### B.E. Mechanical Engineering

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Subject Code</th>
<th>Title</th>
<th>Lecture</th>
<th>Tutorial</th>
<th>Practical</th>
<th>Duration (Hours)</th>
<th>Theory/ Practical Marks</th>
<th>I.A. Marks</th>
<th>Total Marks</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15ME51</td>
<td>Management and Engineering Economics</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>03</td>
<td>80</td>
<td>20</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>15ME52</td>
<td>Dynamics of Machinery</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>03</td>
<td>80</td>
<td>20</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>15ME53</td>
<td>Turbo Machines</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>03</td>
<td>80</td>
<td>20</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>15ME54</td>
<td>Design of Machine Elements - I</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>03</td>
<td>80</td>
<td>20</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>15ME55X</td>
<td>Professional Elective-I</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>03</td>
<td>80</td>
<td>20</td>
<td>100</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>15ME56X</td>
<td>Open Elective-I</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>03</td>
<td>80</td>
<td>20</td>
<td>100</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>15MEL57</td>
<td>Fluid Mechanics &amp; Machinery Lab</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>03</td>
<td>80</td>
<td>20</td>
<td>100</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>15MEL58</td>
<td>Energy Lab</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>03</td>
<td>80</td>
<td>20</td>
<td>100</td>
<td>2</td>
</tr>
</tbody>
</table>

**TOTAL** | 21       | 06        | 04        | 640       | 160       | 800       | 26       |

<table>
<thead>
<tr>
<th>Professional Elective-I</th>
<th>Open Elective-I</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>15ME551</td>
<td>Refrigeration and Air-conditioning</td>
<td>15ME561</td>
<td>Optimization Techniques</td>
</tr>
<tr>
<td>15ME552</td>
<td>Theory of Elasticity</td>
<td>15ME562</td>
<td>Energy and Environment</td>
</tr>
<tr>
<td>15ME553</td>
<td>Human Resource Management</td>
<td>15ME563</td>
<td>Automation and Robotics</td>
</tr>
<tr>
<td>15ME554</td>
<td>Non Traditional Machining</td>
<td>15ME564</td>
<td>Project Management</td>
</tr>
</tbody>
</table>

**1. Core subject:** This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.

**2. Professional Elective:** Elective relevant to chosen specialization/branch

**3. OpenElective:** Electives from other technical and/or emerging subject areas.
MANAGEMENT AND ENGINEERING ECONOMICS

<table>
<thead>
<tr>
<th>Course</th>
<th>Code</th>
<th>Credits</th>
<th>L-T-P</th>
<th>Assessment</th>
<th>Exam Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management And Engineering Economics</td>
<td>15ME51</td>
<td>04</td>
<td>3-2-0</td>
<td>80 20</td>
<td>3Hrs</td>
</tr>
</tbody>
</table>

MODULE – 1


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. 10 Hours

MODULE - 2


Directing & Controlling: Meaning and nature of directing Leadership styles, 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) 10 Hours

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 10 Hours
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

**10 Hours**

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.

**10 Hours**

**Course outcomes**

On completion of this subject students will be able to
1. Understand needs, functions, roles, scope and evolution of Management
2. Understand importance, purpose of Planning and hierarchy of planning and also analyze its types
3. Discuss Decision making, Organizing, Staffing, Directing and Controlling
4. Select the best economic model from various available alternatives
5. Understand various interest rate methods and implement the suitable one.
6. Estimate various depreciation values of commodities
7. Prepare the project reports effectively.

**TEXT BOOKS**

1. Principles of Management by Tripathy and Reddy

**REFERENCE BOOKS**

3. Engineering Economics, R.Paneerselvam, PHI publication
6. Modern Economic Theory, By Dr. K. K. Dewett & M. H. Navalur, S. Chand Publications
DYNAMICS OF MACHINERY

<table>
<thead>
<tr>
<th>Course</th>
<th>Code</th>
<th>Credits</th>
<th>L-T-P</th>
<th>Assessment</th>
<th>Exam Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dynamics of Machinery</td>
<td>15ME52</td>
<td>04</td>
<td>3-2-0</td>
<td>80</td>
<td>20</td>
</tr>
</tbody>
</table>

Course Objectives
1. To gain the knowledge static and dynamic equilibrium conditions of mechanisms subjected forces and couple, with and without friction.
2. Analyse the mechanisms for static and dynamic equilibrium.
3. To understand the balancing principles of rotating and reciprocating masses, governors and gyroscopes.
4. Analyse the balancing of rotating and reciprocating masses, governors and gyroscopes.
5. To understand vibrations characteristics of single degree of freedom systems.
6. Characterise 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. 10 Hours

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. 10 Hours

MODULE 3
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. 10 Hours

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. 10 Hours
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
On completing the course the student will be able to
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:
3. Mechanical Vibrations, V. P. Singh, Dhanpat Rai and Company,

Reference Books:
TURBO MACHINES

<table>
<thead>
<tr>
<th>Course</th>
<th>Code</th>
<th>Credits</th>
<th>L-T-P</th>
<th>Assessment</th>
<th>Exam Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbo Machines</td>
<td>15ME53</td>
<td>04</td>
<td>3-2-0</td>
<td>80 SEE 20</td>
<td>3Hrs</td>
</tr>
</tbody>
</table>

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

(10 Hours)

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.

(10 Hours)

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.

(10 Hours)
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:

REFERENCE BOOKS:
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 and Combined stresses. Stress concentration and determination of stress concentration factor.
10 Hours

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.
10 Hours

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.
10 Hours
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.  
10 Hours

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).  
10 Hours

**Course outcomes**
On completion of the course the student will be able to
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:**

**Design Data Handbook:**
2. Data Hand Book, K. Mahadevan and Balaveera Reddy, CBS Publication

**Reference Books:**
REFRIGERATION AND AIR-CONDITIONING
(Professional Elective-I)

<table>
<thead>
<tr>
<th>Course</th>
<th>Code</th>
<th>Credits</th>
<th>L-T-P</th>
<th>Assessment</th>
<th>Exam Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refrigeration And Air-Conditioning</td>
<td>15ME551</td>
<td>03</td>
<td>3-0-0</td>
<td>80</td>
<td>20</td>
</tr>
</tbody>
</table>

Pre-requisites: Basic and Applied Thermodynamics

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 – I

Industrial Refrigeration - Chemical and process industries, Dairy plants, Petroleum refineries, Food processing and food chain, Miscellaneous

Module – II

10 Hours

Module – III

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

8 Hours

Module – IV
Refrigerants: Primary and secondary refrigerants, Designation of Refrigerants, Desirable properties of refrigerants including solubility in water and lubricating oil, material compatibility, toxicity, flammability, leak detection, cost, environment and performance issues Thermodynamic properties of refrigerants, Synthetic and natural refrigerants, Comparison between different refrigerants vis a vis applications, Special issues and practical implications Refrigerant mixtures – zeotropic and azeotropic mixtures
Refrigeration systems Equipment: Compressors, Condensers, Expansion Devices and Evaporators. A brief look at other components of the system.

8 Hours

Module – V


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

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

1. Illustrate the principles, nomenclature and applications of refrigeration systems.
2. Explain vapour compression refrigeration system and identify methods for performance improvement
3. Study the working principles of air, vapour 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

REFERENCE BOOKS
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/#

Data Book:

E- Learning
• VTU, E- learning, MOOCS, Open courseware
THEORY OF ELASTICITY
(Professional Elective-I)

<table>
<thead>
<tr>
<th>Course</th>
<th>Code</th>
<th>Credits</th>
<th>L-T-P</th>
<th>Assessment</th>
<th>Exam Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory of Elasticity</td>
<td>15ME552</td>
<td>03</td>
<td>3-0-0</td>
<td>80</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3Hrs</td>
<td></td>
</tr>
</tbody>
</table>

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 analyse 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
8 Hours

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
8 Hours

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
10 Hours

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
8 Hours
Module -5

**Thermal stress and Elastic stability:** Thermo elastic stress strain relations, equations of equilibrium, thermal stresses in thin circular discs and in long circular cylinders. Euler’s column buckling load: clamped-free, clamped-hinged, clamped-clamped and pin-ended, Numerical Problems

8 Hours

**Course outcomes**
At the end of course student able to:
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:**

**References Books:**
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.
Module – 5


**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**
On completion of the course the student will be able to

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.

**TEXTBOOKS**


**REFERENCE BOOKS**

NON TRADITIONAL MACHINING  
(Professional Elective-I)

<table>
<thead>
<tr>
<th>Course</th>
<th>Code</th>
<th>Credits</th>
<th>L-T-P</th>
<th>Assessment</th>
<th>Exam Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non Traditional Machining</td>
<td>15ME554</td>
<td>03</td>
<td>3-0-0</td>
<td>80 20</td>
<td>3Hrs</td>
</tr>
</tbody>
</table>

**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.  

08 hours

**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.  


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

08 hours

**MODULE 3**

**ELECTROCHEMICAL MACHINING (ECM)**

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
On completion of the course, the students will be able to
1. Understand the compare traditional and non-traditional machining process and 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:

Reference Books
1. New Technology, Dr. Amitabha Bhattacharyya, The Institute of Engineers (India), 2000
**OPTIMIZATION TECHNIQUES**
*(OPEN ELECTIVE – I)*

<table>
<thead>
<tr>
<th>Course</th>
<th>Code</th>
<th>Credits</th>
<th>L-T-P</th>
<th>Assessment</th>
<th>Exam Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimization Techniques</td>
<td>15ME561</td>
<td>03</td>
<td>3-0-0</td>
<td>80 20</td>
<td>3Hrs</td>
</tr>
</tbody>
</table>

**COURSE OBJECTIVES**

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 I**

*Introduction to Classical Optimization Techniques*


*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.

(8 Hours)

**MODULE II**

*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.

(10 Hours)

**MODULE III**

*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 $\text{M}/\text{M}/1: \infty/\text{FCFS}, \text{M}/\text{M}/\text{C}: \infty/\text{FCFS}, \text{M}/\text{M}/\text{C}: \text{N}/\text{FCFS}$.

(8 Hours)

MODULE IV
Dynamic Programming

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.

(8 Hours)

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

Inventory Models
Role of demand in the development of inventory models, objectives, inventory costs, quantity discount, Economic Order Quantity (EOQ), EOQ when stock replenishment is not instantaneous, Economic lot size when shortages are allowed, economic lot size with different rate of demand in different cycles (Instantaneous replenishment). (No Dynamic EOQ Models)

(8 Hours)

COURSE OUTCOMES
Upon successful completion of this course, students will be able to
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

REFERENCE BOOKS
4. Industrial Engineering and Production Management, M. Mahajan, Dhanpat Rai & co
Course Objectives

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 – I

**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.  

8 Hours

Module – II

**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  

10 Hours

Module – III

**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.  

8 Hours

Module – IV

**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.  

8 Hours
Module – V


8 Hours

Course Outcomes
At the end of the course, the student will be able to:
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 Bharathi Vidyapeeth Institute of environment education and Research ,Pune

REFERENCE BOOKS:

E- Learning
- Open courseware
Module - 1

**Automation**

History of Automation, Reasons for automation, Disadvantages of automation, Automation systems, Types of automation – Fixed, Programmable and Flexible automation, Automation strategies

Automated Manufacturing Systems: Components, classification and overview of manufacturing Systems, Flexible Manufacturing Systems (FMS), Types of FMS, Applications and benefits of FMS. 08 Hours

Module - 2

**Robotics**

Definition of Robot, History of robotics, Robotics market and the future prospects, Robot Anatomy, Robot configurations: Polar, Cartesian, cylindrical and Jointed-arm configuration.

Robot motions, Joints, Work volume, Robot drive systems, Precision of movement – Spatial resolution, Accuracy, Repeatability, End effectors – Tools and grippers. 08 Hours

Module - 3

**Controllers and Actuators**

Basic Control System concepts and Models, Transfer functions, Block diagrams, characteristic equation, Types of Controllers: on-off, Proportional, Integral, Differential, P-I, P-D, P-I-D controllers. Control system and analysis.

**Robot actuation and feedback components**

Position sensors – Potentiometers, resolvers, encoders, velocity sensors. Actuators - Pneumatic and Hydraulic Actuators, Electric Motors, Stepper motors, Servomotors, Power Transmission systems. 09 Hours

Module - 4

**Robot Sensors and Machine vision system**

Sensors in Robotics - Tactile sensors, Proximity and Range sensors, use of sensors in robotics.

Machine Vision System: Introduction to Machine vision, the sensing and digitizing function in Machine vision, Image processing and analysis, Training and Vision systems. 08 Hours
Module - 5

**Robots Technology of the future:** Robot Intelligence, Advanced Sensor capabilities, Telepresence and related technologies, Mechanical design features, Mobility, locomotion and navigation, the universal hand, system integration and networking.

**Artificial Intelligence:** Goals of AI research, AI techniques – Knowledge representation, Problem representation and problem solving, LISP programming, AI and Robotics, LISP in the factory.

---

**Course Outcomes**

On completion of the course student will be able to

1. Classify various types of automation & manufacturing systems
2. Discuss different robot configurations, motions, drive systems and its performance parameters.
3. Describe the basic concepts of control systems, feedback components, actuators and power transmission systems used in robots.
4. Explain the working of transducers, sensors and machine vision systems.
5. Discuss the future capabilities of sensors, mobility systems and Artificial Intelligence in the field of robotics.

---

**Text Books**


**Reference Books**

MODULE – 1

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

Project Selection And Prioritization – Strategic planning process, Strategic analysis, strategic objectives, portfolio alignment – identifying potential projects, methods of selecting projects, financial mode / scoring models to select projects, prioritizing projects, securing and negotiating projects. 08 Hours

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. 08 Hours

MODULE – 3

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

Project Risk Planning: Risk Management Planning, risk identification, risk analysis, risk response planning, Project Quality Planning and Project Kickoff: Development of quality concepts, project quality management plan, project quality tools, kickoff project, baseline and communicate project management plan, using Microsoft Project for project baselines. 08 Hours

MODULE – 4

Performing Projects: Project supply chain management: - Plan purchasing and acquisitions, plan contracting, contact types, project partnering and collaborations, project supply chain management.
**Project Progress and Results:** Project Balanced Scorecard Approach, Internal project, customer, financial issues, Finishing the project: Terminate project 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; PERT for 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**
2. Project Management, A systems approach to planning scheduling and controlling by Harold Kerzner, CBS publication.

**REFERENCE BOOKS**
1. Project Management, Pennington Lawrence, Mc Graw hill
3. Project Management, Bhavesh M. Patal, Vikas publishing House,


Co-requisite Courses: Turbo Machines
Prerequisites: Fluid Mechanics and Thermodynamics
Course Objectives:
1. This course will provide a basic understanding of flow measurements using various 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
6. Orifice meter
   o Nozzle
   o Venturimeter
   o V-notch

PART – B

7. Performance on hydraulic Turbines
   a. Pelton wheel
   b. Francis Turbine
   c. Kaplan Turbines
8. Performance hydraulic Pumps
   d. Single stage and Multi stage centrifugal pumps
   e. Reciprocating pump
9. Performance test on a two stage Reciprocating Air Compressor
10. Performance test on an Air Blower
PART – C (Optional)

11. Visit to Hydraulic Power station/ Municipal Water Pump House and Case Studies

Course Outcomes:

At the end of this course students are able to,

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

Reading:
2. Jagdish Lal, Hydraulic Machines, Metropolitan Book Co, Delhi, 1995

Scheme of Examination:

ONE question from part -A: 25 Marks
ONE question from part -B: 40 Marks
Viva –Voice : 15 Marks
Total: 80 Marks
**ENERGY LAB**

<table>
<thead>
<tr>
<th>Course</th>
<th>Code</th>
<th>Credits</th>
<th>L-T-P</th>
<th>Assessment</th>
<th>Exam Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Lab</td>
<td>15MEL58</td>
<td>02</td>
<td>1-0-2</td>
<td>80</td>
<td>20</td>
</tr>
</tbody>
</table>

**Prerequisites:** Basic and Applied Thermodynamics

**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.
5. Analysis of moisture, volatile matter, ash content and fixed carbon of solid and liquid fuel samples

**PART - B**
   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.
10. Measurement of $p\theta$, $pV$ plots using Computerized IC engine test rig
PART – C (Optional)
11. Visit to Automobile Industry/service stations.
12. CFD Analysis of design, development, performance evaluation and process optimization in I C Engines.

Course Outcomes: At the end of this course students are able to,

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

References

Scheme of Examination:
ONE question from part -A: 25 Marks
ONE question from part -B: 40 Marks
Viva –Voice : 15 Marks
Total: 80 Marks
The relevance of this journal publication aims to inform business leaders of the domestic engineering industry, the leading industry managers, academics, experts about important issues of governance and economic development of machine-building complex of Russia, about the methods and means of increasing its competitiveness and transition to innovative way of development. It allows to publish content about the latest domestic and foreign achievements of economics and management in engineering, which corresponds to the motto of the journal. Engineering 4. Economy a. Economics b. Engineering Economics c. General Steps for Decision Making Processes d. Steps in an Engineering Economical Study 5. Management a. Levels of Management b. Managerial Skills c. Functions of Managers d. Engineering Management e. The Manager Engineer 6. Glossary of Terms. More than 24 years of experience in designing and conducting, teaching/training courses all over the Arab world in all fields of water, engineering and engineering management. More than 125 engineering/research projects as general, coordinator/manager in the design and evaluation of integrated. The scope of the articles in the journal covers a wide field of scientific problems related to economic trends and issues, industrial and business economics; the development, marketing, and financing of new engineering technologies, products and services; product and services markets and demand influences; analytical and simulation models, empirical research, managerial decisions. Material of the manuscripts submitted for publication to the journal must be of a high scientific level and previously unpublished. Current Issue. Vol. 31 No. 5 (2020). Published: 2020-12-10. Economics of engineering decisions. The Interaction between Ownership Concentration and Market Risk in European, American and Chinese Markets: the Effects of BREXIT.