates, combinational circuits design, Flip-flops, Sequential logic circuits design: Counters, Shift registers. Introduction to 8085 Functional Block Diagram, Registers, ALU, Bus systems, Timing and control signals. **(10 hrs)**

Module- II

Machine cycles, instruction cycle and timing states, instruction timing diagrams, Memory interfacing. **(3 hrs)**

Module- III

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

Module- IV

Interfacing Analog to Digital Converter & Digital to Analog converter, Multiplexed seven segments LED display systems, Stepper Motor Control, Data Communication: Serial Data communication (8251), Programmable Timers (8253); 8086/8088 Microprocessor and its advanced features **(10 hrs)**

Module- V

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

Course Outcomes:

1. Students who have done this course will have a good idea of the use of microprocessers for automation.

Text Books:

1. Digital Electronics: An Introduction to Theory and Practice, William H. Gothmann, PHI Learning Private Limited
2. Digital Computer Electronics: An Introduction to Microcomputers, Albert Paul Malvino, Tata McGraw-Hill Publishing Company Ltd.

3. Microprocessor Architecture, Programming, and Applications with the 8085, Ramesh Gaonkar, PENRAM International Publishers.
4. Digital Control Systems, Benjamin C. Kuo, Oxford University Press (2/e, Indian Edition, 2007).
5. Microcomputer Experimentation with the Intel SDK-85, Lance A. Leventhal, Prentice Hall

OPERATIONS RESEARCH

Course Code-ME 607

Course Objectives **:** This course enables the students:

(1) Formulate a real-world problem as a mathematical programming model
(2) Know the theoretical workings of the simplex method for linear programming and perform iterations of it
(3) Analyze the relationship between a linear program and its dual, including strong duality and complementary slackness
(4) Solve specialized linear programming problems like the transportation, assignment, sequencing, games theory, and queuing model problems
(5) The use of Operations Research approaches in solving real problems in industry; mathematical models for analysis of real problems in Operations Research.

Course Outcomes: After completion of the course, the learners will be able to:

(1) Capability to recognize the importance and value of Operations Research and mathematical modeling.
(2) Ability to formulate a managerial decision problem into a mathematical model;
(3) Recognize Operations Research models and apply them to real-life problems;
(4) Use various approaches to solve a mathematical model for various practical problems in industry.
(5) Describe dynamic programming terminology.

Syllabus

MODULE I

Introduction: Scope and limitations of O.R., Linear Programming: Mathematical formulation of the problem. Graphical solution and Simplex Method. **8L**

MODULE II

Linear Programming**:** Big-M Method, Concept of duality, Dual simplex method. **6L**

MODULE III

Transportation Model**:** Basic feasible solution by different methods, Finding optimal solutions, Degeneracy in transportation problems, Unbalanced transportation problems.

Assignment Model: Balanced and unbalanced assignments,Assignment to given schedules.**10L**

MODULE IV

Sequencing: Processing of 2 jobs through machines –graphical method, Processing of n jobs through two machines, processing n jobs through three machines. **5L**

MOLULE V

Games Theory: Two-persons zero sum games, Pure and mixed strategies, Rules of dominance, Solution methods without saddle point. **5L**

MOLULE VI

Queuing Model**:** Queuing systems and their characteristics, The M/M/1/FIFO/∞ Queuing system, Introduction to dynamic programming. **8L**

Text Books:

1. P. Rama Murthy , Operations Research, New Age, New Delhi
2. P.K. Gupta & D. S. Hira , Operations Research, S.Chand & Company Ltd, New Delhi.

References Books:

1. Hamdy A Taha, 1999. Introduction to Operations Research, PHI Limited, New Delhi.

2.Sharma, J.K., 1989. Mathematical Models in Operations Research, Tata McGraw Hill publishing Company Ltd., New Delhi.

3.Beer, Stafford, 1966. Decision and Control, John Wiley & Sons, Inc., New York.

RELIABILITY ENGINEERING

Course Code – ME608

Objectives : To understand the applications of reliability in engineering decision making

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)

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

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.

MACHINE TOOL DESIGN

Course Code – ME609

Objectives:

- Implement the tool design process when designing tooling for the manufacturing of a product.
- Apply Geometric Tolerancing principles in the designs of tooling.
- Evaluate and select appropriate materials for tooling applications.
- Design, develop, and evaluate cutting tools and work holders for a manufactured product.

Contents:

Module- I

Introduction to Machine Tools: Classification, similarities; various cutting tools and cutting fluids: speed of cutting, feed rate, machining rate and machining time. **(4 hrs)**

Module- II

Lathe: Construction, important mechanisms viz. apron, tail stock, head- stock, feed box; specification, operations e.g., taper turning, eccentric turning, screw cutting. **(4 hrs)**

Module- III

Milling machine: Construction, types specifications; cutters, dividing head, simple compound and differential indexing; various operations: Slab milling, angle cutting, slot milling, fly milling, slit gear milling, spur and bevel, T- slot milling, nature of operations, up and down milling. **(10 hrs)**

Module- IV

Shaper, Slotter, Planer: Construction, automatic feed mechanism, quick return mechanisms: operations e.g., horizontal, vertical and inclined machining, spline cutting, keyway cutting, contour machining. **(7 hrs)**

Module- V

Drilling machine: Construction, feed mechanism: Specification, geometry and nomenclature of twist drill, operations e.g. reaming, boring, tapping. **(5 hrs)**

Module- VI

Grinding Machines: M, N types and construction features, Operations e.g. Plane, cylindrical, internal and centreless grinding, tool and cutter grinding, grinding wheels- specifications, shapes, setting, dressing, truing. **(10 hrs)**

Course Outcomes:

At the end of the course, the student will be able to, Understand basic motions involved in a machine tool. Design machine tool structures. Design and analyze systems for specified speeds and feeds. Select subsystems for achieving high accuracy in machining. Understand control strategies for machine tool operations.

Text Books:

1. B.L.Juneja, G.S.Sekhon&Nitin Seth, Fundamentals of Metal Cutting & Machine Tools, New Age International Publications
2. P.N.Rao, Manufacturing Technology: Metal Cutting & Machine Tools, Tata McGraw Hill Publications.
3. G.K.Lal, Introduction to Machining Science ,New Age International Publications.
4. B.S.Raghuwanshi, Workshop Technology , Dhanpat Rai& Sons, Publications
5. HazraChandhari, Elements of Workshop Technology.