MANAGEMENT AND ENGINEERING ECONOMICS

B.E, V Semester, Mechanical Engineering

[As per Choice Based Credit System (CBCS) scheme]

Course Code	**17ME51**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50(10 Hours per Module)**	**Exam Hours**	**03**
Credits – 04			

Course Objectives:

- Examine the meaning, importance, nature of management, its difference between management and administration and role of managers in management.
- Examine the meaning characteristics principles and process of organizing.
- Describe effective communication process, its importance, types and purpose for running an organization.
- Explain the importance of engineering economics, Law of demand and supply in engineering decision making.
- Describe various interest rate factors and implement the same for economic decision making.
- Examine different economic analysis methods-NPW, EAW, IRR, FW for decision making.
- Discuss different component of costs and methods of cost estimation.
- Explain depreciation, different methods of computing depreciation.
- Discuss taxation concepts-income tax and corporate taxes.

Module - 1

Management: Introduction - Meaning - nature and characteristics ofManagement, Scope and Functional areas of management - Management as ascience, art of profession - Management & Administration - Roles ofManagement, Levels of Management, Development of Management Thought-early management approaches – Modern management approaches.

Planning: Nature, importance and purpose of planning process Objectives -Types of plans (Meaning Only) - Decision making Importance of planning -steps in planning & planning premises - Hierarchy of plans.

Module - 2

Organizing And Staffing: Nature and purpose of organization Principles oforganization - Types of organization - Departmentation Committees- Centralization Vs Decentralization of authority and responsibility - Span ofcontrol - MBO and MBE (Meaning Only) Nature and importance of staffing--:Process of Selection & Recruitment (in brief).

Directing & Controlling: Meaning and nature of directing Leadershipstyles, Motivation Theories, Communication - Meaning and importance - coordination, meaning and importance and Techniques of Co Ordination. Meaning and steps in controlling - Essentials of a sound control system - Methods of establishing control (in brief)

Module - 3

Introduction: Engineering and economics, Problem solving and decision making, Laws of demand and supply, Difference between Microeconomics & Macroeconomics, equilibrium between demand & supply, elasticity of demand, price elasticity, income elasticity.
Law of Returns, Interest and interest factors, simple and compound interest, Cash flow diagrams, personal loans and EMI payment calculation with flexible interest rates, Discussion and problems

Module - 4

Present, future and annual worth and rate of returns: Basic present worth comparisons, Present worth-equivalence, Assets with unequal lives and infinites lives, future worth comparisons, payback comparisons, Equivalent annual worth comparisons, situations for annual worth comparisons.
Asset life, Rate of return, minimum acceptable rate of return, IRR anomalies and misconceptions, Cost of capital, comparisons of all present future and annual worth with IRR, product costing, Discussions and problems

Module - 5

Costing and depreciation: Components of costs, estimation of selling price, marginal cost, first cost, all kinds of overheads, indirect cost estimation with depreciation, mensuration and estimation of material cost, cost estimation of mechanical process, idling time.
Product costing (approaches to product costing), causes of depreciation, methods of computing depreciation charges, straight line method, declining balance method, sum of years method, sinking fund method, service output methods, taxation concepts, personal income taxes and corporate taxes, Discussions and problems.

Course outcomes:

On completion of this subject students will be able to

1. Explain the development of management and the role it plays at different levels in an organization.
2. Comprehend the process and role of effective planning, organizing and staffing for the development of an organization.
3. Understand the necessity of good leadership, communication and coordination for establishing effective control in an organization.
4. Understand engineering economics demand supply and its importance in economics decision making and problem solving.
5. Calculate present worth, annual worth and IRR for different alternatives in economic decision making.
6. Understand the procedure involved in estimation of cost for a simple component, product costing and depreciation, its methods.

TEXT BOOKS:

1. Principles of Management by Tripathy and Reddy
2. Mechanical estimation and costing, T.R. Banga& S.C. Sharma, 17th edition 2015
3. Engineering Economy, Riggs J.L. McGraw Hill, 2002
4. Engineering Economy, Thuesen H.G. PHI , 2002

REFERENCE BOOKS

1. Management Fundamentals- Concepts, Application, Skill Development - RobersLusier - Thomson
2. Basics of Engineering Economy, Leland Blank & Anthony Tarquin, McGraw Hill Publication (India) Private Limited
3. Engineering Economics, R.Paneerselvam, PHI publication
4. Fundamentals of Management: Essential Concepts and Applications, Pearson Education, Robbins S.P. and Decenzo David A.
5. Economics: Principles of Economics, N Gregory Mankiw, Cengage Learning
6. Modern Economic Theory, By Dr. K. K. Dewett& M. H. Navalur, S. Chand Publications

DYNAMICS OF MACHINERY

B.E, VSemester, Mechanical Engineering

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17ME52	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50(10 Hours per Module)**	**Exam Hours**	**03**

Credits – 04

Course Objectives:

1. **To gain the knowledge static and dynamic equilibrium conditions of mechanisms subjected forces and couple, with and without friction.**
2. **Analyze the mechanisms for static and dynamic equilibrium.**
3. **To understand the balancing principles of rotating and reciprocating masses, governors and gyroscopes.**
4. **Analyze the balancing of rotating and reciprocating masses, governors and gyroscopes.**
5. **To understand vibrations characteristics of single degree of freedom systems.**
6. **Characterize the single degree freedom systems subjected to free and forced vibrations with and without damping.**

Module - 1

Static force Analysis: Static equilibrium. Equilibrium of two and three force members. Members with two forces and torque, Free body diagrams, Static force analysis of four bar mechanism and Slider-crank mechanism with and without friction.

Dynamic force Analysis: D 'Alembert's principle, Inertia force, Inertia torque. Dynamic force analysis of four-bar mechanism and Slider crank mechanism without friction, numerical problems.

Module - 2

Balancing of Rotating Masses: Static and dynamic balancing, balancing of single rotating mass by balancing masses in same plane and in different planes. Balancing of several rotating masses by balancing masses in same plane and in different planes.

Balancing of Reciprocating Masses: Inertia effect of crank and connecting rod, Single cylinder engine, balancing in multi cylinder-inline engine (primary and secondary forces), numerical problems.

Module - 3

Governors: Types of governors, force analysis of Porter and Hartnell governors. Controlling force, Stability, Sensitiveness, Isochronism, Effort and Power.

Gyroscope:Vectorial representation of angular motion, Gyroscopic couple. Effect of gyroscopic couple on plane disc, aeroplane, ship, stability of two wheelers and four wheelers, numerical problems.

Module - 4

Introduction &Undamped free Vibrations (Single Degree of Freedom)

Types of vibrations, Definitions, Simple Harmonic Motion (SHM), Work done by harmonic force, Principle of super position applied to SHM. Methods of analysis – (Newton's, Energy & Rayleigh's methods). Derivations for spring mass systems, Natural frequencies of simple systems, Springs in series and parallel, Torsional and transverse vibrations, Effect of mass of spring and problems.

Module - 5

Damped free Vibrations (Single Degree of Freedom)

Types of damping, Analysis with viscous damping - Derivations for over, critical and under damped systems, Logarithmic decrement and numerical problems.

Forced Vibrations (Single Degree of Freedom):

Analysis of forced vibration with constant harmonic excitation, Magnification factor (M.F.), Vibration isolation - Transmissibility ratio, Excitation of support (absolute and relative), Numerical problems.

Course outcomes:

1. Determine the forces and couples for static and dynamic conditions of four bar and slider crank mechanisms to keep the system in equilibrium.
2. Determine magnitude and angular position of balancing masses under static and dynamic condition of rotating masses in same and different planes.
3. Determine unbalanced primary, secondary forces and couples in single and multi-cylinder engine.
4. Determine sensitiveness, isochronism, effort and power of porter and hartnell governors.
5. Determine gyroscopic couple and effects related to 2, 4 wheeler, plane disc, ship and aeroplanes.
6. Understand types of vibration, SHM and methods of finding natural frequencies of simple mechanical systems.
7. Determine equation of motion, natural frequency, damping factor, logarithmic decrement of damped free vibration (SDOF) systems.
8. Determine the natural frequency, force and motion transmissibility of single degree freedom systems.
9. Determine equation of motion of rotating and reciprocating unbalance systems, magnification factor, and transmissibility of forced vibration (SDOF) systems.

TEXT BOOKS:

1. Theory of Machines, Sadhu Singh, Pearson Education, 2nd Edition. 2007.
2. Mechanism and Machine Theory, A. G. Ambekar PHI, 2007
3. Mechanical Vibrations, V. P. Singh, DhanpatRai and Company,
4. Mechanical Vibrations, G. K.Grover, Nem Chand and Bros.

REFERENCE BOOKS

1. Theory of Machines, Rattan S.S. Tata McGraw Hill Publishing Company Ltd., New Delhi, 3rd Edition, 2009.
2. Mechanical Vibrations, S. S. Rao, Pearson Education Inc, 4edition, 2003.

TURBO MACHINES

B.E, VSemester, Mechanical Engineering
[As per Choice Based Credit System (CBCS) scheme]

Course Code	17ME53	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50(10 Hours per Module)**	**Exam Hours**	**03**
Credits – 04			

Course Objectives:

- **The course aims at giving an overview of different types of turbomachinery used for energy transformation, such as pumps, fans, compressors, as well as hydraulic and steam turbines.**
- **Explain the working principles of turbomachines and apply it to various types of machines**
- **It will focus on application of turbo machinery in power generation, power absorption and transportation sectors.**

Module - 1

Introduction: Definition of turbo machine, parts of turbo machines, Comparison with positive displacement machines, Classification, Dimensionless parameters and their significance, Effect of Reynolds number, Unit and specific quantities, model studies.

(Note: Since dimensional analysis is covered in Fluid Mechanics subject, questions on dimensional analysis may not be given. However, dimensional parameters and model studies may be given more weightage.)

Thermodynamics of fluid flow: Application of first and second law of thermodynamics to turbo machines, Efficiencies of turbo machines, Static and Stagnation states, Incompressible fluids and perfect gases, overall isentropic efficiency, stage efficiency (their comparison) and polytropic efficiency for both compression and expansion processes. Reheat factor for expansion process

Module - 2

Energy exchange in Turbo machines: Euler's turbine equation, Alternate form of Euler's turbine equation, Velocity triangles for different values of degree of reaction, Components of energy transfer, Degree of Reaction, utilization factor, Relation between degree of reaction and Utilization factor, Problems.

General Analysis of Turbo machines: Radial flow compressors and pumps – general analysis, Expression for degree of reaction, velocity triangles, Effect of blade discharge angle on energy transfer and degree of reaction, Effect of blade discharge angle on performance, Theoretical head – capacity relationship, General analysis of axial flow pumps and compressors, degree of reaction, velocity triangles, Problems.

Module - 3

Steam Turbines: Classification, Single stage impulse turbine, condition for maximum blade efficiency, stage efficiency, Need and methods of compounding, Multi-stage impulse turbine, expression for maximum utilization factor.

Reaction turbine – Parsons's turbine, condition for maximum utilization factor, reaction staging. Problems.

Module - 4

Hydraulic Turbines: Classification, various efficiencies.**Pelton turbine** – velocity triangles, design parameters, Maximum efficiency.

Francis turbine - velocity triangles, design parameters, runner shapes for different blade speeds. Draft tubes- Types and functions. **Kaplan and Propeller turbines** - velocity triangles, design parameters. Problems.

Module - 5

Centrifugal Pumps: Classification and parts of centrifugal pump, different heads and efficiencies of centrifugal pump, Minimum speed for starting the flow, Maximum suction lift, Net positive suction head, Cavitation, Need for priming, Pumps in series and parallel. Problems.

Centrifugal Compressors: Stage velocity triangles, slip factor, power input factor, Stage work, Pressure developed, stage efficiency and surging and problems. Axial flow Compressors: Expression for pressure ratio developed in a stage, work done factor, efficiencies and stalling. Problems.

Course outcomes:

- **Able to give precise definition of turbomachinery**
- **Identify various types of turbo machinery**
- **Apply the Euler's equation for turbomachinery to analyse energy transfer in turbomachines**
- **Understand the principle of operation of pumps, fans, compressors and turbines.**
- **Perform the preliminary design of turbomachines (pumps, rotary compressors and turbines)**
- **Analyze the performance of turbo machinery.**

TEXT BOOKS:

1. An Introduction to Energy Conversion, Volume III, Turbo machinery, V. Kadambi and Manohar Prasad, New Age International Publishers, reprint 2008.
2. Turbo Machines ,B.U.Pai , 1st Editions, Wiley India Pvt, Ltd.
3. Turbines, Compressors & Fans, S. M. Yahya, Tata McGraw Hill Co. Ltd., 2nd edition, 2002

REFERENCE BOOKS

1. Principals of Turbo machines, D. G. Shepherd, The Macmillan Company (1964).
2. Fluid Mechanics & Thermodynamics of Turbo machines, S. L. Dixon, Elsevier (2005).
3. Text Book of Turbo machines, M. S. Govindegouda and A. M. Nagaraj, M. M. Publications, 4Th Ed, 2008.

DESIGN OF MACHINE ELEMENTS – I
B.E, V Semester, Mechanical Engineering
[As per Choice Based Credit System (CBCS) scheme]

Course Code	17ME54	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50(10 Hours per Module)**	**Exam Hours**	**03**
Credits – 04			

Course Objectives:

1. **Able to understand mechanical design procedure, materials, codes and use of standards**
2. **Able to design machine components for static, impact and fatigue strength.**
3. **Able to design fasteners, shafts, joints, couplings, keys, threaded fasteners riveted joints, welded joints and power screws.**

Module - 1

Fundamentals of Mechanical Engineering Design

Mechanical engineering design, Phases of design process, Design considerations, Engineering Materials and their Mechanical properties,Standards and Codes, Factor of safety, Material selection.

Static Stresses: Static loads.Normal, Bending, Shear andCombinedstresses. Theories of failure. Stress concentration and determination of stress concentration factor.

Module - 2

Design for Impact and Fatigue Loads

Impact stress due to Axial, Bending and Torsional loads.

Fatigue failure: Endurance limit, S-N Diagram, Low cycle fatigue, High cycle fatigue, modifying factors: size effect, surface effect. Stress concentration effects, Notch sensitivity, fluctuating stresses, Goodman and Soderberg relationship, stresses due to combined loading, cumulative fatigue damage.

Module - 3

Design of Shafts, Joints, Couplings and Keys

Torsion of shafts, design for strength and rigidity with steady loading, ASME codes for power transmission shafting, shafts under combined loads. Design of Cotter and Knuckle joints, Rigid and flexible couplings, Flange coupling, Bush and Pin type coupling and Oldham's coupling. Design of keys-square, saddle, flat and father.

Module - 4

Riveted Joints and Weld Joints

Rivet types, rivet materials, failures of riveted joints, Joint Efficiency, Boiler Joints, Lozanze Joints, Riveted Brackets, eccentrically loaded joints.

Types of welded joints, Strength of butt and fillet welds, welded brackets with transverse and parallel fillet welds, eccentrically loaded welded joints.

Module - 5
Threaded Fasteners and Power Screws Stresses in threaded fasteners, Effect of initial tension, Design of threaded fasteners under static loads, Design of eccentrically loaded bolted joints. Types of power screws, efficiency and self-locking, Design of power screw, Design of screw jack: (Complete Design).
Course outcomes: **1. Describe the design process, choose materials.** **2. Apply the codes and standards in design process.** **3. Analyze the behavior of machine components under static, impact, fatigue loading using failure theories.** **4. Design shafts, joints, couplings.** **5. Design of riveted and welded joints.** **6. Design of threaded fasteners and power screws**
TEXT BOOKS: 1. Design of Machine Elements, V.B. Bhandari, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition 2007. 2. Mechanical Engineering Design, Joseph E Shigley and Charles R. Mischke. McGraw Hill International edition, 6th Edition, 2009.
Design Data Handbook: 1. Design Data Hand Book, K. Lingaiah, McGraw Hill, 2nd Ed. 2. Data Hand Book, K. Mahadevan and Balaveera Reddy, CBS Publication 3. Design Data Hand Book, S C Pilli and H. G. Patil, I. K. International Publisher, 2010.
REFERENCE BOOKS 1. Machine Design, Robert L. Norton, Pearson Education Asia, 2001. 2. Engineering Design, George E. Dieter, Linda C Schmidt, McGraw Hill Education, Indian Edition, 2013. 3. Design of Machined Elements, S C Pilli and H. G. Patil, I. K. International Publisher, 2017. 4. Machine Design, Hall, Holowenko, Laughlin (Schaum's Outline series) adapted by S.K Somani, tata McGraw Hill Publishing company Ltd., New Delhi, Special Indian Edition, 2008

REFRIGERATION AND AIR-CONDITIONING

B.E, V Semester, Mechanical Engineering

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17ME551	**CIE Marks**	**40**
Number of Lecture Hours/Week	**03**	**SEE Marks**	**60**
Total Number of Lecture Hours	**40(8Hours per Module)**	**Exam Hours**	**03**

Credits – 03

Course Objectives:

1. **Study the basic definition, ASHRAE Nomenclature for refrigerating systems**
2. **Understand the working principles and applications of different types of refrigeration systems**
3. **Study the working of air conditioning systems and their applications**
4. **Identify the performance parameters and their relations of an air conditioning system**

Module - 1

Introduction to Refrigeration –Basic Definitions, Heat pump and Refrigerating Machine, Best Refrigeration Cycle:The Carnot Principle, Gas as a Refrigerant in Reversed Carnot Cycle,Limitations of Reversed Carnot Cycle, Reversed Brayton or Bell Coleman Cycle, Application to Aircraft Refrigeration, Simple Numerical problems.

Industrial Refrigeration-Chemical and process industries, Dairy plants, Petroleum refineries, Food processing units.

Module - 2

Vapor Compression Refrigeration System(VCRS): Modifications in Reversed Carnot Cycle with Vapor as a refrigerant, Vapor Compression Cycle, Ewing's Construction, Actual Vapor Compression Cycle, Effect of Operating Conditions. Simple Numerical problems.

Multistage or Compound Compression, Multi-evaporator systems, Cascade Systems, – Methods like Flash Gas removal, Flash inter cooling and water Inter cooling.

Module - 3

Vapor Absorption Refrigeration Systems: Simple Vapor – Absorption System, Maximum Coefficient of Performance of a Heat Operated Refrigerating Machine, Absorbent – Refrigerant combinations, Water-Ammonia Systems,Practical problems, Lithium- Bromide System, Modifications to Simple Vapor-Absorption, Electrolux Refrigerator.

Other types of Refrigeration systems: (i) Steam-Jet refrigeration system and (ii) Thermoelectric refrigeration,(iii) pulse tube refrigeration, (iv)thermo acoustic refrigeration systems

Module - 4

Refrigerants: Primary and Secondary refrigerants, Designation of Refrigerants, Desirable properties of refrigerants, Selection of a Refrigerant, Ozone Depletion Potential and Global Warming Potential of CFC Refrigerants. Thermodynamic requirements, Comparison between different refrigerants, Substitutes for CFC refrigerants, Secondary Refrigerants.

Refrigeration systems Equipment: Compressors, Condensers, Expansion Devices and Evaporators, A brief look at other components of the system.

Module - 5

Air-Conditioning: Basic Processes in Conditioning of Air, Psychrometric Processes in Air-Conditioning Equipment, Simple Air-Conditioning /system and State and Mass Rate of Supply Air, Summer Air Conditioning, Winter Air Conditioning.

Loading Calculation and Applied Psychometrics : Preliminary Considerations, Internal Hear Gains, System Heat Gains, Break-up of Ventilation Load and Effective Sensible Heat Factor, Cooling Load Estimate. Psychrometric Calculations for Cooling, Selection of Air-Conditioning Apparatus for Cooling and Dehumidification, Building Requirements and Energy Conservation in Air Conditioned Buildings.

Transport air conditioning Systems:Air conditioning systems for automobiles (cars, buses etc.), Air conditioning systems for trains, Air conditioning systems for ships.

Course outcomes:

1. **Illustrate the principles, nomenclature and applications of refrigeration systems.**
2. **Explainvapor compression refrigeration system and identify methods for performance improvement**
3. **Study the working principles of air, vapor absorption, thermoelectric and steam-jet and thermo-acoustic refrigeration systems**
4. **Estimate the performance of air-conditioning systems using the principles of psychometry.**
5. **Compute and Interpret cooling and heating loads in an air-conditioning system**
6. **Identify suitable refrigerant for various refrigerating systems**

TEXT BOOKS:

1. Roy J. Dossat, Principles of Refrigeration, Wiley Limited
2. Arora C.P., Refrigeration and Air-conditioning, Tata Mc Graw –Hill, New Delhi, 2nd Edition, 2001.
3. Stoecker W.F., and Jones J.W., Refrigeration and Air-conditioning, Mc Graw - Hill, New Delhi 2nd edition, 1982.

REFERENCE BOOKS

1. Dossat,Principles of Refrigeration Pearson-2006.
2. McQuistion,Heating,Ventilation and Air Conditioning, Wiley Students edition,5th edition 2000.
3. PITA,Air conditioning 4rth edition, pearson-2005
4. Refrigeration and Air-Conditioning' by Manoharprasad
5. S C Arora& S Domkundwar, Refrigeration and Air-Conditioning DhanpatRai Publication
6. http://nptel.ac.in/courses/112105128/#

THEORY OF ELASTICITY
B.E, V Semester, Mechanical Engineering
[As per Choice Based Credit System (CBCS) scheme]

Course Code	17ME552	**CIE Marks**	**40**
Number of Lecture Hours/Week	**03**	**SEE Marks**	**60**
Total Number of Lecture Hours	**40 (8Hours per Module)**	**Exam Hours**	**03**
Credits – 03			

Course Objectives:

1. **To gain knowledge of stresses and strains in 3D and their relations and thermal stresses.**
2. **To understand the 2D analysis of elastic structural members.**
3. **To gain knowledge of thermal stresses and stability of columns**
4. **To analysis elastic members for the stresses and strains induced under direct loading conditions.**
5. **To analyse the axisymmetric and torsional members.**
6. **To analyse the thermal stresses induced in disks and cylinders.**
7. **To analyse the stability of columns**

Module - 1

Analysis of Stress: Definition and notation of stress, equations of equilibrium in differential form, stress components on an arbitrary plane, equality of cross shear, stress invariants, principal stresses,octahedral stress, planes of maximum shear, stress transformation, plane state of stress, Numerical problems

Module - 2

Analysis of Strain: Displacement field, strains in term of displacement field, infinitesimal strain at a point, engineering shear strains,strain invariants, principal strains, octahedral strains, plane state of strain, compatibility equations, strain transformation, Numerical Problems.

Module - 3

Two-Dimensional classical elasticity Problems: Cartesian co-ordinates - Relation between plane stress and plane strain, stress functions for plane stress and plane strain state, Airy's stress functions, Investigation of Airy's stress function for simple beams, bending of a narrow cantilever beam of rectangular cross section under edge load. Bending of simply supported beam under UDL.General equations in polar coordinates, stress distribution symmetrical about an axis, Thick wall cylinder subjected to internal and external pressures, Numerical Problems.

Module - 4

Axisymmetric and Torsion problems: Stresses in rotating discs of uniform thickness and cylinders. Torsion of circular, elliptical and triangular bars, Prandtl's membrane analogy,torsion of thin walled thin tubes, torsion of thin walled multiple cell closed sections. Numerical Problems

Module - 5
Thermal stress and Elastic stability: Thermo elastic stress strain relations, equations ofequilibrium,thermal stresses in thin circular discs and in long circularcylinders.Euler's column buckling load: clamped-free, clamped-hinged, clamped-clamped and pin-ended, Numerical Problems
Course outcomes: **1. Describe the state of stress and strain in 2D and 3D elastic members subjected to direct loads and thermal loads.** **2. Analyse the structural members: beam, rotating disks, columns.** **3. Analyse the torsional rigidity of circular and non-circular sections.** **4. Analyse the stability of columns.**
TEXT BOOKS: 1. Theory of Elasticity, S. P. Timoshenko and J. N Goodier, Mc. Graw, Hill International, 3rd Ed., 2010. 2. Theory of Elasticity, Dr. Sadhu Singh, Khanna Publications, 2004.
REFERENCE BOOKS 1.Advanced Mechanics of solids, L. S. Srinath, Tata Mc. Graw Hill,2009. 2. Theory of Elastic stability, Stephen P. Timoshenko, Mc Graw Hill, 2nd Ed, 2014.

HUMAN RESOURCE MANAGEMENT

B.E, V Semester, Mechanical Engineering

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17ME553	**CIE Marks**	**40**
Number of Lecture Hours/Week	**03**	**SEE Marks**	**60**
Total Number of Lecture Hours	**40 (8Hours per Module)**	**Exam Hours**	**03**
Credits – 03			

Course Objectives:

1. **To develop a meaningful understanding of HRM theory, functions and practices.**
2. **To apply HRM concepts and skills across various types of organizations**.

Module - 1

Human Resource Management

Introduction, meaning, nature, scope of HRM. Importance and Evolution of the concept of HRM. Major functions of HRM, Principles of HRM, Organization of Personnel department, Role of HR Manager.

Job Analysis: Meaning, process of job analysis, methods of collecting job analysis data, Job Description and Specification, Role Analysis.

Module - 2

Human Resource Planning: Objectives, Importance and process of Human Resource planning, Effective HRP
Recruitment: Definition, Constraints and Challenges, Sources and Methods of Recruitment, New Approaches to recruitment.
Selection: Definition and Process of Selection.

Module - 3

Placement: Meaning, Induction/Orientation, Internal Mobility, Transfer, Promotion, Demotion and Employee Separation.
Training and development: Training v/s development, Training v/s Education, Systematic Approach to Training, Training Methods, Executive Development, Methods and Development of Management Development, Career and Succession Planning.

Module - 4

Performance Appraisal: Concept of Performance Appraisal, the Performance Appraisal process, Methods of Performance Appraisal, Essential Characteristic of an Effective Appraisal System.
Compensation: Objectives of Compensation Planning, Job Evaluation, Compensation Pay Structure in India, Wage and Salary Administration, Factors Influencing Compensation Levels, Executive Compensation.

Employee Welfare: Introduction, Types of Welfare Facilities and Statutory Provisions.
Employee Grievances: Employee Grievance procedure, Grievances management in Indian Industry.
Discipline: Meaning, approaches to discipline, essential of a good disciplinary system, managing difficult employees.

Course outcomes:

1. **Understand the importance, functions and principles Human Resource Management and process of Job analysis**
2. **Summarize the objectives of Human Resource planning, Recruitment and selection process**
3. **Understand the process involved in Placement, Training and development activities.**
4. **Understand the characteristics of an effective appraisal system and compensation planning.**
5. **Understand the issues related to employee welfare, grievances and discipline.**

TEXT BOOKS:

1. Human Resource Management- Rao V.S.P, Excel books, 2010
2. Human Resource Management- Cynthia D. Fisher, 3/e, AIPD, Chennai
3. Human Resource Management: A South Asian Perspective, Snell, Bohlander&Vohra, 16th Rep., Cengage Learning, 2012
4. Human Resource Management- Lawrence S Kleeman, Biztantra, 2012
5. Human Resource Management- Aswathappa K, HPH

REFERENCE BOOKS

1. Human Resource Management- John M. Ivancevich, 10/e, McGraw Hill.
2. Human Resource Management in Practice- Srinivas R. Kandulla, PHI
3. Human Resource Management- Luis R Gomez-Mejia, David B. Balkin, Robert L Cardy, 6/e, PHI, 2010

NON TRADITIONAL MACHINING

B.E, V Semester, Mechanical Engineering

[As per Choice Based Credit System (CBCS) scheme]

Course Code	**17ME554**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**03**	**SEE Marks**	**60**
Total Number of Lecture Hours	**40 (8Hours per Module)**	**Exam Hours**	**03**

Credits – 03

Module - 1

INTRODUCTION

Introduction to Non-traditional machining, Need for Non-traditional machining process, Comparison between traditional and non-traditional machining, general classification Non-traditional machining processes, classification based on nature of energy employed in machining, selection of non-traditional machining processes, Specific advantages, limitations and applications of non-traditional machining processes.

Module - 2

Ultrasonic Machining (USM): Introduction, Equipment and material process, Effect of process parameters: Effect of amplitude and frequency, Effect of abrasive grain diameter, effect of slurry, tool & work material. Process characteristics: Material removal rate, tool wear, accuracy, surface finish, applications, advantages & limitations of USM.

Abrasive Jet Machining (AJM): Introduction, Equipment and process of material removal, process variables: carrier gas, type of abrasive, work material, stand-off distance (SOD).Process characteristics-Material removal rate, Nozzle wear, accuracy & surface finish.Applications, advantages & limitations of AJM.

Water Jet Machining (WJM): Equipment & process, Operation, applications, advantages and limitations of WJM.

Module - 3

ELECTROCHEMICAL MACHINING (ECM)

Introduction, Principle of electro chemical machining: ECM equipment, elements of ECM operation, Chemistry of ECM. ECM Process characteristics: Material removal rate, accuracy, surface finish.

Process parameters: Current density, Tool feed rate, Gap between tool & work piece, velocity of electrolyte flow, type of electrolyte, its concentration temperature, and choice of electrolytes. ECM Tooling: ECM tooling technique & example, Tool & insulation materials.

Applications ECM: Electrochemical grinding and electrochemical honing process. Advantages, disadvantages and application of ECG, ECH.

CHEMICAL MACHINING (CHM)

Elements of the process: Resists (maskants), Etchants. Types of chemical machining process-chemical blanking process, chemical milling process.

Process characteristics of CHM: material removal rate, accuracy, surface finish, advantages, limitations and applications of chemical machining process.

Module - 4

ELECTRICAL DISCHARGE MACHINING (EDM)

Introduction, mechanism of metal removal, EDM equipment: spark erosion generator (relaxation type), dielectric medium-its functions & desirable properties, electrode feed control system. Flushing types; pressure flushing, suction flushing, side flushing, pulsed flushing. EDM process parameters: Spark frequency, current & spark gap, surface finish, Heat Affected Zone. Advantages, limitations & applications of EDM, Electrical discharge grinding, Traveling wire EDM.

PLASMA ARC MACHINING (PAM)

Introduction, non-thermal generation of plasma, equipment mechanism of metal removal, Plasma torch, process parameters, process characteristics. Safety precautions. Safety precautions, applications, advantages and limitations.

Module - 5

LASER BEAM MACHINING (LBM)

Introduction, generation of LASER, Equipment and mechanism of metal removal, LBM parameters and characteristics, Applications, Advantages & limitations.

ELECTRON BEAM MACHINING (EBM)

Introduction, Principle, equipment and mechanism of metal removal, applications, advantages and limitations.

Course outcomes:

1. **Understand the compare traditional and non-traditional machining processand recognize the need for Non-traditional machining process.**
2. **Understand the constructional features, performance parameters, process characteristics, applications, advantages and limitations of USM, AJM and WJM.**
3. **Identify the need of Chemical and electro-chemical machining process along with the constructional features, process parameters, process characteristics, applications, advantages and limitations.**
4. **Understand the constructional feature of the equipment, process parameters, process characteristics, applications, advantages and limitations EDM & PAM.**
5. **Understand the LBM equipment, LBM parameters, and characteristics. EBM equipment and mechanism of metal removal, applications, advantages and limitations LBM & EBM.**

TEXT BOOKS:

1. Modern Machining Process by P.C Pandey and H S Shah, McGraw Hill Education India Pvt. Ltd. 2000
2. Production technology, HMT, McGraw Hill Education India Pvt. Ltd. 2001

REFERENCE BOOKS

1. New Technology, Dr. Amitabha Bhattacharyya, The Institute of Engineers (India), 2000
2. Modern Machining process, Aditya, 2002.

OPTIMIZATION TECHNIQUES

B.E, V Semester, Mechanical Engineering

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17ME561	**CIE Marks**	**40**
Number of Lecture Hours/Week	**03**	**SEE Marks**	**60**
Total Number of Lecture Hours	**40 (8Hours per Module)**	**Exam Hours**	**03**

Credits – 03

Course Objective:

The general objectives of the course is to:

1. **Introduce the fundamental concepts of Optimization Techniques;**
2. **Make the learners aware of the importance of optimizations in real scenarios;**
3. **Provide the concepts of various classical and modern methods of for constrained and unconstrained problems in both single and multivariable.**

Module - 1

Introduction to Classical Optimization Techniques

Statement of an Optimization problem – design vector – design constraints – constraint surface – objective function – objective function surfaces – classification of Optimization problems.

Classical Optimization Techniques

Single variable Optimization, Multi variable Optimization with and without constraints,Multivariable Optimization with equality constraints - solution by method of Lagrange multipliers, Multivariable Optimization with inequality constraints - Kuhn – Tucker conditions. .

Module - 2

Linear Programming

Various definitions, statements of basic theorems and properties, Advantages, Limitations and Application areas of Linear Programming, Graphical method of Linear Programming problem.

Simplex Method – Phase I and Phase II of the Simplex Method, The Revised Simplex method, Primal and Dual Simplex Method, Big –M method.

Module - 3

Transportation Problem

Finding initial basic feasible solution by north – west corner rule, least cost method and Vogel's approximation method – testing for optimality of balanced transportation problems. (Including assignment and travelling salesman problems) (No degeneracy problems)

Queuing

Queuing Models : Essential features of queuing systems, operating characteristics of queuing system, probability distribution in queuing systems, classification of queuing models, solution of queuing M/M/1 : ∞ /FCFS,M/M/1 : N/FCFS, M/M/C : ∞/FCFS, M/M/C : N/FCFS.

Module - 4

Dynamic Programming

Dynamic programming multistage decision processes – types – concept of sub optimization and the principle of optimality – computational procedure in dynamic programming – examples illustrating the calculus method of solution - examples illustrating the tabular method of solution.

Integer Programming

Pure and mixed integer programming problems, Solution of Integer programming problems – Gomory's all integer cutting plane method and mixed integer method, branch and bound method, Zero-one programming.

Module - 5

Simulation Modeling

Introduction, Definition and types, Limitations, Various phases of modeling, Monte Carlo method, Applications, advantages and limitations of simulation

Course outcomes:

1. **Understand the overview of optimization techniques, concepts of design space, constraint surfaces and objective function.**
2. **Review differential calculus in finding the maxima and minima of functions of several variables.**
3. **Formulate real-life problems with Linear Programming.**
4. **Solve the Linear Programming models using graphical and simplex methods.**
5. **Formulate real-life transportation, assignment and travelling salesman problems to find the optimum solution using transportation algorithms**
6. **Analyze the Queuing model for effective customer satisfaction**
7. **Apply dynamic programming to optimize multi stage decision problems.**
8. **Determine the level of inventory that a business must maintain to ensure smooth operation.**
9. **Construct precedence diagram for series of activities in a huge project to find out probability of expected completion time using PERT-CPM networks. Also reduce the duration of project by method of crashing.**

TEXT BOOKS:

1. Engineering optimization: Theory and practice"-by S.S.Rao, New Age International (P) Limited.
2. Operations Research: An Introduction" by H A Taha, 5th Edition, Macmillan, New York.
3. Operations Research by NVR Naidu, G Rajendra, T Krishna Rao, I K International Publishing house, New Delhi.

REFERENCE BOOKS

1. Optimization Methods in Operations Research and systems Analysis" – by K.V. Mittal and C. Mohan, New Age, International (P) Limited, Publishers
2. Operations Research – by S.D.Sharma, KedarnathRamanath& Co
3. Linear programming, G. Hadley, Narosa Publishing House, New Delhi.
4. Industrial Engineering and Production Management, M. Mahajan, DhanpatRai& co

ENERGY AND ENVIRONMENT

B.E, V Semester, Mechanical Engineering

[As per Choice Based Credit System (CBCS) scheme]

Course Code	**17ME562**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**03**	**SEE Marks**	**60**
Total Number of Lecture Hours	**40 (8Hours per Module)**	**Exam Hours**	**03**

Credits – 03

Course Objective:

1. **Understand energy scenario, energy sources and their utilization**
2. **Learn about methods of energy storage, energy management and economic analysis**
3. **Have proper awareness about environment and eco system.**
4. **Understand the environment pollution along with social issues and acts.**

Module - 1

Basic Introduction to Energy: Energy and power, forms of energy,primary energy sources, energy flows, world energy production and consumption,Key energy trends in India:Demand, Electricity, Access to modern energy, Energy production and trade, Factors affecting India's energy development:Economy and demographics Policy and institutional framework, Energy prices and affordability, Social and environmental aspects, Investment..

Module - 2

Energy storage systems: Thermal energy storage methods, Energy saving, Thermal energy storage systems
Energy Management: Principles of Energy Management, Energy demand estimation, Energy pricing
Energy Audit: Purpose, Methodology with respect to process Industries, Characteristic method employed in Certain Energy Intensive Industries
Economic Analysis: Scope, Characterization of an Investment Project

Module - 3

Environment: Introduction, Multidisciplinary nature of environmental studies- Definition, scope and importance, Need for public awareness.
Ecosystem: Concept, Energy flow, Structure and function of an ecosystem. Food chains, food webs and ecological pyramids, Forest ecosystem, Grassland ecosystem, Desert ecosystem and Aquatic ecosystems, Ecological succession.

Module - 4

Environmental Pollution: Definition, Cause, effects and control measures of - Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution and Nuclear hazards , Solid waste Management, Disaster management Role of an individual in prevention of pollution, Pollution case studies.

Module - 5

Social Issues and the Environment: Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies. Wasteland reclamation, Consumerism and waste products, Environment Protection Act, Air (Prevention and Control of Pollution) Act,

Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation.

Course outcomes:

1. **Summarize the basic concepts of energy, its distribution and general Scenario.**
2. **Explain different energy storage systems, energy management, audit and economic analysis.**
3. **Summarize the environment eco system and its need for awareness.**
4. **Identify the various types of environment pollution and their effects.**
5. **Discuss the social issues of the environment with associated acts.**

TEXT BOOKS:

1. Textbook for Environmental Studies For Undergraduate Courses of all Branches of Higher Education by University grant commission and BharathiVidyapeeth Institute of environment education and Research ,Pune
2. De, B. K., Energy Management audit & Conservation, 2nd Edition, Vrinda Publication, 2010.

REFERENCE BOOKS

1. Turner, W. C., Doty, S. and Truner, W. C., Energy Management Hand book, 7th edition, Fairmont Press, 2009.
2. Murphy, W. R., Energy Management, Elsevier, 2007.
3. Smith, C. B., Energy Management Principles, Pergamum, 2007
4. Environment pollution control Engineering by C S Rao, New Age International, 2006, reprint 2015, 2nd edition.
5. Environmental studies, by Benny Joseph, Tata McGraw Hill, 2008, 2nd edition.

AUTOMATION & ROBOTICS
B.E, V Semester, Mechanical Engineering
[As per Choice Based Credit System (CBCS) scheme]

Course Code	**17ME563**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**03**	**SEE Marks**	**60**
Total Number of Lecture Hours	**40 (8Hours per Module)**	**Exam Hours**	**03**
Credits – 03			

Course Objective:

- To identify potential areas for automation and justify need for automation.
- To select suitable major control components required to automate a process or an activity
- To study the various parts of robots and fields of robotics.
- To study the various kinematics and inverse kinematics of robots.
- To study the control of robots for some specific applications.

Module - 1

Introduction to automation

Basic elements of an automated system, advanced automation functions, levels of automation, process industries versus discrete manufacturing industries, continuous versus discrete control, computer process control. Hardware components for automation and process control, sensors, actuators, analog to digital converters, digital to analog converters, input/output devices for discrete data

Module - 2

Automated production lines

Fundamentals of automated production lines, application of automated production lines, analysis of transfer lines, automated assembly systems, fundamentals of automated assembly systems, quantitative analysis of assembly systems, automatic identification methods, barcode technology, radio frequency identification, other AIDC technologies

Module - 3

Industrial Robotics

Robotic configuration, robot anatomy and related attributes, robot control systems, end effectors, sensors in robotics, industrial robot applications, robot accuracy and repeatability, different types of robotics, various generations of robots, degrees of freedom – Asimov's laws of robotics dynamic stabilization of robots.

Module - 4

Spatial descriptions and transformations

Positions, orientations, and frames. Mappings: Changing descriptions from frame to frame. Operators: translations, rotations and transformations, transformation arithmetic transform equations, transformation of free vectors computational considerations, manipulator Kinematics, link description, link-connection description, actuator space joint space and Cartesian space

Module - 5

Robot programming

Introduction, levels of robot programming, requirements of robot programming language, problems pertaining to robot programming languages, offline programming systems, central issues in OLP systems, automating subtasks in OLP systems, simple programs on robot applications

TEXT BOOKS:

1. Automation, Production systems, and computer integrated manufacturing-MikellP.Groover 3rd edition, Pearson 2009
2. Industrial Robotics-Groover, Weiss, Nagel, McGraw Hill International, 2nd edition, 2012

REFERENCE BOOKS

1. Robotics for Engineers –YoramKoren, McGraw Hill International, 1st edition, 1985.
2. Robotic Engineering - An Integrated approach, Klafter, Chmielewski and Negin, PHI, 1st edition, 2009.
3. An Introduction to Automated Process Planning Systems- Tiess Chiu Chang & Richard A. Wysk

PROJECT MANAGEMENT

B.E, V Semester, Mechanical Engineering

[As per Choice Based Credit System (CBCS) scheme]

Course Code	**17ME564**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**03**	**SEE Marks**	**60**
Total Number of Lecture Hours	**40 (8Hours per Module)**	**Exam Hours**	**03**

Credits – 03

Module - 1

Introduction: Definition of project, characteristics of projects, understandprojects, types of projects, scalability of project tools, project roles

Project Selection And Prioritization – Strategic planning process, Strategicanalysis, strategic objectives, portfolio alignment – identifying potentialprojects, methods of selecting projects, financial mode / scoring models toselect projects, prioritizing projects, securing and negotiating projects.

Module - 2

Planning Projects: Defining the project scope, Project scope checklist, Project priorities, Work Breakdown Structure (WBS), Integrating WBS with organisation, coding the WBS for the information system.

Scheduling Projects: Purpose of a project schedule, historical development,how project schedules are limited and created, develop project schedules,uncertainty in project schedules, Gantt chart.

Module - 3

Resourcing Projects: Abilities needed when resourcing projects, estimateresource needs, creating staffing management plant, project teamcomposition issues, Budgeting Projects: Cost planning, cost estimating, cost budgeting, establishing cost control.

Project Risk Planning: Risk Management Planning, risk identification, riskanalysis, risk response planning, Project Quality Planning and ProjectKickoff: Development of quality concepts, project quality management plan, project quality tools, kickoff project, baseline and communicate projectmanagement plan, using Microsoft Project for project baselines.

Module - 4

Performing Projects: Project supply chain management: - Plan purchasingand acquisitions, plan contracting, contact types, project partnering andcollaborations, project supply chain management.

Project Progress and Results: Project Balanced ScorecardApproach, Internal project, customer, financial issues, Finishing the project: Terminateproject early, finish projects on time, secure customer feedback and approval,knowledge management, perform administrative and contract closure.

Module - 5
Network Analysis Introduction, network construction - rules, Fulkerson's rule for numbering the events, AON and AOA diagrams; Critical path method (CPM) to find the expected completion time of a project, floats; PERTfor finding expected duration of an activity and project, determining the probability of completing a project, predicting the completion time of project; crashing of simple projects.
Course Outcomes **On completion of the course the student will be able to** **1. Understand the selection, prioritization and initiation of individual projects and strategic role of project management.** **2. Understand the work breakdown structure by integrating it with organization.** **3. Understand the scheduling and uncertainty in projects.** **4. Students will be able to understand risk management planning using project quality tools.** **5. Understand the activities like purchasing, acquisitions, contracting, partnering and collaborations related to performing projects.** **6. Determine project progress and results through balanced scorecard approach** **7. Draw the network diagram to calculate the duration of the project and reduce it using crashing.**
TEXT BOOKS: 1. Project Management, Timothy J Kloppenborg, Cengage Learning, Edition 2009. 2. Project Management, A systems approach to planning scheduling and controlling by Harold kerzner, CBS publication. Project Management by S Choudhury, Mc Graw Hill Education (India) Pvt. Ltd. New Delhi, 2016
REFERENCE BOOKS 1. Project Management, Pennington Lawrence, Mc Graw hill 2. Project Management, AModer Joseph and Phillips New Yark Van Nostrand, Reinhold. 3. Project Management,Bhavesh M. Patal, Vikas publishing House,

FLUID MECHANICS & MACHINERY LAB

B.E, V Semester, Mechanical Engineering

[As per Choice Based Credit System (CBCS) scheme]

Course Code	**17MEL57**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**03 (1 Hour Instruction+ 2 Hours Laboratory)**	**SEE Marks**	**60**
RBT Levels	**L1, L2, L3**	**Exam Hours**	**03**
Credits – 02			

Course Objectives:

1. **This course will provide a basic understanding of flow measurements usingvarious types of flow measuring devices, calibration and losses associated with these devices.**
2. **Energy conversion principles, analysis and understanding of hydraulic turbines and pumps will be discussed. Application of these concepts for these machines will be demonstrated. Performance analysis will be carried out using characteristic curves.**

PART A

1. Lab layout, calibration of instruments and standards to be discussed
2. Determination of coefficient of friction of flow in a pipe.
3. Determination of minor losses in flow through pipes.
4. Application of momentum equation for determination of coefficient of impact of jets on flat and curved blades
5. Calibration of flow measuring devices.
6. Orifice meter
    - Nozzle
    - Venturimeter
    - V-notch

PART B

1. Performance on hydraulic Turbines
    a. Pelton wheel
    b. Francis Turbine
    c. Kaplan Turbines

2. Performance hydraulic Pumps
    a. Single stage and Multi stage centrifugal pumps
    b. Reciprocating pump
3. Performance test on a two stage Reciprocating Air Compressor
4. Performance test on an Air Blower

PART C(Optional)

1. Visit to Hydraulic Power station/ Municipal Water Pump House and Case Studies
2. Demonstration of cut section models of Hydraulic turbines and Pumps.

Course outcomes:

- **Perform experiments to determine the coefficient of discharge of flow measuring devices.**
- **Conduct experiments on hydraulic turbines and pumps to draw characteristics.**
- **Test basic performance parameters of hydraulic turbines and pumps and execute the knowledge in real life situations.**
- **Determine the energy flow pattern through the hydraulic turbines and pumps**
- **Exhibit his competency towards preventive maintenance of hydraulic machines**
-

Reading:

1. K.L.Kumar."Engineering Fluid Mechanics" Experiments, Eurasia Publishing House, 1997
2. JagdishLal, Hydraulic Machines, Metropolitan Book Co, Delhi, 1995
3.George E. Totten , Victor J. De Negri "Handbook of Hydraulic Fluid Technology, Second Edition, 2011.

Scheme of Examination:

ONE question from part -A: 50 Marks
ONE question from part -B: 30 Marks
Viva –Voice : 20 Marks
Total: 100 Marks

ENERGY LAB

B.E, V Semester, Mechanical Engineering

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17MEL58	**CIE Marks**	**40**
Number of Lecture Hours/Week	**03 (1 Hour Instruction+ 2 Hours Laboratory)**	**SEE Marks**	**60**
Total hours	**50**	**Exam Hours**	**03**
Credits – 02			

Course Objectives:

1. **This course will provide a basic understanding of fuel properties and its measurements using various types of measuring devices**
2. **Energy conversion principles, analysis and understanding of I C Engines will be discussed. Application of these concepts for these machines will be demonstrated. Performance analysis will be carried out using characteristic curves.**
3. **Exhaust emissions of I C Engines will be measured and compared with the standards.**

PART A

1. Lab layout, calibration of instruments and standards to be discussed
2. Determination of Flash point and Fire point of lubricating oil using Abel Pensky and Marten's (closed) / Cleveland's (Open Cup) Apparatus.
3. Determination of Calorific value of solid, liquid and gaseous fuels.
4. Determination of Viscosity of a lubricating oil using Redwoods, Sayboltand Torsion Viscometers.
5. Analysis of moisture, volatile matter, ash content and fixed carbon of solid and liquid fuel samples
6. Valve Timing/port opening diagram of an I.C. Engine.

PART B

1. Performance Tests on I.C. Engines, Calculations of IP, BP, Thermal efficiency, Volumetric efficiency, Mechanical efficiency, SFC, FP, A:F Ratio, heat balance sheet for
    a. Four stroke Diesel Engine
    b. Four stroke Petrol Engine
    c. Multi Cylinder Diesel/Petrol Engine, (Morse test)
    d. Two stroke Petrol Engine
    e. Variable Compression Ratio I.C. Engine.
2. Measurements of Exhaust Emissions of Petrol engine.
3. Measurements of Exhaust Emissions of Diesel engine.

4. Demonstration of $p\theta$, pV plots usingComputerized IC engine test rig

PART C(Optional)

1. Visit to Automobile Industry/service stations.
2. CFD Analysis of design, development, performance evaluation and process optimization in I C Engines.

Course outcomes:

- **Perform experiments to determine the properties of fuels and oils.**
- **Conduct experiments on engines and draw characteristics.**
- **Test basic performance parameters of I.C. Engine and implement the knowledge in industry.**
- **Identify exhaust emission, factors affecting them and report the remedies.**
- **Determine the energy flow pattern through the I C Engine**
- **Exhibit his competency towards preventive maintenance of IC engines.**

1. E.F.Obert, Internal combustion engines and air pollution intext educational publishers (1973). John Heywood, Internal combustion engine fundamentals, McGraw- Hill (1988) - USA.
2. Colin R Ferguson and Allan T. Kirkpatrick Internal combustion engines Applied Thermodynamics, John Wiley & sons – 2001.
3. Richard stone, Introduction to internal combustion engines, MacMillan (1992) – USA
4. M. L. MathurAnd R.P. Sharma A course in internal combustion engines, DhanpatRai& sons- India.
5. C. F. Taylor The internal combustion engines in theory and practice, 2 vols. by:, pub.: Wily.
6. C. F. Taylor The internal combustion engines in theory and practice, 2 vols. by:, pub.: Wily.
7. Ganesan, V., Fundamentals of IC Engines, Tata McGraw Hill, 2003
8. Bosch, Automotive hand book, 9th edition.

Scheme of Examination:
ONE question from part -A: 50 Marks
ONE question from part -B: 30 Marks
Viva –Voice : 20 Marks
Total: 100 Marks