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.
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- 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.