**SYLLABUS**

 **FOR**

**FOUR-YEAR B. TECH PROGRAMME**

**IN**

**MECHANICAL ENGINEERING**

 **DEPARTMENT OF MECHANICAL ENGINEERING**

**ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH**

 **(FORMERLY COLLEGE OF ENGINEERING & TECHNOLOGY)**

**(An Autonomous and Constituent College of BPUT, Odisha) Techno Campus, MahalaxmiVihar, Ghatikia,**

**Bhubaneswar-751029, Odisha, INDIA** [**www.cet.edu.in**](http://www.cet.edu.in/)

**Ph. No.: 0674-2386075 (Off.), Fax: 0674-2386182**

**1st SEMESTER**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Sl.****No.** | **Subject Type** | **Subject Code** | **Subject Name** | **Teaching Hours/Wee k** | **Credit** | **Maximum Marks** |
| **L** | **T** | **P** | **IA** | **EA** | **PA** | **Total** |
| 1 | Basic ScienceCourse | UBSPH101 | Physics | 3 | 1 | 0 | 4 | 30 | 70 | 0 | 100 |
| 2 | Basic ScienceCourse | UBSMH102 | Mathematics-I | 3 | 1 | 0 | 4 | 30 | 70 | 0 | 100 |
| 3 | Engineering ScienceCourse | UESEE103 | Basic Electrical Engineering | 3 | 1 | 0 | 4 | 30 | 70 | 0 | 100 |
| 4 | Basic ScienceCourse | ULCPH101 | Physics Lab | 0 | 0 | 3 | 1.5 | 0 | 0 | 100 | 100 |
| 5 | Engineering ScienceCourse | ULCEE102 | Basic Electrical Engineering Lab | 0 | 0 | 2 | 1 | 0 | 0 | 100 | 100 |
| 6 | Engineering ScienceCourse | ULCME105 | Workshop\Basic ManufacturingPractices Lab | 1 | 0 | 4 | 3 | 0 | 0 | 100 | 100 |
| **7** | Engineering ScienceCourse | UESIE102 | BASIC ELECTRONICS ENGINEERING | 2 | 0 | 0 | 2 | 30 | 70 | 0 | 100 |
| **8** | Engineering ScienceCourse | ULCIE102 | BASIC ELECTRONICS ENGINEERING LAB | 0 | 0 | 2 | 1 | 0 | 0 | 100 | 100 |
|  |  |  | **Total** |  |  |  | **20.5** |  |  |  | **800** |
| **7** | **Mandatory Course** | **Induction Programme** |  |  |  | **0** |  |  |  |  |

**2nd SEMESTER**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Sl.****No.** | **Subject Type** | **Subject Code** | **Subject Name** | **Teaching Hours/Week** | **Credit** | **Maximum Marks** |
| **L** | **T** | **P** | **IA** | **EA** | **PA** | **Total** |
| 1 | Basic ScienceCourse | UBSCH201 | Chemistry | 3 | 1 | 0 | 4 | 30 | 70 | 0 | 100 |
| 2 | Basic ScienceCourse | UBSMH202 | Mathematics- II | 3 | 1 | 0 | 4 | 30 | 70 | 0 | 100 |
| 3 | Engineering ScienceCourse | UESCS203 | Programming for Problem Solving | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 4 | Humanities &SocialSciences | UHSMH205 | English | 2 | 0 | 0 | 2 | 30 | 70 | 0 | 100 |
| 5 | Basic ScienceCourse | ULCCH201 | Chemistry Lab | 0 | 0 | 3 | 1.5 | 0 | 0 | 100 | 100 |
| 6 | Engineering ScienceCourse | ULCCS202 | Programming for Problem SolvingLab | 0 | 0 | 4 | 2 | 0 | 0 | 100 | 100 |
| 7 | Engineering ScienceCourse | ULCME203 | Engineering Graphics andDesign Lab | 1 | 0 | 4 | 3 | 0 | 0 | 100 | 100 |
| 8 | HS | ULCMH204 | English Lab | 0 | 0 | 2 | 1 | 0 | 0 | 100 | 100 |
|  |  |  | **Total** |  |  |  | **20.5** |  |  |  | **800** |

**3rd SEMESTER**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Sl.****No.** | **ubject Type** | **Subject Code** | **Subject Name** | **Teaching Hours/Week** | **Credit** | **Maximum Marks** |
| **L** | **T** | **P** | **IA** | **EA** | **PA** | **Total** |
| 1 | Core Course–1 | UPCME301 | Introduction to Material Science | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 2 | Core Course 2 | UPCME304 | Fluid Mechanics & Hydraulic Machines | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 3 | Core Course3 | UPCME302 | Engineering Thermodynamics | 3 | 1 | 0 | 4 | 30 | 70 | 0 | 100 |
| 4 | Engg. Science Course1 | UPCME303 | Engineering Mechanics | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 5 | Basic ScienceCourse1 | UBSMH301 | Mathematics-III | 3 | 1 | 0 | 4 | 30 | 70 | 0 | 100 |
| 6 | Humanities Science Course1 | UHSMH306 | Organizational Behavior | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 7 | Lab Course | ULCME301 | Fluid Thermal Lab | 0 | 0 | 3 | 1.5 | 0 | 0 | 100 | 100 |
| 8 | Lab Course | ULCME302 | Machine Drawing | 0 | 0 | 3 | 1.5 | 0 | 0 | 100 | 100 |
|  |  |  | **Total** |  |  |  | **23** |  |  |  | **800** |

### 4thSEMESTER

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Sl.****No.** | **ubject Type** | **Subject Code** | **Subject Name** | **Teaching Hours/Week** | **Credit** | **Maximum Marks** |
| **L** | **T** | **P** | **IA** | **EA** | **PA** | **Total** |
| 1 | Core Course4 | UPCME401 | IC Engine & Gas Turbine | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 2 | Core Course5 | UPCME402 | Mechanics of Solids | 3 | 1 | 0 | 4 | 30 | 70 | 0 | 100 |
| 3 | Core Course6 | UPCME403 | Manufacturing Processes | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 4 | Engg. Science Course2 | UPCME404 | Optimization Techniques | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 5 | Humanities Science Course2 | UHSMH407 | Engineering Economics | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 6 | Lab Course | ULCME401 | Production and Material testing Lab | 0 | 0 | 3 | 1.5 | 0 | 0 | 100 | 100 |
| 7 | Lab Course | ULCME402 | Manufacturing Process Lab | 0 | 0 | 3 | 1.5 | 0 | 0 | 100 | 100 |
| 8 | Lab Course | ULCME403 | Machine Dynamics & IC Engine lab | 0 | 0 | 3 | 1.5 | 0 | 0 | 100 | 100 |
| 9 | Mandatory Course | UMCCE401 | Environmental Science | 2 | 0 | 0 | 0 | 30 | 70 | 0 | 100 |
|  |  |  | **Total** |  |  |  | **20.5** |  |  |  | **900** |
| **10** | **Summer Internship programme (4 to 8 weeks) is mandatory as per AICTE rule** |

**5thSEMESTER**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Sl.****No.** | **ubject Type** | **Subject Code** | **Subject Name** | **Teaching Hours per Week** | **Credit** | **Maximum Marks** |
| **L** | **T** | **P** | **IA** | **EA** | **PA** | **Total** |
| 1 | Core Course7 | UPCME501 | Mechanisms of Machines | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 2 | Core Course8 | UPCME502 | Heat Transfer | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 3 | Core Course9 | UPCME503 | Machining Science & Machine Tools | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 4 | Core Course10 | UPCME504 | Design of Machine Element (open Book) | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 5 | Programme Elective-I | UPEME501 | Mechanical Measurement & Metrology | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| UPEME502 | Quality Control & Reliability |
| UPEME503 | Micro Fabrication |
| UPEME504 | Surface Engineering |
| 6 | Open Elective-I |  |  | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 7 | Lab Course | ULCME501 | Machining Lab | 0 | 0 | 3 | 1.5 | 0 | 0 | 100 | 100 |
| 8 | Lab Course | ULCME502 | Heat Transfer | 0 | 0 | 3 | 1.5 | 0 | 0 | 100 | 100 |
| 9 | Lab Course | ULCME503 | Measurement and Metrology | 0 | 0 | 3 | 1.5 | 0 | 0 | 100 | 100 |
|  |  |  | **Total** |  |  |  | **22.5** |  |  |  | **900** |

**6thSEMESTER**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Sl.****No.** | **Subject Type** | **Subject Code** | **Subject Name** | **Teaching Hours/Week** | **Credit** | **Maximum Marks** |
| **L** | **T** | **P** | **IA** | **EA** | **PA** | **Total** |
| 1 | Core Course11 | UPCME601 | Machine Dynamics | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 2 | Core Course12 | UPCME602 | Refrigeration and Air conditioning | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 3 | Programme Elective-II | UPEME601 | Advanced Fluid Mechanics | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| UPEME602 | Gas Dynamics |
| UPEME603 | Combustion theory |
| UPEME604 | Tribology |
| 4 | Programme Elective-III | UPEME605 | Advanced Mechanics of Solids (AMOS) | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| UPEME606 | Simulation, Modelling & Control |
| UPEME607 | Soft Computing Applications |

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | UPEME608 | Computer Aided Design |  |  |  |  |  |  |  |  |
| 5 | Open Elective-II |  |  | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 6 | Lab Course | ULCME601 | Design of Machine Component Lab | 0 | 0 | 3 | 1.5 | 0 | 0 | 100 | 100 |
| 7 | Lab Course | ULCME602 | Numerical Computation lab | 0 | 0 | 3 | 1.5 | 0 | 0 | 100 | 100 |
| 8 | Lab Course | ULCME603 | RAC Lab | 0 | 0 | 4 | 2 | 0 | 0 | 100 | 100 |
|  |  |  | **Total** |  |  |  | **20** |  |  |  | **800** |
| **9** | **Summer Internship programme (4 to 8 weeks) is mandatory as per AICTE rule** |

**7thSEMESTER**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Sl.****No.** | **Subject Type** | **Subject Code** | **Subject Name** | **Teaching Hours/Week** | **Credit** | **Maximum Marks** |
| **L** | **T** | **P** | **IA** | **EA** | **PA** | **Total** |
| 1 | Programme Elective-IV | UPEME701 | Power Plant Engineering | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| UPEME702 | Non-conventional Energy  |
| UPEME703 | Automobile Engineering |
| UPEME704 | Automatic Control System |
| 2 | Programme Elective-V | UPEME705 | Advanced Manufacturing Processes | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| UPEME706 | Micro Electro Mechanical System (MEMS) |
| UPEME707 | Ergonomics |
| UPEME708 | Product Design & Production Tooling |
| 3 | Programme Elective-VI | UPEME709 | Mechanical Vibration | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| UPEME710 | Finite Element Methods |
| UPEME711 | Mechatronics |
| UPEME712 | Robotics |
| UPEME713 | Project and Production Management |
| 4 | Open Elective III |  |  | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 5 | Humanities Science Course | UHSMH701 | Entrepreneurship Development | 3 | 0 | 0 | 3 | 30 | 70 | 0 | 100 |
| 6 | Project Course | UPRME701 | Minor Project | 0 | 0 | 8 | 4 | 0 | 0 | 100 | 100 |
| 7 | Seminar | USEME701 | Seminar | 0 | 0 | 2 | 1 | 0 | 0 | 100 | 100 |
|  |  |  | **Total** |  |  |  | **20** |  |  |  | **700** |

**8thSEMESTER**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Sl.****No.** | **Subject Type** | **Subject Code** | **Subject Name** | **Teaching Hours/Week** | **Credit** | **Maximum Marks** |
| **L** | **T** | **P** | **IA** | **EA** | **PA** | **Total** |
| 1 | Project Course | UPRME801 | Project Course / Internship | 0 | 0 | 24 | 12 | 0 | 0 | 100 | 100 |
| 2 | Core Course | UPCME801 | Comprehensive VivaVoce | 0 | 0 | 2 | 1 | 0 | 0 | 100 | 100 |
|  |  |  | **Total** |  |  |  | **13** |  |  |  | **200** |

Open Electives:

(Offered by Mechanical Engineering for all B.Tech Programmes)

|  |  |  |
| --- | --- | --- |
| Open Elective-I | UOEME501 | Thermodynamics and Heat Transfer |
| UOEME502 | Applied Thermal Engineering |
| Open Elective-II | UOEME601 | Basic Manufacturing Process |
| Open Elective-III | UOEME701 | Mechanics of Solids |

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| **OPEN ELECTIVE OFFERED BY VARIOUS BRANCHES TO****"MECHANICAL ENGINEERING"** |
| **OPEN ELECTIVE - I (5TH SEM)** |
| **Sl. No** | **Branch** | **Subject Code** | **Subject** |
| 1 | CIVIL ENGINEERING | UOECE501 | Fluid Mechanics |
| 2 | ELECTRICAL ENGINEERING | UOEEE501 | Industrial Electrical Systems |
| 3 | INSTRUMENTATION & ELECTRONICS ENGG. | UOEIE501 | Digital Communication |
| 4 | COMPUTER SCIENCE ENGG | UOECS504 | Real-Time Systems |
| UOECS505 | Advance Algorithms |
| UOECS506 | Parallel & Distributed Systems |
| 5 | INFORMATION TECHNOLOGY | UOEIT501 | Data Structure |
| 6 | BIOTECHNOLOGY | UOEBT501 | Physiology for Engineers |
| 7 | FASHION TECHNOLOGY | UOEFT501 | Fundamental Techniques of Apparel Design |
| 8 | TEXTILE ENGG. | UOETE501 | Textile Structural composite |
| **OPEN ELECTIVE - II (6TH SEM)** |
| **Sl. No** | **Branch** | **Subject Code** | **Subject** |
| 1 | CIVIL ENGINEERING | UOECE601 | Mechanics of Solids |
| 2 | ELECTRICAL ENGINEERING | UOEEE601 | Renewable Energy Systems |
| 3 | INSTRUMENTATION & ELECTRONICS ENGG. | UOEIE601 | MICRO ELECTRO MECHANICAL SYSTEM (MEMS) |
| 4 | COMPUTER SCIENCE ENGG | UOECS609 | Cambinatorics & Graph Theory |
| UOECS610 | Human Computer Interaction. |
| 5 | INFORMATION TECHNOLOGY | UOEIT601 | Object Oriented Programming using C++ |

|  |  |  |  |
| --- | --- | --- | --- |
| 6 | BIOTECHNOLOGY | UOEBT601 | Introduction to Biopharmaceutical Technology |
| 7 | FASHION TECHNOLOGY | UOEFT601 | Visual Art and Illustration Techniques |
| 8 | TEXTILE ENGG. | UOETE601 | Clothing Science and Technology |
| **OPEN ELECTIVE - III (7TH SEM)** |
| **Sl. No** | **Branch** | **Subject Code** | **Subject** |
| 1 | CIVIL ENGINEERING | UOECE701 | Composite Materials |
| UOECE702 | Solid Waste & Hazardous Waste Management |
| 2 | ELECTRICAL ENGINEERING | UOEEE701 | Control System Design |
| UOEEE702 | Electric & Hybrid Vehicles |
| 3 | INSTRUMENTATION & ELECTRONICS ENGG. | UOEIE701 | Satellite Communication |
| UOEIE702 | Digital Image and Video Processing |
| 4 | COMPUTER SCIENCE ENGG | UOECS709 | Big Data Analytics |
| UOECS710 | Information Retrieval |
| UOECS711 | Machine Learning |
| 5 | INFORMATION TECHNOLOGY | UOEIT701 | Java Programming |
| UOEIT702 | Data Base Engineering |
| 6 | BIOTECHNOLOGY | UOEBT701 | Computational Biology |
| UOEBT702 | Industrial Biotechnology |
| 7 | FASHION TECHNOLOGY | UOEFT701 | Fashion Photography |
| UOEFT702 | Fashion Business and Forecasting |
| 8 | TEXTILE ENGG. | UOETE701 | Specialty Yarn and Fabric |
| UOETE702 | Color Measurement |

**Physics(3-1-0)**

#### **Course Outcomes:**

At the end of this course, students will demonstrate the ability to

1. Enhance the fundamental knowledge in Physics and its application relevant to various streams of Engineering andTechnology.
2. Understand interaction of light with matter through interference, diffraction and be able to distinguish ordinary light with a laser light and to realize propagation of lightpolarization.
3. Understand various crystal systems and their structures elaborately through opticalfibers.
4. Understand basic knowledge of quantummechanics.

#### **Module 1: (16 Hours)**

Classical Dynamics: Newton’s laws of motion, generalized coordinates, constraints, Principle of virtual work,D’Alembert’sPrinciple,Lagrangian,Actionprinciple,Lagrangeequationofmotion(noderivation) and its application to Simple Harmonic oscillator and simplependulum.

General properties of Matter: Stress, Strain, Hooks’ law, Young’s modulus.

Oscillation & Waves: Simple Harmonic Oscillation, damped harmonic oscillation, forced oscillator, resonance, coupled oscillation, concept of wave and wave equation.

Optics: Concept of interference, two source interference pattern, Biprism, Michelson Interferometer & measurementofwavelength.Diffraction:Huygensprinciple,Fresnel&Fraunhoferdiffraction,Zoneplate, Plane diffraction grating (formulaonly).

#### **Module 2: (12 Hours)**

Solid State Physics: Crystalline and amorphous solid, unit cell, Miller Indices, Reciprocal lattice, Bragg’s law, Brillouin’s zone, concept of fermions, Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein distribution function (only statement and formula), Concept of Fermions and Bosons. Classification of materials: metals, semiconductor and insulator in terms of band theory.

LASER and Fibre Optics: Principle and application, stimulated emission, population inversion, Lasing material (solid and gas), He-Ne laser, Rubi- LASER, Application of LASER (Engineering Application), Principle of optical fibre and its application to communication.

#### **Module 3: (12 Hours)**

Electromagnetism: Student will be familiarized with some basics used in vector calculus prior to development of Maxwell’s electromagnetic wave equations. No proof of theorems and laws included in this unit expected- statement and interpretation should sufficient.

1. Vector calculus: gradient of scalar field, divergence, curl of vector field (Only Physical significance) Gauss divergence theorem, Stoke’s theorem, Green’s theorem (Only Statements) and applications.
2. Gauss’s law of electrostatics in free space and in a medium and application (Only statements) electric displacement (D) magnetic Induction (B), Amperes circuital law (Only statements), displacement current,Faraday’slawofelectromagneticinduction(Onlystatements),BiotSavartsLaw(Onlystatements), Maxwell’s four electromagnetic equations, Wave equation for E and B fields in vacuum, Electromagnetic energy, Poynting vector (noderivation).

Quantum Physics: Elementary concepts of quantum physics formulation to deal with physical systems.

1. Need for Quantum Physics-Historical overviews, Particle aspects of radiation- Black body radiation, photoelectric effect, Compton scattering, pair production. (No derivations), Wave aspect of particles-matterwave,deBroglieHypothesis,HeisenbergUncertaintyprinciples-Statement,Interpretation and application to H-atom, Harmonic oscillator to calculate ground stateenergy.
2. Basic features of Quantum mechanics- Transition from deterministic to probabilistic, States of system-Wavefunction,probabilitydensity,superpositionprinciple,observablesandoperators,expectation values. Schrodinger equation- Time dependent and time independent, wavepackets.

#### **Text Books:**

1. L. Maharana, P. K. Panda, S. N. Dash, B. Ojha, Lectures in Engineering Physics,Pearson.

#### **Reference Books:**

1. An Introduction to Mechanics -D. Klippner & R. Kolenkow,TMH
2. Concepts of Modern Physics - ArthurBeiser.
3. Electricity & Magnetism -E. M.Purecell
4. Engineering Physics by D. K. Bhattacharya and Poonam Tandon, Oxford UniversityPress
5. Engineering Physics by D. R. Joshi, Mc GrawHill
6. Introduction to Electrodynamics- David J. Griffiths, PHIPublication
7. Optics- A. K.Ghatak
8. Physics-I for engineering degree students- B. B. Swain and P. K.Jena.
9. Quantum Mechanics -Powel &Craseman.
10. Quantum Physics -Gasiorowicz

## Basic ElectricalEngineering(3-1-0)

This is a foundation course aimed to expose the students the basic and under- lying principles ofElectrical circuits, Electro-mechanical energy conversion andMeasurements.

#### **Course Outcomes**

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

1. Understand and analyse basic electric and magneticcircuits.
2. Analysis of Transient condition in DCcircuit.
3. Understand the basic of various types of electrical machines andmeasurements.
4. Explain the under-laying principle of generation, transmission and distribution of the electrical power.

#### **Module 1: (10 Hours)**

Fundamentals of Electric Circuits: Fundamentals of electrical circuit, Ohm’s law, Kirchhoff’s laws, series and parallel connections, Electric Power and sign conventions, circuit elements and their characteristics. Practical voltage and current sources. Source Conversion.

ResistiveNetworkAnalysis:nodevoltageandmeshcurrentmethods,supernodeandsupermeshmethods, delta-starandstar-deltaconversions,superpositionprinciple,Thevenin’sandNorton’stheorems.maximum powertransfer.

#### **Module 2: (10 Hours)**

Single phase AC circuits: Single phase emf generation, Representation of sinusoidal waveforms, average, effective, peak and rms values, j operators, phasor concept, Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel) Instantaneous Power in AC Circuits, Real power, reactive power, apparent power, Power Factor, Power triangle, Complex Power.

Three-phase AC circuits: Three phase emf generation, Delta-star and star- delta conversions, voltage and currentrelationsinstaranddeltaconnections.solutionofthethreephasecircuitswithbalancedvoltageand balanced load conditions, phasor diagram, measurement of power in three phasecircuits.

Transient Analysis: Writing differential equations for circuits, DC steady state solutions of first order circuits.

#### **Module 3: (10 Hours)**

ElectricalMeasuringinstruments:Introduction,PMMCAmmetersandVoltmeterswithextensionofrange, Moving-Iron Ammeters and Voltmeters, Dynamometer type Wattmeter, Energymeter.

Magneticcircuits:MMF,flux,reluctance,inductance.ReviewofAmpereLaw,BiotSavartLaw.Magnetic field, Electricity and Magnetism, B-H characteristics and hysteresis loss, series and parallel magnetic circuits.

Transformers:Construction,operatingprinciple,emfequationandturnsratio.Typesoftransformer,phasor diagrams for no loadoperation.

#### **Module 4: (10 Hours)**

DCMachines:PrincipleofOperationofgeneratorandmotor,EMFequation,TorqueEquation,methodsof excitation. Speed equation of d.c. motor, speed control of d.c. shuntmotor.

Induction motor: construction of AC inductor machines, Revolving magnetic flux, torque and slip, synchronous speed.

Power Systems: Brief idea about various generating plants (Thermal, Hydel, and Nuclear), Transmission and Distribution of Electric Energy.

#### **Text Books:**

1. Electrical & Electronic Technology, E. Huges, Pearson, 9thEdition.
2. Electrical Engineering Fundamentals, Vincent Del Toro, 2nd Edition,PHI.

#### **Reference Books**:

1. C. L. Wadhwa,” Electrical Engineering”, New Age International Publishers, 2ndEdition.
2. Basic Electrical Engineering, A. Fitzgerald, D. E. Higginbotham and A. Grabel, TMH, 5thEd.

**English(2-0-0)**

**Course Outcome**

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

1. Equipped with the theory and practice ofcommunication.
2. Equipped with both theoretical vocabulary and basic tools which will help them develop as better communicators.

Select literary texts and establish how these texts contribute to the afore- mentionedobjectives

#### **Module 1: (08 Hours)**

Introduction to Communication:

Importance of Communication in English, the process of communication and factors that influence the process of communication: Sender, receiver, channel, code, topic, message, context, feedback, ’noise’. Principles of Communication. Barriers to Communication & Communication Apprehension, Verbal (Spoken and Written) and non-verbal communication, Body language and its importance in communication.

#### **Module 2: (07 Hours)**

Phonetics and Functional Grammar:

Sounds of English: Vowels (Monophthongs and Diphthongs), Consonants, Syllable division, stress (word, contrastive stress) & intonation, MTI and problem sounds, Review of Parts of Speech, Subject and Predicate, Tense, Voice Change, Idioms and Phrasal Verbs.

(Note:Thisunitshouldbetaughtinasimple,non-technical,applicationorientedmanner,avoidingtechnical terms as fast aspossible.)

**Module 3: (05 Hours)** Reading Literature:

Prose:

* Stephen Leacock: My Financialcareer.
* Mahatma Gandhi: from My Experiments withTruth.
* O’Henry: The Last Leaf.

Poetry:

* Nissim Ezekiel:Professor.
* Jack Prelutsky: Be glad your nose is on yourface.
* Maya Angelou: Still I rise(Abridged).

**PhysicsLab(0-0-3)**

##### ***List of Experiments***

***(At least 10 experiments should be done)***

**Experiment List:**

1. Determination of Young’s modulus by Searle’s method / Bending ofbeams.
2. Determination of Rigidity modulus by staticmethod.
3. Determination of surface tension by capillary risemethod.
4. Determination of acceleration due to gravity by Bar / Kater’spendulum.
5. Verification of laws of vibration of string usingsonometer.
6. Determination of wavelength of light by Newton’s ringapparatus.
7. Determination of grating element of a diffractiongrating.
8. Determination of wavelength of laser source by diffraction ratingmethod.
9. Determination of wavelength using MichelsonInterferometer.
10. Plotting of characteristic curve of a PN junctiondiode.
11. Plotting of characteristic curves ofBJT.
12. Determination of unknown resistance using MeterBridge.
13. Determine of reduction factor of the given tangentgalvanometer.
14. Determination of horizontal component of earth’s magnetic field by using tangentgalvanometer.
15. Determination of Hall coefficient using Hallapparatus.

## Basic Electrical EngineeringLab(0-0-2)

##### ***List of Experiments***

***(At least 10 experiments should be done)***

**Course Outcomes**

 At the end of the course the students are able to:

1. Learn about the working of different measuring instruments for measuring power, power factor, energyetc.
2. Verify different NetworkTheorems
3. Draw the Open Circuit Characteristics of dc generator andTransformer
4. Visualize the constructional details of differentmachines

**Experiment List:**

1. Basic safety precautions. Introduction and use of measuring instruments - voltmeter, ammeter, wattmeter, Rheostat, multi-meter,oscilloscope.
2. Connection and measurement of power consumption of an Incandescent, fluorescent, LED and CFL lamp and determination of power factor.
3. Power and power factor measurements in three phase system by two wattmetermethod.
4. Verification of super position, Thevenin and Norton’stheorem.
5. Plotting of B-H curve of different magnetic material and calculation of hysteresisloss.
6. Testing of a single-phase energy meter at different powerfactor.
7. Calculation of power and power factor in series R-L-C circuit excited by single-phase AC supply and draw the phasor diagram.
8. Determination of open circuit characteristics (OCC) of DC shuntgenerator.
9. Measuring the steady-state and transient time-response of R-L, R-C, and R-L-C circuits to a step change involtage.
10. Observationoftheno-loadcurrentwaveformofatransformeronanoscilloscopeandmeasurement of primary and secondary voltages and currents, and power at differentload.
11. Demonstration of cut-out sections of machines: dc machine (commutator- brush arrangement), induction machine (squirrel cage rotor), synchronous machine (field winding - slip ringarrangement).

## Workshop/Basic ManufacturingPractices(1-0-4)

#### **Module 1: (05 Hours)**

Engineering materials: Classification of Engineering materials. Mechanical properties of Steel,Aluminum andPlastics.

Safety precautions in workshop.

Fitting: Knowledge of hand tools: V-block, Marking Gauge, Files, Hack Saw, Drills, Taps, Types of fitting.

#### **Module 2: (05 Hours)**

Welding: Study of electric arc welding tools & equipments, Models: Butt Joint, Lap Joint, T joint & L- joint.

Machining: Introduction to different machine tools: Lathe machine, Shaper machine and milling machine.

Brief introduction to other basic manufacturing processes like foundry, sheet metal operation and forming processes.

#### **Text Books:**

1. Elements of Workshop Technology, Vol. I and II by Hajrachoudhary, KhannaPublishers.
2. Workshop Technology by W. A. J. Chapman, VivaBooks.
3. Workshop Manual by Kannaiah/ Narayana,Scitech.

**EnglishLab(0-0-2)**

##### ***List of Experiments***

***(All the experiments should be done)***

**Course Outcome:**

At the end of the course the students are able to:

1. Acquaintedwiththeirstrengthandweaknessinexpressingthemselves,theirinterestsandacademic habits.
2. ImproveskillsofLSRW(Listening,Speaking,ReadingandWriting)throughmutualconversation and activities related to theseskills.
3. Promote the creative and imaginative practices before theteacher-trainer.

Lab sessions will give a platform for the students to indulge in activities based on the first two modules of theorytaughtintheclassroom.Allthelabclasseswillbedividedinsuchamannerthatallthefouraspects of language (LSRW) arecovered.

#### **Experiment List:**

1. Speaking: Ice-breaking and Introducing each other, Writing: Happiest and saddest moment of my life.
2. Listening: Listening practice (ear training): News clips, Movie clips, Presentation, Lecture or speech by a speaker, Speaking:Debate.
3. Reading: Reading comprehension, Writing: Creative writing (Short story: Hints to be given by teacher).
4. Reading:TopicsofGeneralawareness,CommonerrorsinEnglishusage,Writing:Constructionof different types ofsentences.
5. Speaking: Practice of vowel and consonant sounds, Writing: Practice of syllabledivision.
6. Speaking: My experience in the college/ or any other topic as per the convenience of the student, Writing: Phonemic transcription practice.
7. Listening: Practice of phonetics through ISIL system and also with the help of a dictionary, Speaking: Role-play ingroups.
8. Speaking: Practice sessions on Stress and Intonation, Writing: Practice sessions on Grammar (Tense and voicechange).
9. Speaking: Extempore, Writing: Framing sentences using phrasal verbs andidioms.
10. Watching a short English Movie, Writing: Critical analysis of themovie.

End-termAssignment:Studentsarerequiredtomakeaprojectofatleast5pagesonatopiconthefollowing broad streams: Technology, General awareness, Gender, Environment, Cinema, Books and the like. The assignment should involve data collection, analysis andreporting.

**Basic Electronics Engineering**

**Module 1: (12 Hours)**

**Semiconductor Diodes:**

Semiconductor materials- intrinsic and extrinsic types, Ideal Diode, Terminal characteristics of diodes ( p-n junction under open circuit condition, p-n junction under forward bias and reverse bias condition)p-n junction in breakdown region, Diode small signal model, Zener diode and applications , Rectifier Circuits ( Half wave, Full wave centre tap and bridge rectifiers )

**Bipolar Junction Transistors (BJTs):**

Physical structure and operation modes**,** Active region operation of transistor**,**  D.C. analysis of transistor circuits**,**  Transistor as an amplifier**,**

**Module 2: (12 Hours)**

**BJT Biasing and Modeling:**

Biasing the BJT: fixed bias, emitter feedback bias and voltage divider bias**,** Basic BJT amplifier configuration: common emitter, common base andcommon collector amplifiers

**Field Effect Transistor:**

JFET-types, Operations and their Characteristics ,MOSFETs- types, Operations and their Characteristics

**Feedback Amplifiers and Oscillators:**

Types of feedback, Advantages of Negative feedback, Barkhausen criterion, RC oscillators (phase shift, Wien bridge), LC oscillators (Hartley)

**Extra (To be taught in Department level)**

Transistor as a switch: cut-off and saturation modes, High frequency model of BJT amplifier.

**Operation Amplifier (Op-amps):**

Ideal Op-amp, Differential amplifier: differential and common mode operation, common mode rejection ratio (CMRR), Practical op-amp circuits: inverting amplifier, non -inverting amplifier, weightedsummer, integrator, differentiator

**Reference Books:**

1. A. S. Sedra and K. C. Smith, *Microelectronic Circuits: Theory and Applications*, 7th edition. Oxford, 2017.

2. B. Razavi, *Fundamentals of Microelectronics*, 2nd edition. Wiley-India, 2014.

3. R. L. Boylestad and L. Nashelsky, *Electronic Devices and Circuit Theory*, 11th edition. Pearson, 2013.

4. T. C. Carusone, D. Johns, and K. Martin, *Analog Integrated Circuit Design*, 2nd edition. Wiley-India, 2013.

5.  P. R. Gray, P. J. Hurst, S. H. Lewis, and R. G. Meyer, *Analysis and Design of Analog Integrated Circuits*, 5th edition. Wiley-India, 2009.

6. D. A. Neamen, *Electronic Circuits: Analysis and Design*, 3rd edition. Tata McGraw-Hill, 2008.

**Basic Electronics Laboratory Experiment List**

***List of Experiments***

***(At least 5 Experiments Should be done)***

|  |  |  |
| --- | --- | --- |
| **Sl No.** | **Name of the Experiment** | **Week** |
| 1 | Familiarization with electronic components&equipment’s (Active & Passive, Multi-meters, CROs and function generators) | 1 |
| 2 | Study of the characteristics of P-N junction diode and finding dynamic resistance. | 2 |
| 3 | Construction of half-wave rectifier and full wave rectifier circuits & study of their output waveforms by CRO and calculation of efficiency and ripple factor. | 3 |
| 4 | Study of the output characteristics of a Common Emitter Transistor | 4 |
| 5 | Design, setup and plot the frequency response of Common Source JFET/MOSFET amplifier and obtain the bandwidth. | 5 |
| 6 | Study of the characteristics of Zener diode. | 6 |
| 7 | Construction of clipper circuits & study of their output waveforms of positive clipper, negative clipper and two level clipper by CRO. | 7 |
| 8 | Construction of clamper circuits & study of their output waveforms of positive clamping, negative clamping by CRO. | 8 |

 **Mathematics-I(3-1-0)**

#### **Course Outcomes**

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

1. Applytheprinciplesofdifferentialcalculustosolveavarietyofpracticalproblemsinengineering and appliedsciences.
2. Possess fundamental understanding of Fourier series and be able to give Fourier expansions of a function,
3. Apply the principles of vector calculus to solve a variety of basic problems in engineering and appliedscience,
4. Solve a variety of first order and higher order differential equations selecting from a variety of techniques covered in thesyllabus.

#### **Module 1: (10 Hours)**

Calculus:Asymptote,Curvature,Convergenceofsequenceandseries,testsforconvergence,powerseries, Taylor’s series, Fourierseries.

Partialdifferentiation,Taylor’stheoremforfunctionoftwovariables,MaximaandMinimaforfunctionof twovariables.

#### **Module 2: (10 Hours)**

Vector differential calculus: vector and scalar functions and fields, Derivatives, Curves, tangents and arc length, gradient, divergence, curl.

Vector integral calculus: Line Integrals, Green Theorem, Surface integrals, Gauss theorem and Stokes Theorem.

#### **Module 3: (10 Hours)**

Differential Equation: Differential Equation: First order differential equations, Separable Equation, Exact differentialequation,lineardifferentialequation,Bernoulli’sequationandapplicationtoElectricalcircuits.

Lineardifferentialequationofsecondandhigherorder,Homogeneousequationwithconstantco-efficient, Euler-Cauchy equations, Solution by undetermined co-efficient, Solutions by variation of parameters, Modelling of electriccircuits.

#### **Module 4: (10 Hours)**

Series solution of differential equations, Power series method, Legendre equation and Legendre polynomials.

Laplace transformation and its use in getting solution to differential equations, Convolution, Integral Equations.

#### **Text Books:**

1. Differential Calculus by Santi Narayan and Mittal, Chapters 14, 15Publication.
2. Advanced Engineering Mathematics by E. Kreyszig, Tenth Edition,Wiley.
3. Higher Engineering Mathematics by B. V. Raman, McGraw HillsEducation.

#### **Reference Books:**

1. Engineering Mathematics by Pal and S. Bhunia, OxfordPublication.
2. Ordinary and Partial Differential equations by J. Sinha Roy and S. Padhy, KalyaniPublishers.
3. Advance Engineering Mathematics by P. V. O’Neil,Cengage.

 **Chemistry(3-1-0)**

#### **Course Outcomes**

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

1. Understand the basics of molecularinteractions.
2. Idea about organometallic and their catalyticapplications.
3. Understand basics of fuels and corrosionchemistry.

#### **Module 1: (10 Hours)**

QuantumChemistryandSpectroscopy:Basicconceptsandpostulatesofquantummechanics.Introduction to Schrodinger Wave Equation, Particle in a box: Energy levels, quantum numbers and selectionrule.

Spectroscopy: Lambert Beer’s Law, Principles and applications of UV-Visible Molecular Absorption Spectroscopy; Chromophores, applications to colorimetry. Effect of conjugation on chromophores, Absorption by aromatic systems, introductory idea on Rotational and Vibrational Spectroscopy Principles and application to diatomic molecules.

The phase rule: Statement of Gibb’s phase rule and explanation of the terms involved, Phase diagram of onecomponentsystem-waterandsulfursystem,Condensedphaserule,Phasediagramoftwocomponent system - Eutectic Bi-Cdsystem

#### **Module 2: (10 Hours)**

Organometallics: Introduction to organometallics, EAN rule; classification, nomenclature and characteristics of organometallic compounds. Applications of organometallic compounds and catalyst in alkene isomerization hydrogenation and hydroformylation (detail mechanisms are to be excluded).

#### **Module 3: (10 Hours)**

Fuels: Classification of fuels, calorific value. (Determination by Dulong’s formula), G. C. V. and N. C. V. Liquid fuels: Classification of petroleum, refining of petroleum, Cracking, Knocking and anti-knocking, cetane and octane numbers. Unleaded petrol, synthetic petrol, power alcohol. Gaseous Fuel: Producer gas, Water gas, LPG, CNG, Kerosene gas, Combustion calculation.

#### **Module 4: (10 Hours)**

Corrosion: Electrochemical theory of corrosion, galvanic series, Types of corrosion; Differential metal corrosion, Differential aeration corrosion (Pitting and water line corrosion), Stress corrosion (caustic embrittlementinboilers),Factorsaffecting,Metalcoatings-GalvanizingandTiming,Corrosioninhibitors, cathodicprotection.

#### **Text Books:**

1. Text Book in Applied Chemistry by A. N. Acharya and B. Samantaray, PearsonIndia.
2. Introductory to Quantum Chemistry by A. K. Chandra, 4th Edition, McGraw HillEducation.
3. Fundamentals of Molecular & Spectroscopy by Banwell, Tata McGraw HillEducation.
4. Physical Chemistry by Gordon M. Barrow,McGraw-Hill
5. Engineering Chemistry, 12th Edition, Author: Wiley India Editorial Team PublishersWiley.
6. Engineering Chemistry: Fundamentals and Applications. Shikha Agarwal. Cambridge University Press.
7. Engineering Chemistry, Jain and Jain, Dhanpat RaiPublication.

#### **Reference Books:**

1. Inorganic Chemistry by Donald A. Tarr, Gary Miessler, Pearson India, ThirdEdition.
2. Quantum Chemistry by Ira N. Levine, Pearson 7thEdition.
3. Molecular Spectroscopy, Ira N. Levine, John Wiley andSons
4. Modern Spectroscopy - A Molecular Approach, by Donald McQuarrie and John Simon,published by University ScienceBooks.
5. Inorganic Chemistry by W. Overton, Rounk and Armstrong, Oxford University Press, 6thedition.

**Programming for ProblemSolving (3-0-0)**

#### **Module 1: (10 Hours)**

Introduction to Programming, Introduction to components of a computer sys- tem (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.)

IdeaofAlgorithm:stepstosolvelogicalandnumericalproblems.RepresentationofAlgorithm:Flowchart/ Pseudo code with examples, From algorithms to programs; source code, variables (with data types) variables and memory lo- cations, Syntax and Logical Errors in compilation, object and executable code, Arithmetic expressions andprecedence

#### **Module 2: (07 Hours)**

Conditional Branching and Loops, Arrays (1-D, 2-D), Character arrays and Strings, Functions (including using built in libraries), Parameter passing in functions, call by value, passing arrays to functions: idea of call by reference, Recursion, as a different way of solving problems.

#### **Module 3: (07 Hours)**

Structure & Unions, defining structures and Array of Structures, Pointers, Idea of pointers, Defining pointers, Pointers to functions, Double pointers.

#### **Module 4: (06 Hours)**

Dynamicmemoryallocation,useofmalloc(),calloc(),realloc(),free().Storageclasses:local,global,static & register variables. File handling: reading & writing to afile.

#### **Text Books:**

1. Byron Gottfried, Schaum’s Outline of Programming with C, McGrawHill.
2. E. Balaguruswamy, Programming in ASI C, Tata McGrawHill.

#### **Reference Books:**

1. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India.

**ChemistryLab(0-0-3)**

##### List of Experiments

***(At least 10 experiments should be done)***

**Experiment List:**

1. Determination of amount of sodium hydroxide and sodium carbonate in amixture.
2. Determination of total hardness of water by EDTAmethod.
3. Estimation of calcium in calcium inlimestone.
4. Determination of percentage of available chlorine in a sample of bleachingpowder.
5. Preparation ofPhenolphthalein.
6. Acid-Base Titration byPotentiometry.
7. Preparation of buffer solution and determination of pH of a buffersolution.
8. Standardization of KMnO4 using sodium oxalate. Determination of ferrous iron in Mohr’s salt by potassiumpermanganate.
9. Determination of partition coefficients of iodine between benzene andwater.
10. Determination of rate constant of acid catalyzed hydrolysisreaction.
11. Determination of concentration of a colored substance byspectrophotometer.
12. Determination of dissolved oxygen in a sample ofwater.
13. Determination of Viscosity of a lubricating oil by Red Woodviscometer.
14. Determination of Flash point of a given oil by Pensky-Marten’s flash pointapproach.
15. Determination of Critical Micelle concentration (CMC) of an ionic surfactant (Both cationic and anionic).

## Programming for Problem Solving Lab (0-0-4)

##### **List of Experiments**

***(At least 10 experiments should be done)***

**Experiment List:**

1. Familiarization with programmingenvironment.
2. Simple computational problems using arithmeticexpressions.
3. Problems involving if-then-elsestructures.
4. Iterative problems e.g., sum ofseries.
5. 1-D Arraymanipulation.
6. Matrix problems, Stringoperations.
7. Simplefunctions.
8. Programming for solving Numerical methods problems(1).
9. Programming for solving Numerical methods problems(2).
10. Recursivefunctions.
11. Pointers andstructures.
12. Fileoperations.

**Engineering Graphics and Design (1-0-4)**

#### **Module 1: (05 Hours)**

Introduction: Introduction to Engineering Drawing, Drawing Instruments and their uses, Dimensioning, Scale, types of lines, Lettering. (1 sheet)

Orthographic Projection: Introduction to Projection, Projection types or methods (First angle and Third angle)

PlaneofProjection,Referenceline,orthographicProjectionofPoints(pointslocatedinallfourquadrants), Projection of Straight lines (first and third quad- rant only), traces of lines. (1sheet)

Orthographic Projection of Plane Surfaces in various positions (Triangle, Square, Rectangle, Rhombus, Pentagon, hexagon and Circle), Traces of a Plane. (1 sheet)

Introduction to Solids and Types of Solids, Orthographic Projection of Solids in different Positions. (1 sheet)

#### **Module 2: (05 Hours)**

Sections and Development of Lateral Surface of Solids: Sectional view (half section and full section), development of surfaces of right regular prisms, pyramids, cylinders and cones. (1 sheet)

Isometric Projection: Introduction, Isometric Scale, Isomeric projection of cube, right regular prism, cylinders and cones. (1 sheet)

Applications: Orthographic and sectional view of Machine components (Screw Thread, nut and bolt). (1 Sheet)

Auto CAD: Introduction to Auto CAD. Fundamental concepts.

#### **Text Books:**

1. Machine Drawing by N. D. Bhatt, V. M. Panchal, Charotar PublishingHouse.
2. Machine Drawing by N. D. Junarkar, PearsonEducation.
3. Machine Drawing with AutoCAD by Goutam Pohit and Goutam Ghosh, PearsonEducation.

Machine Drawing includes AutoCAD by Ajeet Singh, Tata McGrawHill

**Mathematics-II(3-1-0)**

***Course Outcome:***

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

1. Use the basic concepts of vector and matrix algebra, including linear dependence / independence, basisanddimensionofasubspace,rankandnullityforanalysisofmatricesandsystemsoflinearequations,
2. Apply linear algebra techniques to solve various engineeringproblems,
3. Select appropriate numerical methods to apply to various types of problems in engineering and science in consideration of the mathematical operations involved, accuracy requirements, and available computational re-sources,
4. Compare different numerical methods with respect to accuracy and efficiency of thesolution.

#### **Module 1: (10 Hours)**

Matrices, vectors: addition and scalar multiplication, matrix multiplication: Linear systems of equations, linear independence, rank of a matrix, determinants, Cramer’s rule, inverse of a matrix, Gauss elimination and Gauss-Jordan elimination.

Vector space, linear dependence of vectors, basis, dimension.

#### **Module 2: (10 Hours)**

Linear transformations (maps), range and kernel of a linear map, rank and nullity, Inverse of a linear transformation, rank-nullity theorem, composition of linear maps, matrix associated with a linear map.

Eigenvalues, eigenvectors, symmetric, skew-symmetric and orthogonal matrices, Eigen basis, Diagonalization, Inner product spaces, Gram-Schmidt orthogonalization.

#### **Module 3: (10 Hours)**

Solution of polynomial and transcendental equations - Bisection method, Newton- Raphson methods and Regula-Falsi method.

Finite differences, Interpolation using Newton’s forward and backward difference formulae, Newton’s divided difference and Lagrange’s formulae, Numerical approximation of functions.

#### **Module 4: (10 Hours)**

Numerical differentiation, Numerical integration: Trapezoidal rule and Simpson’s 1/3rd and 3/8 rules, Gauss Legendre and Gauss quadrature rule.

Gauss Siedel iteration method for solving a system of linear equations Euler and modified Euler’s methods, Runge-Kutta methods.

#### **Text Books:**

1. Advanced Engineering Mathematics by E. Kreyszig, John Willey & Sons Inc. 10thEdition
2. Linear algebra and its applications by Gilbert Strang, Cengagelearning.

#### **Reference Books:**

1. Higher Engineering Mathematics by B. V. Ramana, McGraw Hill Edu-cation.
2. Engineering Mathematics by Pal and S. Bhunia, OxfordPublication.
3. Advance Engineering Mathematics by P. V.O’Neil.
4. Introductory methods of numerical analysis by S. S. Sastry,PHI.

# 3rdSemester

**Objectives:**

UPCME301 Introduction to Material Science

1. Understanding of the correlation between the internal structure of materials, their mechanical properties and various methods to quantify their mechanical integrity and failurecriteria.
2. To provide a detailed interpretation of equilibrium phasediagrams
3. LearningaboutdifferentphasesandheattreatmentmethodstotailorthepropertiesofFe-Calloys.

**Course Outcomes:**

1. Studentwillbeabletoidentifycrystalstructuresforvariousmaterialsandunderstandthedefects in suchstructures
2. Understand how to tailor material properties of ferrous and non-ferrousalloys
3. How to quantify mechanical integrity and failure inmaterials

**Course Content:**

**Module-I (08 Hours)**

Classification of Engineering Materials, Engineering properties of materials. Characteristic property of metals,bondinginsolids,primarybondslikeionic,covalentandmetallicbond,crystalsystems,common crystalstructureofmetals,representationsofplanesanddirectionsincrystals,atomicpackingincrystals, calculation of packing density, voids in common crystal structures and imperfectionscrystals.

### Module-2 (08 Hours)

Concept of plastic deformation of metals, critical resolve shear stress, dislocation theory, deformation by slip and twin, plastic deformation in polycrystalline metals, yield point phenomenon and related effects, concept of cold working preferred orientation. Annealing; recovery; recrystalization and grain growth; hot working.

Concept of alloy formation, types of alloys, solid solutions, factors governing solids solubility viz. size factor,valencyfactor,crystalstructurefactorandchemicalaffinityfactor;order/disordertransformation.

### Module-3 (10 Hours)

Binary phase diagrams (a) Isomorphism system, (b) Eutectic system, (c) Peritectic system, (d)Eutectoid system and (e) Peritectoid system. Allotropic transformation. Lever rule and its application, Interpretation of solidification behaviors and microstructure of different alloys belonging to those systems, Effect of non-equilibrium cooling, coring and homogenization.

Iron-cementiteandiron-graphitephasediagrams,microstructureandpropertiesofdifferentalloys(alloy steels; stainless steel, tool steel, HSS, high strength low alloy steel) types of cast iron, their microstructures and typical uses. Specification of steel. T.T.T. diagram: concept of heat treatment of steels i.e. annealing, normalizing, hardening and tempering; microstructural effects brought about by these processes and their influences on mechanical properties; factor affectinghardenability.

### Module-4 (10 Hours)

Optical properties of Materials: Scattering, Refraction, Theory of Refraction and absorption, Atomic Theory of optical properties. Lasers, Optical fibres- Principle, structure, application of optical fibres.

Plastic-: Thermosetting and thermoplastics.

Ceramics: Types, structure, Mechanical properties, application

Composite Materials: Agglomerated Materials: Cermets .Reinforced Materials: Reinforced Concrete. Fibre reinforced plastics, Properties of composites, Metal matrix composites, manufacturing procedure for fiber reinforced composite.

### Text Books:

1. Introduction to Physical Metallurgy by Avner, Tata McGrawHill
2. Materials Science and Engineering by W.D.Callister, Wiley and SonsInc.
3. Physical Metallurgy: Principles and Practice by Ragahvan,PHI

### Reference Books

1. Engineering Physical Metallurgy and Heat Treatment by Y.Lakhtin, Mir Publisher,Moscow.
2. Elements of Material Science and Engineering, L.H.Van Vlack, AddisonWesley
3. Materials Science and Engineering by V.Raghavan, Prentice Hall of IndiaPvt.Ltd.
4. Elements of Materials Science & Engineering by Van Vlack,Pearson
5. Mechanical Metallurgy by Dieter, Tata MacGrawHill
6. Composite Material science and Engineering by K. K. Chawla,Springer
7. Material Science and Metallurgy, by U. C. Jindal,Pearson

**Objectives:**

UPCME302 Fluid Mechanics & Hydraulic Machines

* 1. To learn about the application of mass and momentum conservation laws for fluidflows
	2. To understand the importance of dimensionalanalysis
	3. To obtain the velocity and pressure variations in various types of simpleflows
	4. To analyze the flow in water pumps andturbines.

**Course Outcomes:**

Upon completion of this course, students will be able to

1. Mathematically analyze simple flowsituations
2. Evaluate the performance of pumps andturbines

### Module: 1 (12 Hour)

Introduction and Fluid Statics- properties of fluids, concept of continuum, pressure and stress tensor Brief description of Newtonian and Non Newtonian fluids, Pascal’s Law of Hydrostatics, Pressure and its measurement by different manometers, force on submerged surfaces (Inclined), Buoyancy and stability of floating and submerged bodies.

Fluid Kinematics - Lagrangian and Eulerian description, streamline, streakline and pathline, continuity

equation (Onlythe 3D general form for Cartesian and cylindrical coordinates), stream function, rotation and angular deformation, irrotational flow, velocitypotential

### Module II: (13 Hour)

Inviscid flow - Euler equation, Bernoullis equation and its applications to venture meter, orifice meter and siphons, Reynolds transport theorem, conservation of mass, Linear and angular momentum, linear andangularmomentum,StokeslawofviscosityandNavier-Stokesequations(Onlythe3Dgeneralform for Cartesian and cylindrical coordinates), some exact solutions such as, Flow in straight channel and Hagen Poiseuille Flow, Dimensional analysis and similarity - Buckingham Pitheorem.

### Module III: (15Hours)

Internal flows: Pipe flows, friction factor, Moody Diagram, major and minor losses, pipe networks Externalflows:Prandtl’sBoundarylayerequationoveraflatplate(OnlyEquations),momentumintegral method, and flowseparation

Potential Flow - elementary plane flow in 2D Plane (Uniform flow and Vortex flow), Flow about a cylinder without circulation, Drag and lift of cylinder without circulation.

Fluid Machinery - similarity, Euler equation for turbo machines, Pelton wheel, Francis and Kaplan Turbines, centrifugal

### Books:

1. S. K. Som, G. Biswas, S. Chakraborty, Introduction to fluid Mechanics and Fluid Machines, 3rdEdition,McGrawhill.
2. Y.Cengel,J.M.Cimbala,FluidMechanics,3e(Sie)-FundamentalsandApplications,McGraw Hill
3. K. Subramanya, Hydraulic Machines, Mcgraw Hill
4. [Robert W. Fox](https://www.flipkart.com/books/robert-w-fox~contributor/pr?sid=bks), [Alan T. Mcdonald](https://www.flipkart.com/books/alan-t-mcdonald~contributor/pr?sid=bks), Fluid Mechanics,Wiley
5. Ethirajan Rathakrishnan, Fluid Mechanics,PHI
6. P. N. Modi, S. M. Seth, Hydraulics and Fluid Mechanics Including Hydraulics Machines, Standard BookHouse.

UPCME302 Engineering Thermodynamics

### Course Outcome

At the end of the course the students will be able to

1. Understand the concepts and application of laws ofthermodynamics.
2. Distinguish between steady flow and unsteady flow energy equation and relatedproblems
3. Understand the concepts Pure substance and uses of steam table and mollierchart
4. Understand the concepts reactive system and chemicalequilibrium
5. Solve different problems related to property, work, energy andheat
6. Solve problem related to entropy andAvailability
7. Understand Vapour cycle and solve relatedproblems

### Module-1 (18 Hr)

Introduction:FundamentalConcepts:definitionsofsystemandsurrounding,conceptofcontrolvolume, thermodynamic state, concepts of simple compressible substances, pure substance and phase, thermodynamic processes and thermodynamic equilibrium; Temperature and Zeroth law; Thermodynamicpropertiesanduseoftablesofthermodynamicproperties;Ideaofageneralizedchart

andthelawofcorrespondingstates;Conceptofidealgasesandtheirequationsofstate;Thermodynamic concept of energy; Modes of work and heat transfer.

First Law of Thermodynamics: The first law referred to cyclic and non-cyclic processes, concept of internalenergyofasystem,conservationofenergyforsimplecompressibleclosedsystems;Definitions of enthalpy and specific heats; Conservation of energy for an open system or control volume, steady & transientprocesses.

Second Law of Thermodynamics: The directional constraints on natural processes; Formal statements; Concept of reversibility; Carnot principle; Absolute thermodynamic temperature scale

### Module-2 (18 Hr)

Entropy, Clausius Inequality, change in entropy in various thermodynamic processes, TdS relations, entropy balance for closed and open systems, Principle of increase-in-Entropy, entropy generation.

Energy:Conceptofreversiblework&irreversibility;Secondlawefficiency;Energychangeofasystem: closed & open systems, exergy transfer by heat, work and mass, energy destruction, energy balance in closed & opensystems.

Properties of pure substances Properties of pure substances: p-v, p-T, T-S, h-S diagram for steam, different types of steam, Introduction to steam tables with respect to specific volume, pressure, temperature, enthalpy and entropy

### Module-3 (12 Hr)

Vapour Cycles: Carnot cycle; Simple Rankine cycle, Techniques for efficiency improvement, Reheat and Regenerative cycles with open & closed feed water heater; Cogeneration (Back pressure and Pass- out turbines), Combined cycle power generation systems, Binary vapour cycles.

ThermodynamicPropertyRelations:Maxwellrelations;Clausius-Clapeyronequation;Differenceinheat capacities; Ratio of heat capacities; Joule-Thompsoncoefficient.

### Text books:

1. Engineering Thermodynamics by P. K. Nag,Publisher:TMH
2. Engineering Thermodynamics by P. Chattopadhyay,OXFORD
3. Fundamentals of Thermodynamics by Sonntag, Borgnakke, Van Wylen, John Wiley &Sons
4. Fundamentals of Engineering Thermodynamics by E. Rathakrishnan,PHI

### Reference

1. Engineering Thermodynamics by M.Achyuthan,PHI
2. Engineering Thermodynamics by Y.V.C. Rao, UniversityPress
3. Thermodynamics and Thermal Engineering by Kothandaraman & Domkundwar,Dhanpat Rai
4. Applied Thermodynamics by P.L.Ballaney, KhannaPublishers
5. Steam Tables in SI Units by Ramalingam,Scitech
6. Steam Tables by C.P.Kothandaraman, New AgeInternational

### Objectives

UPCME303 Engineering Mechanics

The students completing this course are expected to understand the concepts of forces and itsresolution in different planes, resultant of force system, Forces acting on a body, their free body diagrams using graphical methods. They are required to understand the concepts of centre of gravity and moments of inertia and their application, Analysis of frames and trusses, different types ofmotion.

### Module-1

Basic Concepts of Statics: Scalar and vector quantities- Representation vectors- Free vector force, Specification of force- Effect of force on rigid body- Free body diagram.

ConcurrentForcesandParallelForcesinaPlane:Principlesofstatics-Equilibriumofconcurrentforces in a plane- Method of projections- Equilibrium of three forces in a plane Method of moments- Friction. Two parallel forces- General case of parallel forces in a plane-Centre of parallel forces and centre of gravity- Centroids of composite plane figures and curves- Distributed force in aplane.

### Module-2

General Case of Forces in a Plane: Composition of forces in a plane- Equilibrium of forces in a plane- Planetrusses,Funicularpolygon,Maxwelldiagrams,methodofjoints,methodofsections-Planeframe- method of members, Distributed force in a plane- Flexible suspensioncables.

Force Systems in Space: Concurrent forces in space; method of projections, method of moments; Couples in space- Parallel forces in space- Centre of parallel forces and centre of gravity- General case of forces in space.

### Module-3

Basic concepts of Dynamics: Kinematics- Kinetics- Newton laws of motion- Particle- Rigid body- Path of particle.

Rectilinear Translation: Kinematics of rectilinear motion Principles of dynamics, Differential equation of rectilinear motion- Motion of a particle acted upon by a constant force, Force as a function of time- Force proportional to displacement; free vibrations- D’Alembert’s principle- Momentum and impulse- Work and energy- Ideal systems: conservation of energy.

CurvilinearTranslation:Kinematicsofcurvilinearmotion-Differentialequationsofcurvilinear-Motion ofaprojectile-D’Alembert’sprinciple-Momentofmomentum-workandenergyincurvilinearmotion.

### Module-4

Rotation of rigid body about a fixed axis: Kinematics of rotation- Equation of motion for a rigid body rotating about a fixed axis- Rotation under the action of a constant moment . The compound pendulum- General case of moment proportional to angle of rotation- D’Alembert’s principle in rotation.

Plane Motion of a Rigid Body: Kinematics of plane motion- Instantaneous center Equations of plane motion- D’Alembert’s principle in plane motion- The principle of angular momentum in plane motion- Energy equation for plane motion.

### Text Book:

1. Engineering Mechanics by S.Timoshenko and D.HYoung McGraw-Hill.

### References:

1. Engineering Mechanics, Vol.1 & 2 by J.L. Meriems and L.G.Kraige.
2. Engineering Mechanics bySinger.
3. Engineering Mechanics by K.L. Kumar, Tata Mc-GrawHill.

### Course Objectives:

UBSMH301Mathematics-III

* 1. To give an exposure to the students the basic concepts of Probability and Statistical methods and theirapplication.
	2. To use appropriate statistical terms to describedata.
	3. To use appropriate statistical methods to collect, organize, display and analyze relevantdata.
	4. To serve as a foundation to analyze problems in Science and Engineering applications through Statistical testingMethod.

**Course Outcomes:** On successful completion of this course, the students will be able to

* + 1. Have a fundamental knowledge of the concepts of probabilitytheory,
		2. Do correlation and regression and fitting of different types ofcurves,
		3. Apply sampling theory and theory of estimation in various engineering problems and dovarious tests of hypothesis andsignificance,
		4. Use calculators and tables to perform simple statistical analyses for small samples and use popular statistics packages, such as SAS, SPSS, S-Plus, R or MATLAB to perform simple and sophisticated analyses for largesamples.

### Course Content:

**Module I(10 Hours)**

Probability: Introduction, Probability of an event, additive rule & multiplication rule, conditional probability, Bayes’ rule, random variable, discrete and continuous probability distribution, Joint probability distribution, Mathematical expectations, Variance and Co- variance of random variables, Mean and Co- variance of linear combination of random variables, Chebyshev theorem,

### Module II (12 Hours)

**Discrete Probability Distribution:** Binomial & Multinomial, Hyper-geometric, Geometric, Poisson distribution.

**Continuous Probability Distribution:** Uniform , Normal , Exponential Distribution, Weibull’s Distribution,Chi-squareDistribution,SamplingDistribution:SamplingDistributionofS2,tDistribution, FDistribution.

### Module III (10 Hours)

Estimationofparameter:methodsofestimation,Estimatingthemeanofasinglesample,Standarderror, Prediction interval, Tolerance limits, Estimating the difference between means of two samples, Estimatingproportionandvarianceofsinglesample,Estimatingthedifferencebetweentwoproportions and variances of two samples, maximum likelihood estimation.

### Module IV (13 Hours)

Testingofhypothesis:oneandtwotailedtest,test onasinglemeanwhenvarianceisknown&variance isunknown.Testontwomeans,testonsinglemeanandtwomeanpopulations.Oneandtwosampletest for variance. χ2test for goodness of fit and test forindependence.

Introduction to linear regression: Simple regression models, method of least squares, Properties of least square estimators, Inferences concerning the regression coefficients, Coefficients of determination and

its application.

Statistical quality control (Simple Idea only) Text Books :

1. RonaldE.Walpole,RaymondH.Myers,SharonL.Myers&KeyingYe,“Probability&Statistics for Engineers & Scientists", Eighth Edition, 2007, Pearson Education Inc., NewDelhi.
2. Jay L. Devore, “Probability and Statistics for Engineering and Sciences”, Seventh Edition, Thomson/CENGAGE Learning India Pvt.Ltd

Reference books:

1. William Mendenhall, Robert J. Beaver & Barbara M. Beaver, "Introduction to Probability and Statistics", 13th Edition, 2009, CENGAGE Learning India Pvt. Ltd., NewDelhi.
2. T. Veerarajan,” Probability, Statistics and Random Processes”, Tata McGrawHill
3. Ronald Deep, “ Probability and Statistics”, AcademicPress

### Module-1 (12 Hrs)

UHSMH301 Organizational Behaviour

**The study of Organisational Behaviour**: Definition, Meaning, Why study OB; Learning – Principles of learning and learning theories; Personality- Meaning, Determinants, Types, Personality and OB; Perception- Perceptual Process, perceptual errors, Importance of perception in organizations; Motivation-Nature and Importance, Theories of motivation (Herzberg, Maslow, McGregor) .

**Module -2:**(12 hours) **Group level:**

Groups in Organizations –Nature, Types, Reasons behind forming groups, Determinants, factors contributing to Group Cohesiveness, Group Decision Making- Process, advantages and disadvantages; Team- Effective Team Building; Types of Leadership- Effective Leadership, Styles of leadership, Leadership Theories-Trait Theory and Contingency Theory, Leadership and Followership; Conflict- Healthy Vs Unhealthy conflict, Conflict Resolution Techniques

### Module - 3 : Structural level(10hrs):

Organizational Culture: culture and organizational effectiveness; Organizational Change: Types of change, Reasons to change, Resistance to change and to manage resistance. Introduction to organisational development.

### Text Books:

* 1. Stephens P Robbins, Organisational Behaviour,PHI
	2. K. Aswatthappa, Organisational Behaviour,HPH

### Reference Books:

1. Kavita Singh, Organisational Behaviour,Pearson
2. D.K.Bhttacharya, Organisational Behaviour,OUP
3. PradeepKhandelwal, Organisational Behaviour,TMH
4. Keith Davis, Organisational Behaviour,McGrawHill
5. Nelson Quick, ORGB, Cengage Learning

ULCME301 Fluid Thermal Lab

Any 10 experiments from the following

1. Determination of Metacentric Height and application to stability of floatingbodies.
2. Determination of Cv and Cd of Orifices.
3. Experiments on impact of Jets
4. Study on Pelton / Francis / KaplanTurbine
5. Experiments on performance of centrifugalpump
6. Experiments on performance of reciprocatingpump
7. Experiments on Reynold’sApparatus
8. Experiments on Flow throughpipes
9. Experiments on performance of Gearpump
10. Verifications of momentumequation
11. Study of steam powerplant.
12. Study of refrigerationsystem.
13. Study of gas turbine powerplant.
14. Measurement of steam quality usingcalorimeter
15. Verification of Joule-Thomsoncoefficient.

ULCME302 Machine Drawing

Orthographic and Sectional drawing of Machine components: (Any seven)

Screwthreads,Screwedfastenings,TurnBuckle,Keys,CotterjointsandKnucklejoints;Pulley;Flanged coupling, Pedestal Bearing or PlummerBlock.

Fundamentals of AutoCAD (Two classes)

1. Dimension &annotations
2. Use ofLayers
3. Working with constraint indimension
4. Creatingassembly
5. Axi-symmetricalparts
6. Creating surfacefeatures
7. Working with bill ofmaterial

Drawing of the following using AUTOCAD: (Any two)

1. Projection ofsolids
2. Nut & bolt andFasteners
3. Cotter joint
4. Expansion joint
5. Shaftcoupling

### Text Books:

1. Machine Drawing by N.D.Bhatt, V.M.Panchal, Charotar PublishingHouse.
2. Machine Drawing by N.D.Junarkar, PearsonEducation
3. Machine Drawing with AutoCAD by Goutam Pohit and Goutam Ghosh, PearsonEducation
4. Machine Drawing includes AutoCAD by Ajeet Singh, Tata MacGrawHil

# 4thSemester

### Course outcomes

UPCME401 IC Engine & Gas Turbine

* 1. Understand various types of I.C. Engines and Cycles ofoperation.
	2. Analyze the effect of various operating variables on engineperformance
	3. Identify fuel metering and fuel supply systems for different types ofengines
	4. Understand normal and abnormal combustion phenomena in SI and CIengines
	5. Evaluate performance Analysis of IC Engine and Justify the suitability of IC Engine for differentapplication
	6. Understand the conventional and non-conventional fuels for IC engines and effects of emission formation of IC engines, its effects and the legislationstandards.
	7. Analyze & Solve the performance of GasTurbine

### Course Content Module 1 (12 hours)

**Introductio**n: Classification, Engine nomenclature, engine operating and performance parameters, Valve timing diagram of SI & CI Engines, Comparison of SI and CI engine.

**Thermodynamic Analysis of cycles**: Air standard cycles: Carnot cycle, Stirling cycle,Ericsson cycle, Otto cycle, Diesel cycle, Dual cycle, Comparison of the Otto, Diesel and Dual Cycle. Strilingcycle.

SignificanceofFuel-Air&ActualcyclesofI.C.engines.ComparisonwithAirStandardCycles.Analysis ofFuel-Air&Actualcycles(Effectofchemicalequilibriumandvariablespecificheats.Effectofairfuel ratio and exhaust gas dilution. Time Loss Factor, Heat Loss Factor, Exhaust Blow down, Loss Due to Gas Exchange Processes, Volumetric Efficiency, Loss due to RubbingFriction)

**Carburetion:** Requirement of carburetor**,** Factors Affecting Carburetion, Principle of Carburetion, Simple Carburetor and its drawbacks, Calculation of the Air–Fuel Ratio, Modern Carburetors.

### Module 2 (12 hours)

**Fuel Injection:** Functional Requirements of an Injection System, Classification of Injection Systems, FuelFeedPump,InjectionPump,InjectionPumpGovernor,MechanicalGovernor,PneumaticGovernor, Fuel Injector, Nozzle, Injection in SI Engine, Electronic Injection Systems, Multi-Point Fuel Injection (MPFI) System, Functional Divisions of MPFI System, Injection Timing, Group Gasoline Injection System, Electronic Diesel InjectionSystem.

**Ignition: Energy** requirement for ignition, requirements of an ignition system, conventional ignition systems, modern ignition systems (TCI and CDI), firing order, Ignition timing, Spark advance mechanism,

**Combustion in SI engines** – stages of combustion, ignition lag, engine variable affecting flame propagation, detonation, effects of detonation & its control, octane rating, combustion chamber design principle and types.

**CombustioninCIengines**–stages,delayperiodandit’s,variable,dieselknockanditscontrol,Cetane rating of fuels, different types of combustionchambers.

**Super Charging & Scavenging:** Thermodynamics Cycles of supercharging. Effect of supercharging, Efficiency of supercharged engines. Methods of super charging, supercharging and scavenging of 2- stroke engines.

### Module 3 (12 hours)

**Testing and performance** – Review of IC engine testing, and trial calculation on testing at different load characteristics, Performance characteristics such as brake thermal efficiency volumetric efficiency BSFC, Economical running, Williams line, interrelationship of various engines variables, performance graphs.

### Engine Emission and control:

Introduction, constituents of exhaust gas, effects on human health and **causes of formation and their measurement pollution control device and EURO standards**

**AlternativefuelsforICengines**likeLPG,CNG,Alcohols,Hydrogenetc.,theirneed,properties,engine modification andperformance.

### Module 4 (08 hours)

**GasTurbines:**Introduction,Brytoncycle.Openandclosedcyclegasturbines,Analysisofpracticalgas turbinecycle.

**Air Craft Propulsion: Analysis** of Turbo Jet, Turbo Prop, Turbo fan & Ram jet engines.

**Axial Flow & Centrifugal Compressor: Basic** construction of centrifugal and axial flow compressor, Velocity diagram, performance characteristics of centrifugal and axial flow compressor, effects of slip, surging and stalling on compressor.

### TEXTS & REFERENCE BOOKS:

1. IC Engines, Mathur &Sharma
2. Internal Combustion Engines, V. Ganesan, TMH, 3rdedition
3. Gas Turbines, V.Ganesan, TMH, 3rdedition
4. Heywood J.B., “Internal combustion Engine Fundamentals”, McGraw Hill,1988
5. ObertE.F.,“InternalcombustionEngineandAirPollution”,IntextEducationalPub,1974
6. Ganesan V., “Internal combustion Engines”, 6 th Ed.Tata Mc Graw Hill PublishingCo.
7. Domkundwar V.M. “Internal Combustion Engines”-Mathur M.C.,Sharma R.D.,“Internal combustion engines”,8thEd.;
8. Dhanpat Rai publication.,2003 PulkrabekW, “Engineering Fundamentals Of Internal Combustion Engine”, Prentice Hall,1997
9. Fundamentals IC Engines, J.B.Heywood, McGrawHill
10. A course in IC Engines, V.M.Domkundwar, Dhanpat rai andsons
11. Gas Turbines, Cohen andRoser
12. An Introduction to Energy Conversion, Vol.III, V.Kadambi and Manohar Prasad, New Age International
13. Internal Combustion Engines, K.K.Ramalngam, ScitechPublications

UPCME402 Mechanics of Solids

**Prerequisites:** (i) Physics 1, (ii) Mathematics course with ordinary differential equations and (iii) Engineering Mechanics

**Objectives:**

* To understand the nature of stresses developed in simple geometries such as bars, cantilevers, beams, shafts, cylinders and spheres for various types of simpleloads
* To calculate the elastic deformation occurring in various simple geometries for differenttypes ofloading

**Course Outcomes:**

After completing this course, the students should be able to

* Recognise various types loads applied on machine components of simple geometryand understand the nature of internal stresses that will develop within thecomponents
* Evaluate the strains and deformation that will result due to the elastic stresses developed within the materials for simple types ofloading

### Module – 1

SIMPLE STRESSES & STRAINS : Elasticity and plasticity – Types of stresses & strains–Hooke’s law

–stress–straindiagramformildsteel–Workingstress–Factorofsafety–Lateralstrain,Poisson’sratio &volumetricstrain– Barsofvaryingsection–compositebars–Temperaturestresses-Principalplanes and principal stresses -Mohr’s circle - Relation between elastic constants, Strain energy – Resilience – Gradual, sudden, impact and shockloadings.

SHEARFORCEANDBENDINGMOMENT:Definitionofbeam–Typesofbeams–Conceptofshear force and bending moment – S.F and B.M diagrams for cantilever, simply supported and overhanging beamssubjectedtopointloads,u.d.l,uniformlyvaryingloads andcombinationoftheseloads–Pointof contra flexure – Relation between S.F., B.M and rate of loading at a section of abeam.

### Module – 2

FLEXURAL STRESSES : Theory of simple bending – Assumptions – Derivation of bending equation, Determination bending stresses – section modulus of rectangular and circular sections

(Solid and Hollow), Angle and Channel sections – Design of simple beam sections.

SHEAR STRESSES: Derivation of formula – Shear stress distribution across various beams sections like rectangular, circular, triangular, I, T angle sections.

DEFLECTION OF BEAMS : Bending into a circular arc – slope, deflection and radius of curvature – Differentialequationfortheelasticlineofabeam–Determinationofslopeanddeflectionforcantilever andsimplysupportedbeamssubjectedtopointloads,-U.D.Luniformlyvaryingload.Mohr’stheorems

– Moment area method – application to simple cases including overhanging beams, Statically Indeterminate Beams and solution methods.

### Module – 3

THIN CYLINDERS: Thin seamless cylindrical shells – Derivation of formula for longitudinal and circumferentialstresses–hoop,longitudinalandVolumetricstrains–changesindia,andvolumeofthin cylinders – Riveted boiler shells – Thin sphericalshells.

THICKCYLINDERS:–lame’sequation–cylinderssubjectedtoinside&outsidepressures–compound cylinders.

TORSION: Introduction-Derivation- Torsion of Circular shafts- Pure Shear-Transmission of power by circular shafts, Shafts in series, Shafts in parallel.

COLUMNS:

Buckling and Stability, Columns with Pinned ends, Columns with other support Conditions, Limitations of Euler’s Formula, Rankine’s Formula,

### Text Books:

1. Strength of materials /GH Ryder/ Mc Millan publishers IndiaLtd
2. Solid Mechanics, byPopov
3. Mechanics of Materials/Gere and Timoshenko, CBSPublishers

### References:

1. Strength of Materials -By Jindal, UmeshPublications.
2. Analysis of structures by Vazirani andRatwani.
3. Mechanics of Structures Vol-III, byS.B.Junnarkar.
4. Strength of Materials byS.Timoshenko
5. Strength of Materials by Andrew Pytel and Ferdinond L. SingerLongman.

### Course objectives:

UPCME403 Manufacturing Processes

To study various casting, welding and forming methods including advanced techniques, with emphasis on basic principles, limitations and application areas.

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

* 1. Identify types of pattern, core, core print and gating system in metal castingprocesses.
	2. To obtain knowledge of various metal joiningprocesses.
	3. Acquire the knowledge of Powder metallurgy and its application.
	4. Understand and apply process-maps for metal forming processes using plasticityprinciples

### Module-1 (12 hours)

Types of patterns, Pattern materials and Pattern allowances. Molding Materials - sand molding, metal molding, investment molding, shell molding, Composition of molding sand, additives, Binders, Properties of molding sand and sand testing.

Melting furnaces - cupola, resistance furnace, induction and arc furnace, Solidification of castings, design of risers and runners, feeding distance, centre line freezing resistance chills and chaplets, Degasification and inoculation of metals.

Casting methods like continuous casting, centrifugal casting, disc casting, Casting defects.

### Module-2 (12 hours)

Classificationofweldingprocesses,gaswelding,electricarc,arclength,powersources,constantcurrent and constant voltage power sources; ISI classification of coatedelectrodes;

Special welding methods: MMAW, GTAW, GMAW, GMAW-CO2 welding, submerged arc welding, electro-slag welding, electron beam welding, laser beam welding, ultrasonic welding and resistance welding, welding defects, arc blow, non-destructive examination of weldments.

Brazing and soldering

### Module-3 (14 hours)

Brief introduction to powder metallurgy processes.

Mechanism of plastic deformation, fundamentals of plasticity, Dependence of stress strain diagram on Strain rate and temperature. Hot and cold working of metals, classification of metal forming processes. Rolling: Pressure and Forces in rolling, types of rolling mills, rolling defects, Forging: Smith Forging, Drop and Press forging, M/c forging, Forging defects.

Extrusions:Direct,Indirect,ImpactandHydrostaticextrusionandtheirapplications,Extrusionoftubes, Wire drawing methods and variables in wire-drawing, Brief introduction to sheet metal working: Bending, Forming and Deep drawing, shearing, Brief introduction to explosiveforming.

### Books:

1. Manufacturing Technology by P.N.Rao, Tata McGraw Hillpublication.
2. Welding Technology by R.A. Little,TMH
3. Manufacturing Science by A.Ghosh and A K Malick,EWP
4. Fundamentals of metal casting technology by P.C. Mukherjee, OxfordPIBI.
5. A Text Book of Production Engineering by P.C.Sharma,S.Chand

### Course Objectives:

UPCME404 Optimization Techniques

* 1. To understand the theory of optimization methods and algorithms developed for solving various types of optimizationproblems.
	2. To introduce the students about optimization concepts, formulation of engineering problems amenable tooptimization.
	3. To provide students with the modeling skills necessary to describe, formulate, solve andinterpret optimization problems inengineering.
	4. To find the solution of optimal decision making and engineering design problems in which the objective and constraints are linear or nonlinear functions.

### Course Outcomes

On successful completion of this course, the students will be able to

1. understand and use methods for constrained and unconstrainedOptimization,
2. understand the mathematical background to solve optimizationproblems,
3. formulate and solve nonlinear programming problems from real fielddata,
4. demonstrate the ability to choose and justify optimization techniques that are appropriate for solving realistic engineeringproblems.

### Course Content:

**Module-1:**

Idea of Engineering optimization problems, Classification of optimization algorithms, Modeling of problems and principle of modeling. Linear Programming: Formulation of LPP, Graphical solution, Simplex method, Big M method, Revised simplex method, Duality theory and its application, Dual simplex method, Sensitivity analysis in linear programming.

### Module-2:

Transportation problems: Finding an initial basic feasible solution by Northwest Corner rule, Least cost rule, Vogel’s approximation method, Degeneracy, Optimality test, MODI method, Stepping stone method. Assignment problems: Hungarian method for solution of Assignment problems.

Integer Programming: Branch and Bound algorithm for solution of Integer Programming problems.

Queuing models: General characteristics, Markovian queuing model, M/M/1 model, Limited queue capacity, Multiple server, Finite sources, .

### Module-3:

Introduction to non-linear programming, Unconstrained optimization: Fibonacci and Golden Section Search method, Steepest Descent Method, Constrained optimization with equality constraint: Lagrange multiplier, Projected gradient method, Constrained optimization with inequality constraint: Kuhn- Tucker condition, Primal-Dual Method, Quadratic programming.

### Text Book :

1. Ravindran, D. T. Philips, J. Solberg, “ Operations Research- Principle and Practice”, Second edition, Wiley India PvtLtd
2. Kalyanmoy Deb, “ Optimization for Engineering Design”, PHI Learning PvtLtd

### Reference Books :

1. AnintroductiontoLinearAlgebrabyV.Krishnamurthy,V.P.MainraandJ.L.Arora,EastWest Publication
2. M.Artin, Algebra, Prentice-Hall of India.
3. Hoffman and Kunze, Linear Algebra, 2nd ed.,PHI.
4. H.A.Taha,A.M.Natarajan, P.Balasubramanie, A.Tamilarasi, “Operations Research”, Eighth Edition, PearsonEducation
5. F.S.Hiller, G.J.Lieberman, “ Operations Research”, Eighth Edition, Tata McDrawHill
6. P.K.Gupta, D.S.Hira, “Operations Research”, S.Chand and CompanyLtd.
7. KantiSwarup, P. K. Gupta, Man Mohan, “Operations Research”, Sultan Chand andSons

UHSMH401 Engineering Economics

### Modules - 1 (12 Hours)

Engineering Economics- Nature, Scope, Basic problems of an economy, Micro Economics and Macro Economics.

Demand- Meaning of demand, Demand function, Law of Demand and its exceptions, Determinants of demand, Demand Estimation and Forecasting, Elasticity of demand & its measurement (Simple numerical problems to be solved ), Supply-Meaning of supply, Law of supply and its exception, Determinants of supply, Elasticity of supply, Determination of market equilibrium (Simple numerical problems to be solved).

Production-Production function, Laws of returns: Law of variable proportion, Law of returns to scale

### Modules - 2 (12 Hours)

Cost and revenue concepts, Basic understanding of different market structures, Determination of equilibrium price under perfect competition (Simple numerical problems to be solved), Break Even Analysis-linear approach (Simple numerical problems to be solved).

Banking -Commercial bank, Functions of commercial bank, Central bank, Functions of Central Bank. Inflation-Meaning of inflation, types, causes, measures to control inflation.

National Income-Definition, Concepts of national income, Method of measuring national income.

### Modules - 3 (12 Hours)

Timevalueofmoney-Interest-Simpleandcompound,nominalandeffectiverateofinterest,Cashflow diagrams, Principles of economicequivalence.

Evaluation of engineering projects-Present worth method, Future worth method, Annual worth method, Internal rate of return method, Cost benefit analysis for public projects.

Depreciation-Depreciationofcapitalassert,Causesofdepreciation,Methodsofcalculatingdepreciation (Straight line method, Declining balance method), After tax comparison ofproject.

### Text Books

1. Riggs, Bedworth and Randhwa, “Engineering Economics”, McGraw Hill EducationIndia
2. DevigaVengedasalam “Principles of Economics”, Oxford UniversityPress.
3. William G.Sullivan, ElinM.Wicks, C. PatricKoelling“Engineering Economy”,Pearson
4. R. PaneerSelvam, “Engineering Economics”,PHI
5. S.P.Gupta, “Macro Economics”,TMH.
6. S.B. Gupta,”Monetary Economics”, Sultan Chand andCo.

ULCME401 Production and Material Testing Lab

Any eight of the following experiments

* 1. Study of microstructure of steelspecimen
	2. Determination of tensile strength/ compressive strength/ bending strength of materials by Universal TestingMachine
	3. Double shear test in Universal TestingMachine
	4. Determination of Impact strength of material (Charpy and Izod)
	5. Determination of Hardness strength of materials (Brinnel, Rockwell andVickers)
	6. Determination of Rigidity modulus ofmaterial
	7. Determination of Fatigue strength ofmaterial
	8. Estimation of Spring Constant under Tension andCompression.
	9. Strain measurement using StrainGauge.
	10. Stress measurement using strainrosette

ULCME402 Manufacturing Process Lab

Any six of the following experiments

* + 1. Determination of grain size, clay content, permeability and green compressive strengthof molding sand. (2 to 3experiments)
		2. FoundryPractices
		3. Preparation of a woodpattern.
		4. Determination of strength of brazed and solderjoints
		5. Practice and preparation of job in TIG/MIG welding
		6. Practice and preparation of job in sheet metal using processes like forming and deepdrawing.
1. Demonstration of different rollingmills
2. Demonstration of Extrusionprocesses

ULCME403 Machine Dynamics & IC Engine lab

Any six of the following experiments

1. Dynamic analysis of Epi-cyclic geartrains
2. Measurement of cutting forces in Drilling, turning and Milling usingDynamometers.
3. Velocity ratios of simple, compound, epicyclic and differential geartrains.
4. Radius of gyration of compound pendulum / connecting rod
5. Experiment on ScrewJack
6. Experiment on Journal BearingApparatus
7. Experiment/Study onclutches
8. Experiments on Simple / Compound / Reverted / Epicyclic Geartrains
9. Experiment onBrake
10. Experiment on Coriolis component ofacceleration Any four of the followingexperiments
11. Study of Cut-Sections of 2 stroke and 4 stroke DieselEngine.
12. Study of Cut-Sections of 2 stroke and 4 stroke PetrolEngine.
13. Load test on 4-stroke single cylinder C.I. engine / S.I.engine.
14. Morse Test on multi-cylinder S.I. or C.I.engine
15. Load test on variable compression ratio S.I.engine
16. Load test and Heat balance on 2 stroke S.I.Engine
17. Valve timing diagram of an ICengine
18. Analysis of exhaust gas of automobile

### Course Objectives:

**Environmental Science 4th Sem**

* Understanding the importance of ecological balance for sustainabledevelopment.
* Understanding the impacts of developmental activities and mitigationmeasures
* Understanding the environmental policies andregulations

### Course Outcomes:

Based on this course, the Engineering graduate will understand /evaluate / develop technologies on the basis of ecological principles and environmental regulations which in turn help in sustainable development

**UNIT – I**

An Introduction to – Multidisciplinary nature of Environmental Studies.

|  |
| --- |
| The Earth and Biosphere (The Earth Science)**Ecology:** Concept and Principle of Ecology, Ecological Succession, Population Ecology, Community Ecology, Relationship, Human Ecology, Origin and Evolution of Life, Plant and Speciation.**Ecosystems: Definition, Properties, Function and Structure of Ecosystem.** Ecological Balance:Cause, Food chains, food webs, Flow of Energy, Ecological Pyramids, Types of Ecosystem: Land, Aquatic and Artificial ecosystem. Biogeochemical cycles, Bioaccumulation, Bio magnification, ecosystem value, Degradation ofEcosystem.Bio-diversity and Conservation**Natural Resources:** Classification of Resources, Conservation of Resources, Environmental Degradation, Equitable use of Resources for Sustainable Life styles, Role of Individual in Conservation of natural Resources.**Water Resources: Sources,** Status of World and Indian’s Water Resources, Over Utilization of Water, Conservation, Flood and Control measure, Others.MineralResources.LandResources,EnergyResources,FoodResources,etc.:Classification,Conservation, EnvironmentalImpacts. |
| **UNIT – II****Environmental Pollution:** Types of Pollution and Control Measures, Role of Individual in Pollution Prevention.**Waste Management:** MSW, WM Techniques, Agricultural Solid Waste Management and Legislation on Solid Waste management.**Disaster Management:** Objectives, Type of Disaster. Elements, Organisational Set- up, NDMA, Preparedness, Mitigation, Prevention, Response.**Environment and Development:** Social Issues, environmental Ethics, Sustainable Development, SustainableEnergyandmaterials,EnvironmentalChallenges,:ClimateChange,GreenHouseEffect,Global Warming, Ozone Layer Depletion, Protection of Ozone Layer, Acid Rain, EL Nino, Waste land and its ReclamationHuman Population and the Environment: Pupation Growth and Explosion, Pupation Growth and Environment, Family Welfare Programme, Women and Child welfare, HIV/ AIDS, Environment and Health, Human Rights, Value of Education.**Resettlement and Rehabilitation:** Introduction, Social Impact Assessment, Methodology of SIA, Land Acquisition and Impact, Stake holder participation and consultation, Socio-economic Issue,, Mitigation Measure.Rehabilitation Action Plan, Legal Frame work, Training and capacity Building, Grievance and Redressal Mechanism. |
| **UNIT - III****Environmental Protection**: Introduction, International efforts, Government Effort, environmental Organisations, Public Awareness, Environmental Education and Training, Green Building, Clean |

Development Mechanism, carbon Credits.

Environmental Legislation: Environmental Legal Framework, environmental Protection Act, 1986, the Air Act 1981, Water Act 1974, Wild Life Act, 1972, Forest Conservation Act, 1980.

**Environmental Management:** Environmental Impact Assessment, TOR for EIA, EIA Methodology (Brief), Baseline Data, Environmental Clearance, MoEF Notification Dated September 2006, Stake holder in EIA Process

Environment Management and EMP: Introduction, Issues covered, Environmental Management System- ISO-14000,InstitutionandImplementationArrangement,Mitigationmeasures,EnvironmentalMonitoring, EnvironmentalAuditing.

### TEXT BOOKS:

1. Environmental Studies(Concept, Impacts, Mitigation and management) by M. P. Poonia and S. C. Sharama, Khana Book Publishing Co. (P) T Ltd. 2019Edition
2. Textbook of Environmental Studies for Undergraduate Courses by Erach Bharucha for University GrantsCommission.
3. Environmental Studies by R. Rajagopalan, Oxford UniversityPress.

### REFERENCE BOOKS:

1. Environmental Science: towards a sustainable future by Richard T. Wright. 2008 PHL Learning Private Ltd. New Delhi.
2. Environmental Engineering and science by Gilbert M. Masters and Wendell P. Ela. 2008 PHI Learning Pvt.Ltd.
3. Environmental Science by Daniel B. Botkin & Edward A. Keller, Wiley INDIAedition.
4. Environmental Studies by Anubha Kaushik, 4th Edition, New age internationalpublishers.
5. Text book of Environmental Science and Technology - Dr. M. Anji Reddy 2007, BSPublications.

5th Semester

UPCME501 Mechanisms of Machines

**Prerequisites:** Engineering Mechanics, Mechanics of Solid, Engineering Mathematics, Material Science

### Course objectives:

Thiscourseisidealvehicleforintroducingthemechanicalengineeringstudentstotheprocessofdesign. The objectives of the course learningare:

* Theobjectiveofkinematicsistoachievevariousmeansoftransformingmotiontoaspecifickind needed in variousapplications.
* The objective of dynamics is analysis of the behaviour of a given machine or mechanism when subjected to dynamicforce.
* The objectives of Kinematics and dynamics of machines are to use the general concepts which arepreviouslystudiedwithillustrativeexamplestodevelopingmethodsandperforminganalysis of realdesigns.
* Hence the KDM involves a great deal of creativedetails.

### Course Outcome:

On successful completion of this course the students should be able to:

* Understand the requisites of *Machine Design* as Kinematic and dynamics of machinery and mechanics of material forms this subject. Therefore this course is ideal vehicle for introducing the mechanical engineering students to the process ofdesign.
* Able to do Basic Kinematic concepts and definitions ofMechanism
* Conversion with Kinematic Analysis andsynthesis
* Able to use friction theory to brakes, dynamometers, belt, rope, chain andclutches
* Understanding basics of gear and geartrains

### Course Content:

**Module – I : (10 Lectures)**

**Kinematic fundamental**: Introduction to mechanisms and its terminologies - Degree of freedom – Mobility - Kutzbach criterion - Grü ebler’s criterion for planar mechanisms, Grashoff’s law, Kinematic Inversions of 4-bar chain - Single slider and double slider crank chains, Quick return mechanism, Limiting positions, Mechanical advantage - Transmission angle and toggle position, Ratchets and escapements, Indexing Mechanisms, Rocking Mechanisms, Straight line generators.

**Kinematic Analysis** : Graphical analysis of position, velocity and acceleration of simple mechanisms having turning, sliding and rolling pair, Coriolis acceleration using graphical relative motion method, Aronhold-Kennedy Theorem, Instantaneous center method - Four bar and slider crank mechanisms - Analytical method for four bar and slider crank mechanisms.

### Module – II : (10 Lectures)

**Mechanism Synthesis :** Classification of kinematic synthesis problems - Two position synthesis of slider crank and crank rocker mechanisms, Three position synthesis of double rocker mechanism,

Chebychev spacing for precision positions, Freudenstein analytical method, synthesis of function generator using three precision positions, Graphical and analytical design of a four bar linkage for body guidance, path generation by graphical method.

**Mechanism Trains :** Spur gear terminology and definitions, fundamental law of gearing, Theory of shape and action of tooth properties and methods of generation of standard tooth profiles, Standard proportions,Forceanalysis,Pathofcontact,Arcofcontact,Contactratio,InterferenceandUndercutting, MethodsforeliminatingInterference,Minimumnumberofteethtoavoidinterference.Geartrains,Speed ratio, train value, Parallel axis gear trains, Epicyclic Gear Trains, Sun and Planet Gear, Differentials – Automobile gearbox.

### Module – III : (16 Lectures) Dynamics of Machinery

**Friction Effects:** Screw jack, Friction between pivot and collars, single, multi-plate and cone clutches, Anti friction bearing, film friction, friction circle, friction axis.

**FlexibleMechanicalElements:**Belt,ropeandchaindrives,Initialtension,Effectofcentrifugaltension on power transmission, Maximum power transmission capacity, Belt creep and slip.

**Brakes & Dynamometers :** Classification of brakes, Analysis of simple block, Band and internal expanding shoe brake, Braking of a vehicle. Absorption and transmission dynamometers, Prony brake, Rope brake dynamometer, Belt transmission, epicyclic train, torsion dynamometer.

### Text Books

1. Kinematics and Dynamics of Machinery by R L Norton, Tata MacGrawHill
2. Theory of Machines and Mechanisms by John J. Uicker Jr., Gordon R. Pennock and JosephE. Shigley, Oxford UniversityPress
3. Theory of Machines by S.S.Rattan, Tata MacGrawHill
4. Theory of Machines by Thomas Bevan, CBSPublications

### Reference

1. Kinematics and Dynamics of Machinery by Charles E. Wilson and J.Peter Saddler, Pearson Education
2. Mechanism and Machine Theory by J.S.Rao and R.V.Dukipatti, New AgeInternational.
3. Theory of Mechanisms and Machines by A. Ghosh & A. K. Mallick, East WestPress.
4. Kinematics and Dynamics of Machines by G.H. Martin,McGraw-Hill.
5. Mechanisms and Dynamics of Machinery by Hamilton H Mabie and Charles F Reinholtz, John- Wiley andSons.
6. Kinematics, Dynamics, and Design of Machinery by Kenneth J Waldron and Gary L Kinzel, John-Wiley andSons.

### Course outcomes:

UPCME502 Heat Transfer

1. Apply basic principles of fluid mechanics, thermodynamics, and heat transfer for engineering applications.
2. Analyze the mechanism of conduction and its application to thermal and energysystems.
3. Solve the complex problems of convection heat transfer in fluids for implementation in various industrial and scientificsystems.
4. Accessthephenomenaofboilingandcondensationapplicabletodesignofindustrialandthermal systems.
5. Develop an efficient heat exchange process for design and fabrication of heat exchangers used in various industrialpurposes.
6. Formulate an analysis of radiation heat exchange process in various thermal and energysystems for the solution of heat transferproblems.

### Module 1: (14 Classes)

Basic concepts: conduction, convection and radiation Laws. General equation of heat conduction. Derivation in Cartesian, cylindrical and spherical coordinates. One dimensional steady state heat conduction in simple geometries, plane wall, cylinder and sphere. Heat transfer composite walls , composite cylinders and composite spheres. Critical thickness of insulation, Thermal contactresistance. Overall heat transfer coefficient, Electrical analogy, Heat generation in plane wall, cylinder and sphere. Extended surfaces. General equations, types and applications of fins, Fin efficiency and effectiveness – Fin performance. Unsteady state heat conduction. Lumped parametersystem

### Module 2: ( 12 Classes)

Forcedconvection,ConvectionBoundarylayertheory.Thermalboundarylayer.Conservationequations ofmass,momentumandenergyforlaminarflowoveraflatplate.Turbulentflowoveraflatplate,Flow over cylinders, spheres, tube bank. Internal flow through pipes, annular spaces, Analogy between momentum and heattransfer

Natural convection in vertical, inclined and horizontal surfaces. Mixed convection, Dimensional analysis.

Boiling, Pool boiling , flow boiling. Regimes of Boiling. Forced convection boiling Condensation,Film condensation, dropwise condensation

### Module 3: (14 Classes)

Basic concepts, laws of radiation, Wien’s displacement law, Stefan Boltzman law, Kirchoff law, Black body radiation, Grey body radiation, Shape factor algebra , Electrical analogy, Radiation shields, Solar radiation, Introduction to gas radiation.

Heatexchangebetweenblackbodiesthroughnon-absorbingmedium.Graybodiesandrealbodies.Heat exchange between gray bodies. Radiosity and irradiation. Electrical analogy and radiation networkfor a 2-surface and 3-surface enclosures in non-absorbing medium, radiationshields.

Heatexchangers:Typesofheatexchangersandheatexchangerconfigurations.Theoverallheattransfer coefficient and fouling factor. LMTD and effectiveness-NTU analysis of heatexchangers.

### Text books

1. Heat transfer, J P Holman and S. Bhattacharya, McGraw Hill Education, 10th Edition. 2.Heat Transfer, R.C. Sachdeva, (2010) Fundamentals of Heat and Mass Transfer (SI Units)

1. Heat and Mass Transfer, R. K. Rajput, S. Chand & Company, 5thEdition
2. Heat Tranfer, P. K.Nag

### Reference books

1. Introduction to Heat Transfer, S. K. Som, PHI Learning Private Ltd, 2013.

2 Heat and Mass Transfer, Y. A. Cengel and A. J. Ghajar, McGraw Hill Education, 4th Edition

UPCME503 Machining Science & Machine Tools

### Course objectives:

To provide clear view on theory of metal cutting and tool geometry and to impart knowledge about mechanisms involved in the conventional and Non-conventional machines.

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

1. Interpret and design the geometry of single point cutting tool and multi point cuttingtools
2. Acquire the mechanisms involved in lathe, shaper, drilling, milling, planermachines
3. Understand the working principle of USM, LBM, ECM, EDM, AJM,EDM

### Module-1 (12 hours)

Theoryofmetalcutting:Definitionoftool,Classificationandtoolangles.Cuttingtoolmaterials&their properties.Orthogonalandobliquecutting.Mechanismofchipformation,typesofchips,toolgeometry and tool signature for ASA & ORS system, Machinability, Merchant’s theory of mechanics of metal cutting, Relationship between cutting velocity, shear velocity & chip velocity & Force, speed, feed and depth of cut, Design of single point turning tool, optimum value of tool angles, Tool life and factors affecting on it, Tool life calculation, Economic tool life, influence of tool geometry on tool life, Tool wear,Toolweartypes(craterandflank),chipformationmechanisms&typesofchipformation,Cutting fluids types andcharacteristics.

### Module-2 (14 hours)

Conventional machine tools:

Lathe: Principles, construction, types, production machine tools capstan & turret lathe, single point cutting tool layout, thread cutting mechanisms, calculations of cutting velocity, feed and depth of cut.

Shaper, Planer: Construction, operations, Quick return mechanism.

Milling: Construction, milling cutters, up milling & down milling, dividing and indexing mechanisms, maximum chip thickness & power required, Gear shaper and Gear hobbing machines

Drilling and Boring: Construction, classifications, drilling and boring tools, nomenclature & geometry of twist drill (Multi point cuttingtools)

Grinding and super finishing: Grinding wheels, abrasive & bonds, cutting action, grinding wheel specifications, grinding wheel wear-attritions wear, fracture wear. Dressing and Truing, maximum chip thickness, classification of grinding- surface and cylindrical grinding, center less grinding.Super finishing: Honing, lapping &polishing

### Module-3 (12 hours)

Introduction to non-conventional machining process: Needs & benefits, working principle and applications: Ultrasonic machining(USM), Laser Beam Machining (LBM), Electro Discharge Machining (EDM), Wire EDM, Electro Chemical Machining (ECM), Abrasive Jet Machining (AJM), Water Jet Machining (WJM),Plasma Arc Machining (PAM).

### References:

1. Metal cutting theory and practice- Amitabh Bhttacharya, central Book Publication,Calcutta.
2. Manufacturing science- A. Ghosh, A. K. Mallik, Affiliated East-Westpress.
3. Manufacturing Technology- P. N. Rao, Tata McGraw hillpublications.
4. Modern manufacturing process- P.C. Pandey & H. S. Shan, McGraw hillpublications.
5. Advance machining process- V. K. Jain, Alliedpublishers.
6. Production Engineering- P. C. Sharma, S. Chand, Company limited NewDelhi.

UPCME504 Design of Machine Element (open Book) **Prerequisites:** Engineering Mechanics, Mechanics of Solid, Machine Theory, Material Science **Course learning objectives**

A suitable combination of the two subjects, mechanism & machine theory and mechanics of material forms the subject *Machine Design*. The creation of a scheme for the construction and assembly of a machine is called *Machine Design*. The objectives of the course learning are:

* 1. Conception of an arrangement of components or elements or parts, which will accomplish the desiredpurpose.
	2. Definition of the geometry of each part andmaterial
	3. Theprocessing
	4. Construction and assembly based on design details Hence the design process involves a great deal of creativedetails **CourseOutcome**

On successful completion of this course the students should be able to:

1. Understand the design principles: i.e., Mechanical Engg. Design, phases of Design, design considerations, factor of safety, stress concentration, methods of reducing stress concentration, Notch sensitivity, Types ofloading,
2. Able to do design of permanentjoints
3. Conversion with the design ofsprings
4. Able to do Design ofbearings.

### Module-1 (12 hours)

1. Mechanical engineering design: Introduction to design procedure, Stages in design, Code and Standardization, Interchangeability, Preferred numbers, Fits and Tolerances, Engineering materials: Ferrous,Non-ferrous,Non-metals,designrequirements–propertiesofmaterials,Materialselection,Use of Databooks.
2. FundamentalsofMachineDesign:Typesofload,Modesoffailure,factorofsafetyconcepts,Theories ofFailure,conceptandmitigationofstressconcentration,Fatiguefailureandcurve,endurancelimitand factors affecting it, Notch sensitivity, Goodman, Gerber and Soderbergcriteria.

### Module-2 (12 hours)

1. Machine Element Design: Design of Joints: Rivets, welds and threaded fasteners based on different types of loading, Boiler joints, cotter joints and knuckle joints.
2. Design of Keys, Shaft and Couplings: Classification of keys and pins, Design of keys and pins, Theories of failure, Design of shafts: based on strength, torsional rigidity and fluctuating load, ASME code for shaft design, Design of couplings: Rigid coupling, Flexiblecoupling.

### Module-3 (12 hours)

1. DesignofMechanicalSprings:Typesofhelicalsprings,DesignofHelicalsprings,bulkingofspring, spring surge, end condition of springs, Design of leaf springs:nipping.
2. Bearings: Types and selection of ball and roller bearings, Dynamic and static load ratings, Bearing life, Design of sliding contact bearings, Journal bearing, foot stepbearing.

### Text Books:

* 1. Mechanical Engineering Design, J.E.Shigley, C.R.Mischke, R.G.Budynas and K.J.Nisbett, TMH
	2. Design of Machine Elements, V.B. Bhandari, Tata McGrawHill
	3. Machine Design Theory and Practice, Deutschman, D., Michels, W.J. and Wilson, C.E., , Macmillan,

### Reference Books:

1. Fundamentals of Machine Component Design by R.C.Juvinall and K.M.Marshek, John Wiley & Sons
2. Machine Design, P.C.Sharma and D.K.Agrawal, S.K.Kataria &Sons
3. Machine Design, Pandya and Shah, Charotar BookStall
4. Machine Design, Robert L. Norton, Pearson EducationAsia.

### Design Data Hand Books:

1. P.S.G. Design Data Hand Book, PSG College of Tech Coimbature

UPEME501 Mechanical Measurement & Metrology

### Course Outcomes:

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

1. Understand the principles of measurement instrument and theirapplications
2. To obtain knowledge about standards of measurements andcomparators.
3. Acquire the knowledge of limits, fit, andtolerances.

### Module 1

**Mechanical Measurements:** Introduction to measurement and measuring instruments. General concept–Generalizedmeasurementsystemanditselements-Unitsandstandards-measuringinstruments: sensitivity, stability, range, accuracy and precision-static and dynamic response- repeatability- systematic, Source of error, statistical analysis of error and random errors- correction, calibration. Dimensionalandgeometrictolerance.**SensorsandTransducers**:Typesofsensors,typesoftransducers and their characteristics.**Measurement of Pressure:** Gravitational, directing acting, elastic and indirect type pressure transducers, Measurement of very low pressures (high vacuum). **Strain Measurement**: Types of strain gauges and their working, strain gauge circuits, temperature compensation. Strain rosettes,calibration.**FlowMeasurement:**Flowcharacteristicsobstructionmeters,Obstructionmeterfor compressible fluids- Orifice, Venturimeter and Pitot tube, the variable-area meter, Turbine Flow meters.**Temperature Measurement**: Thermometers, bimetallic thermocouples, thermistors and pyrometers. **Measurements of Force, Torque:** Different types of load cells, elastic transducers, pneumatic & hydraulic systems. Seismicinstruments.

### Module 2

**Coordinate measuring machine (CMM):** Need, constructional features and types, **Metrology and Inspection:** Standards of linear measurement, line and end standards. Interchange ability and standardization. Linear and angular measurements devices and systems. **Comparators:** Sigma, Johansson’s Microkrator. Limit gauges classification, Taylor’s Principle of Gauge Design.

### Module 3

**Limits, Fits &Tolerance and Surface roughness:** Introduction to Limits, Fits, Tolerances and IS standards, Limit-gauges, and surface-roughness. Measurement of geometric forms like straightness, flatness, roundness. Tool makers microscope, profile projector, autocollimator. **Interferometry**: principle and use of interferometry, optical flat. Measurement of screw threads and gears. Surface texture: quantitative evaluation of surface roughness and its measurement.

### Books:

1. Experimental Methods for Engineers by Holman, MCGRAW HILLINDIA
2. Mechanical Measurements by Beckwith,Pearson
3. Principles of Measurement Systems by Bentley,Pearson
4. Metrology of Measurements by Bewoor and Kulkarni, MCGRAW HILLINDIA
5. Jain, RK, “Engineering Metrology” KhannaPublishers
6. Jain, R.K., “Mechanical Measurement” Khanna Publishers
7. Gupta SC, Engineering Metrology, Dhanpat RaiPublications

### Module- I (8 hours)

UPEME502 Quality Control & Reliability

Attributes of quality, Evolution of philosophy of Quality Management: Inspection, Quality Control, Quality Assurance, Total Quality Management, Cost of quality

Acceptance sampling: Design of single sampling plan. Double, multiple and sequential sampling plans,

O.C. curve, Producer‟s risk and consumer‟s risk, AOQ, AOQL

### Module-II (10 hours)

Statistical process control, Use of control charts and process engineering techniques for implementing quality plan, X-Chart, R-Chart, p-chart, np-chart, c-chart, cusum-chart, Process capability analysis, statistical tolerance analysis

Experimental designs and factorial experiments: 2kfactorial experiments, Taguchi philosophy; Loss function; Signal to noise ratio, Orthogonal arrays for parameter and tolerance design.

### Module-III (6 hours)

Definition – Reliability vs quality; Reliability function – MTBF, MTTR, availability; Bathtubcurve – time dependent failure models – distributions – normal, weibull; Reliability of system and models – serial,parallelandcombinedconfiguration;Economicanalysisandlifecyclecost;Proactive,preventive, predictive maintenance; Maintainability andavailability

### Module-IV (8 hours)

Quality Improvement: Fundamentals of TQM; Some important philosophies and their impact on

quality (Deming, Juran, Crossby); Quality circle, QC Tools;Service Quality; Quality Standard: Product and Process Standard, Introduction to ISO 9000 and 14000 standards; Concept of Six Sigma, Lean Management and TPM

### Books

* 1. Quality Planning and Analysis, Juran J M and Gryna F M,TMH
	2. Statistical Process Control and Improvement, A. Mitra,Pearson.
	3. Introduction to Statistical Quality control, D.C. Montgonery, John Wiley &sons.
	4. Introduction to /reliability and MaitainabilityEngg E. Ebeling, MC-GrawHill.
	5. Quality control and Application ,B.L. Hansen and P.M. Ghare, Prentice Hall ofIndia.
	6. Statistical Quality Control, M. Mahajan, Dhanpat Rai &Sons.
	7. K C Jain and A K Chitale, Quality Assurance and Total Quality Management,Khanna Publishers
	8. K.S. Krishnamoorthi& V. Ram Krishnamoorthi, “A First Course in QualityEngineering” CRCPress

### Course objectives:

UPEME503 Micro Fabrication

TointroducestudentsdifferentmethodsofmicrofabricationandappreciateIntegrationprocessesindetail. To educate on the applications of Micro fabrication techniques to disciplines beyond Mechanical engineering.

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

* + 1. Ability to design micro systems using micro machining techniques and know different micro fabricationsystem.
		2. Select the correct fabrication process for a specific micro-device or microsystem. Resource planning for a given microsystem fabrication and Be familiar withit.
		3. Identify how physical and chemical phenomena govern miniaturized systems for various applications

### Module-I (9 hours)

Introduction to Micro fabrication technologies and Materials for fabrication: substrate and wafers, siliconas a substrate material, crystal structure, single crystal andpolycrystalline, mechanical properties, siliconcompounds, silicon piezo-resistors, gallium arsenide, quartz, piezo-electric crystals, polymers, packagingmaterials, Fabrication equipment, Growth technology, Silicon-based process

### Module-II (10 hours)

Fabrication Processes: Photolithography, X-ray and electron beam lithography, Thin film deposition- spincoating,thermaloxidation,chemicalvapourdeposition(CVD),electronbeamevaporation,Physical vapor deposition- Deposition epitaxy, sputtering; Doping- diffusion, ion implantation;Etching- wet etching, dry etching,Silicon Anisotropic Etching, Dry Etching of Silicon- Plasma Etching-Deep

Reaction Ion Etching (DRIE)- Isotropic Wet Etching- Gas Phase Etchants- photoresists, Case studies.

### Module-III (17 hours)

Micro system manufacturing: Bulk Micro manufacturing- surface micro machining- Wafer bonding- glass-frit, anodic and fusion bonding- Structural and Sacrificial Materials- Acceleration of sacrificial Etch- LIGA- SLIGA-applications; Micro system packaging materials - die level - device level - system level - packaging techniques- die preparation- surface bonding - wire bonding - sealing. Mechanical micromachining- Chip formation- Size effect in micromachining- micro turning, micro milling,micro drilling-Micromachiningtooldesign-PrecisionGrinding-Partialductilemodegrinding-Ultraprecision grinding- Binder less wheel- Free formoptics.

### Module-IV (8 hours)

Microfabrication process integrations, Wafer IC manufacturing- feature micro fabricationtechnologies- PSM- IC industry- New Materials- Bonding and layer transfer- devices- clean room- yield modelmicro fabricationindustries.

### Books:

1. Sami Franssila, “Introduction to Micro Fabrication”, John Wiley and sons Ltd., UK,2004
2. Mark J. Jackson, “Microfabrication and Nanomanufacturing”, CRC Press,2006.
3. Peter Van Zant, “Microchip fabrication”, McGraw Hill, 2004.
4. V. K. Jain, “Micromanufacturing”,CRC press,2012.
5. N. P. Mahalik, “Micromanufacturing & Nanotechnology”,Springer.

### Module-1

UPEME504 Surface Engineering

Philosophy of surface engineering, general applications and requirements; Corrosion Processes: Basic principles of electrochemistry and aqueous corrosion processes; pitting, crevice and exfoliation corrosion;influenceofdepositsandanaerobicconditions;corrosioncontrol;hightemperatureoxidation and hot corrosion; corrosion/mechanical propertyinteractions.

### Module-2

Friction and Wear: Abrasive, erosive and sliding wear. The interaction between wear and Corrosion. Analytical Techniques: X-ray diffraction, TEM, SEM and WDP analysis, surface analysis by other techniques;

### Module-3

Surface Engineering: Philosophy; surface engineering as part of a manufacturing process; integrating coating systems into the design process; Coating Manufacture: Electro deposition; flame and plasma spraying; physical vapor deposition; chemical vapor deposition; surface treatments; paint and paint systems; Applications: Coating systems for corrosion and wear protection; new coating concepts including multi-layer structures, functionally gradient materials, intermetallic barrier coatings and thermal barrier coatings.

### Books:

1. SurfaceWearAnalysis,Treatment&Prevention-ASMInernational,MaterialsPark,OH,U.S.

A., 1st Ed. 1995

1. Advanced Thermally Assisted Surface Engineering - Kluwer Academic Publisher, MA, USA,2nd ed. 2002.

ULCME501 Machining Lab

Any six of the following experiments

1. Job on lathe with tapper turning, thread cutting, knurling and groove cutting (3experiments).
2. Gear cutting (with index head) on millingmachine
3. Working with shaper, Planner and slottingmachine.
4. Working with surface and cylindricalgrinding.
5. Determination of cutting force using Lathe tooldynamometer.
6. Determination of cutting force in drilling using drill tooldynamometer.
7. Study of Non-traditional machining processes.(USM, AJM, EDM,ECM)
8. Study of CNC Lathe and demonstration of making job in CNClathe.
9. Study of CNC Milling machine and demonstration of making job in CNC Millingmachine

ULCME502 HeatTransfer

1. Determination of Thermal conductivity of compositeslab
2. Determination of heat transfer coefficient in natural/forcedconvention.
3. Determination of surfaceemissivity
4. Performance test on parallel flow and counter flow heatexchanger
5. Efficiency and effectiveness of fins (Natural / Forcedconvection)
6. Determination of Critical heat flux during boiling heattransfer.
7. Verification of Stefan Boltzman’slaw.

ULCME503 Measurement and Metrology

Any eight of the following experiments

1. Calibration of LVDT using indicator /CRO
2. Calibration of load cell using electrical resistance straingauge
3. Calibration of a Rotameter for fluid flowmeasurement
4. Calibration of thermocouples
5. Calibration of Bourden Tube Pressure Gauge and measurement of pressure usingmanometer
6. Experiment on Pneumatictrainer
7. Experiment on Hydraulic trainer
8. Determinationofdampingcoefficientofvibrationabsorbingmaterialsusingvibrationmeasuring equipment.
9. Strain measurement using resistant straingauge
10. Measurement of straightness andflatness
11. Measurement of roughness of thesurface
12. Experiment on slip gauges and sinebar
13. Experimental stress analysis throughPhoto-elasticity.

# 6thSemester

### Prerequisites:

UPCME601 Machine Dynamics

Engineering Mechanics, Mechanics of Solid, Engineering Mathematics, Material Science, Kinematics and Dynamics of Machines

### Course objectives:

1. To understand the concepts of turning moment diagrams, flywheel design and the dynamics of reciprocatingengines.
2. To be able to design some linkage mechanisms and cam systems to generate specified output motion
3. Tounderstandthebalancingproceduresforrotatingandreciprocatingmasses,rotorsandengines.
4. To understand the fundamentals of free and forcedvibrations.
5. To understand the mechanisms forcontrol.

### Course Outcome

On successful completion of this course the students should be able to:

1. Demonstrateanunderstandingofturningmomentdiagramsinvariousapplications.Demonstrate skills to design flywheel for an IC engine and punching press with the consideration of geometrical and economical constraints.
2. Perform static and dynamic balancing of high speed rotary and reciprocatingmachines.
3. Analyze free and forced vibrations of machines, engines andstructures.
4. Calculate gyroscopic couple on various vehicles and apply concept ofgovernors.

### Module – I (12 hours)

1. Combined Static and Inertia Force Analysis: Inertia forces Analysis, Velocity and acceleration of slidercrankmechanismbyanalyticalmethod,Engineforceanalysis-Pistoneffort,forceactingalong

the connecting rod, Crank effort. Dynamically equivalent system, compound Pendulum, correction couple.

1. Mechanisms with lower pairs : Motor Vehicle Steering Gears - Davis Steering Gear & Ackermann Steering Gear, Hooke’sJoint.
2. Cams Design: Fundamental law of Cam, Cam Terminology, Classification of Cams and followers, Analysis of follower motions (Displacement, velocity, Acceleration and jerk) – Simple Harmonic, Uniform Velocity and Constant Acceleration & Retardation Types, Generation of Cam Profiles by Graphical Method, Introduction on Cams with specified contours.

### Module – 2 (12 hours)

1. Turning Moment Diagram and Flywheel: Turning moment diagram. Turning moment diagrams for differenttypesofengines,Fluctuationofenergyandfluctuationofspeed.DynamicTheoryofFlywheel, Flywheel of an internal combustion engine and for a punch machine. Determination of flywheel size from Turning MomentDiagram.
2. Mechanism for Control (Governors): Governors - Watt, Porter, Proell, Hartnell, Wilson-Hartnell Governor.Performanceparameters:Sensitiveness,Stability,Hunting,Isochronism.GovernorEffortand Power, Controlling Force & Controlling Force Curve, Friction & insensitiveness, Comparison between governor andflywheel.
3. Mechanism for Control (Gyroscope): Introduction to Gyroscopes. Gyroscopic forces and Couple. EffectofGyroscopicCoupleonAeroplanes,Gyroscopicstabilizationofship,StabilityofTwoWheelers and Four Wheelers. Rigid disc at an angle fixed to rotatingshaft.

### Module 3 (12 hours)

1. Balancing of rotating components and linkages: Static and Dynamic Balancing, Balancing of Single Rotating Mass by Balancing Masses in Same plane and in Different planes. Balancing of Several Rotating Masses rotating in same plane and in Different planes. Effect of Inertia Force due to ReciprocatingMassonEngineFrame,Partialbalanceofsinglecylinderengines.PrimaryandSecondary BalanceofMulti-cylinderIn-lineEngines.Balancingoflocomotive:variationoftractiveforce,swaying couple, hammer blow. Direct and Reverse Crank method of balancing for radial engines. Balancing of V-engine. Balancing machines: Pivoted-Cradle BalancingMachine.
2. Vibrations: Introduction to Mechanical Vibration – Definitions, elements of vibratory system, Longitudinal, Torsional & Transverse Systems. Differential equations and solutions of motion for a coupled spring mass system. Determination of natural frequency of vibratory systems using energy method, equilibrium method and Rayleigh’s method, Free and Forced Vibration of Un-damped and Damped Single Degree Freedom Systems, Logarithmic decrement, Magnification factor, Vibration isolation and transmissibility, whirling of shafts and Evaluation of Critical Speeds ofshafts.

### Text Books

1. Theory of Machines by S.S.Rattan, Tata MacGrawHill
2. Mechanism and Machine Theory by J.S.Rao and R.V.Dukipatti, New AgeInternational.
3. Theory of Mechanisms and Machines by A. Ghosh & A. K. Mallick, East WestPress.

### Reference

1. Theory of Machines by Thomas Bevan, CBSPublications.
2. Kinematics and Dynamics of Machinery by R.L.Norton, Tata MacGrawHill
3. Theory of Machines and Mechanisms (India Edition) by John J. Uicker Jr., Gordon R. Pennock and Joseph E. Shigley, Oxford UniversityPress
4. Kinematics & Dynamics of Machinery-Charles E. Wilson & J.Peter Saddler,PearsonEd.

**Objectives:**

UPCME602 Refrigeration and Air Conditioning

1. To familiarize with the terminology associated with refrigeration systems and airconditioning
2. To understand basic refrigeration processes
3. To understand the basics of psychrometry and practice of appliedpsychrometrics
4. To acquire the skills required to model, analyse and design different refrigeration as well as air conditioning processes andcomponents

**Course Outcomes:**

A student who has done the course will have a good understanding of the working principles of refrigeration and air-conditioning systems.

**Course Content:**

**Module – 1 (12 Hours)**

1. Air Refrigeration System : Introduction, Unit of refrigeration, Coefficient ofperformance,

Reversed Carnot Cycle, Temperature limitations, maximum COP, Bell Coleman air cycle, Simple Air Cycle System for Air-craft with problems.

1. Vapour Compression System : Analysis of theoretical vapour compressioncycle,

RepresentationofcycleonT-Sandp-hdiagram,Simplesaturationcycle,sub-cooledcycleandsuper- heatedcycle,Effectofsuctionanddischargepressureonperformance,Actualvapourcompressioncycle. Problem illustration andsolution.

1. Multi-stage compression and Multi-evaporator systems : Different arrangements of compressors and inter-cooling, Multistage compression with inter-cooling, Multievaporator system, Dual compression system. Simpleproblems

### Module – 2 ( 12 Hours)

1. Vapour Absorption System : Simple Ammonia - absorption system, Improved absorption system, Analysis of vapour absorption system (Specifically of analyzing coloumn and rectifier), Electrolux / Threefluidsystem,Lithium-bromide-watervapourabsorptionsystem,comparisonofabsorptionsystem with vapour compression system. Simple Problems andsolution.
2. Thermoelectric Refrigeration: Basics and Principle. Defining the figure of Merit. (NoProblem)
3. Refrigerants ; Classification of refrigerants and its degignation- Halocarbon(compounds,

Hydrocarbons, Inorganic compounds, Azeotropes, Properties of refrigerants, comparison of common refrigerants, uses of important refrigerants, Brines. Alternative refrigerants (Organic and inorganic compounds).

### Module – 3 (10 Hours)

1. Psychrometrics : Properties of air-vapour mixture, Law of water vapour-airmixture,

Enthalpy of moisture, Psychrometric chart, simple heating and cooling, Humidification, Dehumidification,

Mixture of air streams. Review question and discussions

Requirementsofcomfortairconditioning:Oxygensupply,Heatremoval,moistureremoval,airmotion, purityofair,Thermodynamicsofhumanbody,comfortandcomfortchart,effectivetemperature,factors governing optimum effectivetemperature

### Module – 4 (06 Hours)

1. Air Conditioning System: Process in air conditioning: Summer air conditioning, Winter air conditioning and year round air conditioning, Cooling load calculations. Review question and discussions.

### TEXT BOOKS :

1. Refrigeration and Air Conditioning by R.C. Arora , PHIPublication
2. Refrigeration and Air conditioning by C.P. Arora, Tata McGrawHill.
3. 2Refrigeration and Air Conditioning by S.C. Arora and S. Domkundwar, Dhanpat Rai &Sons. Chapters ;3,4,5,6,7,11,16,17,19,20
4. Refrigeration and Airconditioning Data book by ManoharPrasad

### REFERENCE BOOKS :

1. Refrigeration and Air conditioning by P.L. Ballney, KhannaPublishers.
2. Refrigeration and Air conditioning by Manohar Prasad,New Age internationalpublishers

### Module 1 (08 Hours)

UPEME601 Advanced Fluid Mechanics

Conceptofcontinuumanddefinitionofafluid.Bodyandsurfaceforces,stresstensor,Scalarandvector fields, Eulerian and Lagrangian description of flow. Motion of fluid element - translation, rotation and vorticity; strain rate tensor, continuity equation, stream function and velocitypotential.

### Module -2 (10 Hours)

Transporttheorems,constitutiveequations,derivationofNavierStokesequationsforcompressibleflow. Exact solutions of Navier Stokes equations : plane Poiseuille flow and Couette flow, Hagen-Poiseuille flow, flow between two concentric rotating cylinders, Stoke's first and second problem, Hiemenz flow, flowneararotatingdisk,flowinconvergent-divergentchannels.Slowviscousflow:StokesandOseen's approximation,

### Module - 3 (10 Hours)

Theoryofhydrodynamiclubrication.Boundarylayer:derivation,exactsolutions,Blasius,FalknerSkan, series solution and numerical solutions. Approximate methods. Momentum integralmethod.

### Module - 4 (08 Hours)

Two dimensional and axisymmetric jets.Description of turbulent flow, velocity correlations,

Reynold's stresses, Prandtl's Mixing Length Theory, Karman's velocity defect law, universal velocity distribution.

### Text Book:

1. Advanced Fluid Mechanics, Som and Biswas, Tata McGraw Hill

### Reference Books:

1. Fluid Mechanics, A.K.Mohanty, PHI
2. Fundamentals of Fluid Mechanics,Schlitching
3. Introduction to Fluid Mechanics, Shaughnessy, Oxford UniversityPress
4. Fluid Mechanics:-Frank M .White,TMH
5. Fluid Mechnics:- Cengel and Cimbala,TMH

**Course Objectives:**

UPEME602 Gas Dynamics

1. To understand the features of compressible isentropic flows and irreversibilities likeshocks.
2. To provide a basic knowledge of jet and rocket propulsiontechnologies.

**Course Outcomes:**

Upon completion of this course, the students will be able to apply gas dynamics principles to jet and space propulsion systems

**Contents:**

**Module - 1**

Compressible flow, definition, Mach waves and Mach cone, stagnation states, Mass, momentum and energy equations of one-dimensional flow, Isentropic flow through variable area ducts, nozzle s and diffusers, subsonic and supersonic flow

**Module - 2**

Variable area ducts, choked flow, Area-Mach number relations for isentropic flow

Non-isentropic flow in constant area ducts, Rayleigh and Fanno flows, Normal shock relations, oblique shock relations, isentropic and shock tables

**Module - 3**

Theory of jet propulsion, thrust equation, thrust power and propulsive efficiency, Operating principle and cycle analysis of ramjet, turbojet, turbofan and turboprop engines.

Types of rocket engines, propellants & feeding systems, ignition and combustion, theory of rocket propulsion, performance study, staging, terminal and characteristic velocity, space flights

**Text Books:**

1. Ahmed F. El-Sayed, Aircraft Prpoulsion and Gas Turbine Engines, CRC Press,2008.
2. H.S. Mukunda, “Understanding Aerospace Chemical Propulsion”, Interline Publishing,2004.
3. Hill P. and Peterson C., Mechanics & Thermodynamics of Propulsion, Addison Wesley,1992.
4. Zucrow N. J., Aircraft and Missile Propulsion, Vol.I& II, John Wiley,1975.
5. Sutton G.P., Rocket Propulsion Elements, John Wiley, New York,1986.

### Course Outcome:

UPEME603 Combustion Theory

After completing this course students will be able to:

* 1. Design the combustion chamber of furnaces, boiler, gas turbine and ICengine.
	2. Identify the combustion problems in any type of Powerplants.
	3. Able to compile the type of combustion and give the plan forbetterment
	4. Able to evaluate the flame propagation in different types of combustiongeometry. Able to predict and solve the combustion problems in IC engine and gasturbine

### Module - 1

CYCLEANALYSIS;Gas,steamandcombinedpowercycles,refrigerationandairconditioningcycles, The First and Second Laws of Thermodynamics applied tocombustion.

### Module - 2

COMBUSTION THEORY ; Fuels and types, combustion process, combustion mechanism; Governing equations for a reacting flow, General characteristics of combustion volumetric combustion, explosion and detonation, adiabatic flame temperature, flame propagation, stability, kinetics, combustion aerodynamics, gaseous detonations, flame ignition and extinction and condensed phase combustion, combustion in SI and CI engines, ignition and burning rate analysis.

### Module - 3

COMBUSTION SYSTEMS ; Solid burning equipments, stokers, pulverized coal burning systems, cyclone combustors, emissions, types of fluidized beds, fluidized bed combustion, fundamentals bubbling bed, gas and liquid burners types, gas turbine combustion systems, combustion modeling

### Module - 4

DESIGN OF COMBUSTION SYSTEMS ; Design of combustion systems for boilers, furnaces, gas turbines and internal combustion engines, combustion chamber performance.

PROPELLANT SYSTEMS; Types, theory of combustion, energy balance calculations

### Books:

1. C.R.FergusonandA.T.KirkPatrick,―InternalCombustionEngines,JohnWiley&Sons.Inc.2001.
2. Stephen R Turns, ―Introduction to Combustion: Concepts and Applications, McGraw Hill,2000
3. G.L. Borman and K.N. Ragland, ―Combustion Engineering, McGraw Hill, 1998.
4. D.Winterbone, ―Advanced Thermodynamics for Engineers, Elsevier,1996

### Module - 1 (12 Hours)

UPEME604 Tribology

Introduction : Lubricant and lubrication, Types of bearings, properties and testing of lubricants,

Basic equations: Generalized Reynolds equation, Flow and Shear Stress, Energy equation, Equation of stateHydrodynamiclubrication:Mechanismofpressuredevelopmentandloadcarryingcapacity,Plane- slider bearing, Idealized slider bearing with a pivoted shoe, Step bearing, Idealized journal bearing. – infinitely long journal bearing, Petroffs equation for a lightly loaded bearing, narrowbearing,

### Module - 2 (11 Hours)

Oil flow and thermal equilibrium - Heat balance of lubricants Hydrostatic Bearing**:**

Principles, Component of hydrostatic lubrication , Hydrostatic circular thrust bearing , calculation of pressure, load carrying capacity, flow rate , power loss in bearing due to friction.

### Module - 3 (12 Hours)

Concept of gas lubricated bearing

Concept of Elastohydrodynamic lubrication, Design and selection of antifriction bearing Friction and wear of metals :

Theories of friction, surface contaminants, Effect of sliding speed on friction, classification and mechanism of wear, Wear resistant materials.

### Text Books

1. Introduction to Tribology of Bearing , B.C .Majumdar , S. Chand & Co

### Reference Books

1. Fundamentals of Tribiology , Basu S K., Sengupta A N., Ahuja B. B., , PHI2006
2. Basic Lubrication theory, A. Cameron, John Wiley &sons
3. Lubrication Fundamentals, D.M.Pirro and A.A.Wessol, CRCPress
4. Theory and Practice of Lubrication for Engineers**,** Fuller, D., New York company1998
5. Principles and Applications of Tribiology**,** Moore, Pergamaon press1998
6. Tribiology in Industries**,** Srivastava S., S Chand and Company limited, Delhi2002
7. Lubrication of bearings – Theoretical Principles and Design**,** Redzimovskay EI., Oxford press company2000

UPEME605 Advanced Mechanics of Solids (AMOS)

### Modules - 1 (12 Hours)

Elementary concept of elasticity, stresses in three dimensions, Principal Stresses, Stress Invariants, Mohr’s Circle for 3-D state of stress, Octahedral Stresses, State of pure shear, Differential equations of equilibriumandcompatibilityconditions,planestress.Analysisofstrain,Stateofstrainatapoint,Strain Invariant,PrincipalStrains,Planestateofstrain,Strainmeasurements.TheoriesofFailure,Variousyield criteria

### Modules - 2 (14 Hours)

Energy Methods: Work done by forces and elastic strain energy stored. Reciprocal relations,

Theorem of virtual work, Castigliano’s theorems, Bending of beams: Asymmetrical bending, Shear centre, Bending of curved beams, Stress distribution in beam with rectangular, circular and trapezoidal cross section, stresses in crane hooks, ring and chain links., Deflection of thick curved bars. Axisymmetric problems: Thick walled cylinder subjected to internal and external pressures, Compound cylinders, Shrink fit,

### Modules - 3 (10 Hours)

Repeated stresses and fatigue in metals, Fatigue tests and fatigue design theory, Goodman, Gerber and Soderberg criteria, Concept of stress concentration, Notch sensitivity. Introduction to Mechanics of Composite Materials: Lamina and Laminates, Micromechanics of FRP Composites. Introduction to Fracture Mechanics: Basic modes of fracture, Fracture toughness evaluation.

### Text Book:

1. Advanced Mechanics of Solids, L.S. Srinath, Tata McGrawHill
2. Advanced Mechanics of Materials: Boresi and Schmdt,Willey
3. Strength of Materials by G. H. Ryder, MacmillanPress

### Reference Book:

1. Advanced Mechanics of Materials: Siley andSmith
2. Strength of Materials Vol.II, byS.Timoshenko
3. Mechanics of Materials by Beer and Johnston, Tata McGrawHill
4. Mechanics of Materials by R.C.Hibbeler, PearsonEducation
5. Mechanics of Materials by William F.Riley, Leroy D.Sturges & Don H.Morris, WileyStudent.
6. Mechanics of Materials by James M. Gere, ThomsonLearning
7. Strength of Materials by S. S. Rattan, Tata Mc GrawHill

UPEME606 Simulation, Modeling & Control

### Module – 1 (14 Hours)

Basic simulation modeling, Discrete event simulation, Simulation of queuing and inventory systems, Continuous, Discrete-continuous and Monte Carlo simulations.

Statistical models in simulation, Discrete and continuous distributions, Poisson process, Empirical distribution,

Generation of pseudo random numbers, Analysis of simulation data, Parameter estimation, Goodness- of-fit tests, Multivariable time series models.

### Modules - 2 (12 Hours)

Overview of feedback control systems, Dynamics of mechanical systems, Differential equations and statevariableform,Modelsofelectromechanical,Heat-andfluidflowmodels,Linearizationandscaling, Models from experimental data, Dynamic response using pole-zero locations, Time domain specifications, Classical 3-term controllers and its digital implementation, Stability analysis by Routh Criterion.

### Modules - 3 (10 Hours)

Simulationofmanufacturingandmaterialhandlingsystems,Goalsandperformancemeasures,Modeling downtime and failures, Trace driven models, Casestudies.

### Text Books:

* 1. Discrete-Event system simulation by Jerry Banks, J.S. Carson, B.L. Nelson and D.M. Nicol (PearsonPublications).
	2. Feedback control of dynamic systems by G.F. Franklin, J.D. Powell, A-Naeini, Pearson Publications.
	3. Simulation modeling and analysis by A.M. Law, W.D. Kelton, Tata McGrawHillPublications.

UPEME607 Soft Computing Applications

**Prerequisites** Engineering Mathematics

### Course objectives:

1. To introduce the concepts of neural networks and advanced neuralnetworks
2. To understand the fundamentals of fuzzy sets and fuzzylogic
3. To establish basic knowledge about optimization techniques in softcomputing.

### Course Outcome

On successful completion of this course the students should be able to:

1. Design soft computing techniques for various applicationsdomains
2. An ability to design, implement and evaluate a system / computer based system process, component or program to meet desiredneeds.
3. An ability to identify, formulate and solve engineeringproblems.

### Course Content:

**Module – 1: Neural Networks (12 hours)**

Introduction to Soft Computing, Artificial Neural Network(ANN) : History, Mathematical model of neuron, Fundamentals of ANN, Basic Models of an artificial Neuron, Neural Network Architecture, Learning methods, Terminologies of ANN, Perceptron, network, Backpropagation network, Backpropagationlearninganditsapplications,VariantsofBPA,AssociativeMemory:Autocorrelation, Hetero Correlation, Exponential BAM, Adaptive Resonance Theory: Vector Quantization, ART1, ART2, applications, Kohonen’s Self OrganizingMap.

Applications - Real life Problems: Design of Journal Bearing, Hot Extrusion of Steel using MATLAB.

### Module – 2: Fuzzy Logic Techniques (12 hours)

UncertaintyandImprecision,Chancevsambiguity,FuzzySets,FuzzyRelations,Membershipfunctions, PropertiesofMembershipfunctions,FuzzificationandDefuzzification.ClassicalLogicandFuzzylogic, Fuzzy Rule based systems, Fuzzy Decision making, Fuzzy Classification, Fuzzy Pattern Recognition, Hybrid Soft Computing Techniques Hybrid system, neural Networks, fuzzylogic.

Applications - Real life Problems: Fuzzy Washing Machines, Fuzzy Systems in Cars, Fuzzy Control of a Cement Kiln, Fuzzy Control of Subway Train using MATLAB.

### Module – 3: Optimization Techniques (12 hours)

Derivative based Optimization – Descent Methods – Genetic Algorithms – Ant Colony Optimization – Particle Swarm Optimization

Case Study - fraud detection, health care using Soft computing techniques.

### Text Books

1. Neuro Fuzzy and Soft Computing, J. S. R. JANG,C.T. Sun, E. Mitzutani,PHI
2. NeuralNetworks,FuzzyLogic,andGeneticAlgorithm(synthesisandApplication)S.Rajasekaran,

G.A. Vijayalakshmi Pai, PHI

### Reference

1. Fuzzy Logic with Engineering Applications, T.J. Ross, McGraw BooksHill.
2. Genetic Algorithms: Search, Optimization and Machine Learning, Davis E. Goldberg, Pearson Educaton.
3. Introduction to Artificial Neural systems, Zurada, J.M., Jaico PublishingHouse.

**Course Objective:**

UPEME608 Computer Aided Design

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

**Course Outcome:**

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

**Course Contents:**

Fundamentals of Computer Graphics- Product cycle, sequential and concurrent engineering,

Computer Aided Design, CAD system architecture, computer graphics, Coordinate systems, 2D and 3D transformations, viewing transformation

Geometric Modeling- representation of curves, Hermite curves, Bezier curves, B-spline curves, rational curves,Techniquesofsurfacemodelling,surfacepatch,Coonsandbicubicpatches,Bezier andB-spline surfaces, Solid modelling techniques, CSG andB-rep.

Visual realism- hidden line-surface-solid removal algorithms, shading, colouring, computer animation

Assembly of parts- assembly modelling, interferences of positions and orientation, tolerance analysis, mass property calculations, mechanism simulation and interefence checking

CAD standards- Graphical Kernel System (GKS), standards for vexchange images, Open Graphics Library (OpenGL), Data exchange standards- IGES, STEP, CALS etc., Communication standards

**Text Books:**

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

ULCME601 Design of Machine ComponentLab

1. Design of any one working model related to Design of machine components i.e., Module I andII.
2. Design of any one working model related to Design of machine components i.e., ModuleIII
3. Design & drawing of pressurevessel
4. Design and drawing oflever
5. Design and drawing of belt drive andpulley
6. Design ofclutch
7. Design and drawing ofbrake
8. Design ofpiston
9. Design of connecting rod, crankshaft

Total number of Design: 1 and 2 are compulsory and any 5 from the rest. One or two designs should be in AutoCad/Pro-E/ CATIA/ANSYS

ULCME601 Numerical Computation lab

1. Basics of MATLAB or similarsoftware/language
2. Finding solution by Numerical Methods (including graphics) for the following: **(Minimum 06problems)**
	1. BisectionMethod
	2. Newton-RaphsonMethod
	3. SecantMethod
	4. Gauss EliminationMethod
	5. NumericalDifferentiation
	6. Numerical Integration (e.g. Newton CotesQuadrature)
	7. Curve fittingMethod
	8. Initial-Value Problems (e.g. Runge-Kutta Method)
	9. Boundary Value Problem (eg. ShootingMethod)
	10. Eigen ValueProblem
3. Using Solid Modeling software eg. AUTOCAD / ProE / CATIA / SolidWorksetc)
	1. Learning the Basics of Solid ModelingSoftware
	2. Describe and Apply the CONE, SPHERE and TORUS command to draw solidprimitives
	3. Describe and Apply the EXTRUDE and REVOLVE command to draw solid models that can not be drawn witha composition ofprimitives

Minimum 05 experiments

ULCME601 RAC Lab

* + 1. Determination of C.O. P on vapour compressionsystem
		2. Determination of C.O. P on vapour absorptionsystem
		3. Performance test on Air conditioning test rig (Windowtype)
		4. Performance test on Air conditioning test rig (Ducttype)
		5. Determination of C.O.P of iceplant
		6. Determination of C.O.P of HeatPump
		7. Performance analysis in an experimental coolingtower.

# 7thSemester

UPCME701 Project and Production Management

### Course Objective:

The course aims at acquainting all engineering graduates irrespective of their specializations the basic issues and tools of managing production and operations functions of an organization.

### Module - 1 (12 Hours)

1. Operations Function in an Organization, Manufacturing Vrs Service Operations, System view of Operations, Strategic Role of Operations, Operations Strategies for Competitive Advantage,Operations Quality and Productivity Focus, Meeting Global Challenges of Production and OperationsImperatives.
2. Designing Products, Services and Processes: New Product Design- Product Life Cycle, Product Development Process, Types of Production Systems: Jobshop, Batch, Mass Production; Process Technology Trends, FMS, CIM, CAD, CAM; Design for Services, Services ProcessTechnology.
3. LocationandLayoutPlanning:FactorInfluencingPlantandWarehouseLocations,ImpactofLocation on cost and revenues. Layout Planning: Process Layout, Product Layout, Fixed Position Layout, Line balancing, computerized layout planning- overview, GroupTechnology
4. Work Study: Methods Study- Techniques of Analysis, recording, improvement and standardization; Work Measurement : Work Measurement Principles using Stopwatch Time Study, Predetermined Motion Time Standards and Work Sampling, Standard TimeEstimation.

### Module - 2 (12 Hours)

1. Forecasting : Principles and Method, Moving Average, weighted Moving Average,Exponential

Smoothing, Winter’s Method for Seasonal Demand, Forecasting Error.

1. Manufacturing Planning and Control: Aggregate Planning, Master Production Scheduling, Material Requirements Planning, Capacity RequirementsPlanning.
2. Sequencing and Scheduling: Single Machine Sequencing : Basics and Performance Evaluation Criteria,MeanFlowTime,Flowshopsequencing:2and3machinescases:Johnson’sRuleandJobshop Scheduling: Priority dispatchingRules.
3. Inventory Control: Relevant Costs, Basic EOQ Model, Model with Quantity discount, Economic Batch Quantity, Periodic and Continuous Review Systems, Safety Stock, Reorder Point and Order Quantity Calculations. ABCAnalysis.
4. ModernTrendsinManufacturing:OverviewofJustinTime(JIT)System,TotalQualityManagement, Total Productive Maintenance, ISO 9000, Quality Circle, Kaizen, PokaYoke, Supply Chain Management.

### Module - 3 (8 Hours)

1. Attributes of a Project, Project LifeCycle
2. Project feasibility Analysis: Technical feasibility, commercial and financial visibility, Environment Analysis. BreakevenAnalysis
3. Project Execution: work breakdown structure, Network Techniques: AOA and AON, CPM and PERT, Resource allocation, Crashing and ResourceSharing

### Text Books:

1. S.N.Chary, “Production and Operations Management”, Tata McGrawHill.
2. R. Paneerselvam, “Production and Operations Management, Prentice Hall ofIndia.
3. Aswathappa & Bhatt – Production & Operations Management, HPH.
4. Gaither & Frazier - Operations Management, CengagePublication
5. Russell & Taylor - Operations Management, PHIPublication
6. Chase, Aquilanno, Jacob & Agarwal - Operations Management, TMHPublication.
7. E.E. Adam and R.J. Ebert “Production and Operations Management”, Prentice Hall ofIndia

UPEME701 Power Plant Engineering

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

* 1. Describe different sources of energy, understand & explain the principle of power generation. Select suitablelocation.
	2. Analyze & evaluate the design layout of steam, Nuclear, Oil based Powerplant.
	3. Calculate the performance of Power plant, Load factor, Capacity factor, Cost of power generation, EnergyTarrifs
	4. Describe the working principle of the nuclear power plant and safetyinvolved.
	5. Understand the alternative sources of energy and the working of different non conventional powerplant

### UNIT-I ( 10 HOURS)

**Introduction**: Energy sources for electric power generation (Conventional and non-

conventional),Principal types of power plant, Brief layout of different power plants, Site selection of power station, Present energy scenario of India, Central power station.

**Economics of power generation:** Load & load duration curves, Base load and peak load power plant, load estimation, variable load problem, Costs of electric generation (fixed, Operating cost),depreciation and replacement , Factors affecting economics of generation and distribution, energy rates (Tarrifs),Performance and operating characteristics. Economic load sharing.

### UNIT-II ( 10 HOURS)

**Steam power plant** : Overview of thermodynamic cycle, Heat balance & Efficiencies in steam power plant, Modern high pressure boilers, Deaeration, Coal & ash handling system, Dust Collectors, Co- generation of power plant & process heat, Combined Cycle power plant: Coal based combined plant, Integratedgasification(IGCC),Combined-MHDsteampowerplant,Thermoelectricsteampowerplant.

**Fuels & Combustion**: Fuels, Combustion reaction, Heat & enthalpy of combustion, free energy of formation, Equilibrium constant, Combustion Mechanism, Combustion equipment.

### UNIT-III ( 16 HOURS)

**Diesel Power Plants**: General layout, Components of Diesel engine power plant, Application of diesel engines in power field, Advantages and disadvantages, Performance characteristics, Diesel plant operation & efficiency, Comparison with steam based power plant.

**Nuclear Power Plant:** Nuclear fuels, Fusion ,Fission ,Chain reactions, Types of nuclear reactors, Pressurizedwaterreactor,BWR,CANDUreactor,Gas-cooledreactor,Liquidmetalfastbreederreactor, Uranium enrichment, Nuclear Safety and disposal of nuclear waste, India's nuclear powerstations.

**Non-ConventionalPowerplants**:Solarthermalandsolarphotovoltaicplants,Windpowerplants,Bio- mass plants, Geothermal power plant, Tidal power plant,Brief idea about Components, working & selectioncriteria.

### Texts/Reference:

1. Power Plant Engineering: P.K. Nag: Tata McGraw HillPublisher
2. Power Plant Engineering: G.R.Nagpal: Khanna Publication
3. A Course in Power Plant Engineering: Arora & Dom Kundwar: Dhanpat Rai &Sons
4. Power Plant Engineering: P.C. Sharma: S.K. Kataria &Sons
5. Power Plant Technology, M.M. El-Wakil, McGraw-HillEducation

UPEME702 Non-conventional Energy

**Prerequisites:** Thermodynamics, Fluid Mechanics

### Course outcomes:

* + Learnthefundamentalsofsolarenergyconversionsystems,availablesolarenergy,solarthermal and PVapplications.
	+ Learnhowtoadvancethecurrenttechnologyofthesolarenergysystemsformakingtheprocess economical, environmentally safe andsustainable.
	+ Learn the basics of wind, geothermal, ocean thermal, tidal, bio mass, wave and fuelcell.
	+ Apply the non conventional energy sources for day to day applications for betterenvironment.

### Module 1: (10 Classes)

Energy, Ecology and environment: Introduction, Classification of Energy Resources, Common Forms of Energy, Energy Chain, Advantages and Disadvantages of Conventional Energy Sources, Importance and Salient Features of Non-Conventional Energy Sources, Environmental and ecological Aspects of Energy use, Environment-Economy-Energy and Sustainable Development, World Energy Status, Energy Scenario in India. Energy Conservation and Energy Storage: Salient Features of “Energy Conservation Act, 2001”, Various Aspects of Energy Conservation, Principles of Energy Conservation, General Electrical ECO’s (Energy Conservation Opportunities),

### Module 2: (15 Classes)

Solar Energy: Basics, The Sun as a Source of Energy, Sun, Earth Radiation Spectrums, Extraterrestrial and Terrestrial Radiations, Spectral Energy Distribution of Solar Radiation, Depletion of Solar Radiation, Measurements of Solar Radiation, Solar Time (Local Apparent Time), Solar Radiation Geometry, Solar Day Length, Empirical Equations for Estimating Solar Radiation( Hourly Global, DiffuseandBeamRadiations)onHorizontalSurfaceUndercloudlessandcloudySkies,SolarRadiation on Inclined Plane Surface only (empirical relations for numerical). Solar Thermal Systems: Solar Collectors: Flat plate and concentric collectors, Solar Water Heater, Solar Passive Space - Heating and Cooling Systems, Solar Refrigeration and Air Conditioning Systems, Solar Cookers, Solar Furnaces, Solar Green House, Solar Dryer, Solar Distillation (or Desalination of Water ), Solar Photovoltaic Systems: Solar Cell Fundamentals, Solar Cell Characteristics, Solar Cell Classification, Solar Cell, Module, Panel and Array Construction, Solar PV Systems, Solar PVApplications.

### Module 3: (15 Classes)

Wind Energy: Origin of Winds, Nature of Winds, Wind Turbine Siting, Major Applications of Wind Power, Wind Turbine Types and Their Construction, Wind Energy Conversion Systems (WECS), Effects of Wind Speed and Grid Condition (System Integration), Biomass Energy: Photosynthesis Process,UsableFormsofBiomass,theirCompositionandFuelProperties,BiomassResources,Biomass Conversion Technologies, Urban Waste to Energy Conversion, Biomass Gasification ,Biomass Liquefaction,BiomasstoEthanolProduction,BiogasProductionfromWasteBiomass,EnergyFarming. Geothermal Energy: Applications, Origin and Distribution of Geothermal Energy, Types of a. Geothermal Resource. Ocean Energy: Tidal Energy, Wave Energy, Ocean Thermal Energy 8. Fuel Cell Technology: Types, Principle of operation, Advantages anddisadvantages.

### Text Books:

1. Solar Energy Technology: Sukhatme and Nayak,TMH
2. Renewable Energy Sources and Emerging Technology: D.P.Kothari and etal.,PHI
3. Renewable Energy Sources & Conversion Technology: N.K.Bansal, Manfred Kleenman & Michael Meliss, TMHPublication.
4. Non Conventional Energy Sources: B.M Khan, TMHPublications

UPEME703 Automobile Engineering

**Course description**: After completing this course, students will have a broad and fundamental understanding of Automobile Engineering. Topics range from a classification of automobile to details

subsystemsofvehiclesuchasengine,clutch,gearbox,transmissionline,differentialgearbox,typesof axles,steeringsystem,breakingsystemandelectricalsystemoverdrivesuspensionsystemetc.andcareer options available within thisfield

### Course Objectives:

* 1. To study basics of principles of actual automobilesystems.
	2. To study importance and features of different systems like axle, differential, brakes, Steering, suspension, and balancingetc
	3. To study working of various AutomobileSystems.
	4. To know some modern trends in AutomotiveVehicles.

### Course Outcomes:

Course objectives are to be fulfilled. Students learn and become familiar with

1. UnderstandtheConstruction,workingandotherdetailsaboutInternalCombustionEnginesused in automobiles
2. Identify Construction, working, preventive maintenance, trouble shooting and diagnosis of various AutomobileSystems.
3. Understand importance and features of different systems like axle, differential, brakes, steering, suspension, and balancingetc.
4. Identify Modern technology and safety measures used in AutomotiveVehicles

### Course Content:

**Module 1:**

Classification of automobiles, chassis, body, layout types, Sub-systems of automobile PowerUnit:- Functions and locations power for propulsion, Engine parts-types, construction and functions, multiple cylinder engines. General considerations of engine balance vibration, firing order road performance curves.

### Module 2:

Fuel feed systems: - fuel feed systems for petrol engines. Fuel pumps, Basicprinciples of MPFI and CRDI. Multipoint Fuel Injection Systems (MPFI), Common Rail Diesel Injection Systems (CRDI), Cooling system: purpose, types of cooling system, troubles and remedies of cooling system.

Lubrication: - Types of lubricants, multi viscosity oils, chassis lubrication. Engine lubrication:-types of lubricating systems, crankcase ventilation, and Engine lubrication troubles and remedies.

### Module 3:

Transmission system: - Construction, transmission, requirements of single plate friction clutch and multiplateclutch,clutchadjustments,clutchtroublesandremedies.GearBoxes:-Slidingmesh,constant meshandsynchromeshgearbox,functionofoverdrives,troubleshootingandremedies.Propellershaft, Hotchkiss drive torque tube drive, differential, Final drives Types of rearaxles.

### Module 4:

Brakingsystem:-Mechanical,hydraulicbrakes,powerbrakes,airbrakesandvacuumbrakesFault findingandmaintenanceofbrakes,Steeringsystem:-Function,typesoflinkages,Steeringgears, steering gear ratio. Wheelalignment, steering geometry, & their

effects, Introduction of power steering.

Suspensions: - Types of Rigid, axle and independent suspension system, shock absorbers.

### Module 5:

Startermotordrive-Bendixdrive,overrunningclutchdrive,Solenoidswitch;solenoidsswitch.Ignition system:-Batterycoilandmagnetoignitionsystem,Ignitiontiminganditseffectonengineperformance, Ignition advance mechanisms, Electronic ignitionsystem.

**Electrical vehicles**: History, electrical vehicles and the environment pollution, description of electric vehicle,operationaladvantages,presentEVperformanceandapplications,batteryforEV,Batterytypes and fuel cells, Solar powered vehicles, hybridvehicles.

### Module – 1

UPEME704 Automatic Control System

**Introduction**: Control systems, Feedback and its effects. Transfer Function, Block Diagram and Signal Flow Graph: Impulse response and Transfer functions of linear systems, Block diagrams.

### Module – 2

**Mathematical Modeling of Physical Systems:** Equations of electrical networks, Modeling of mechanical system elements, Equations of mechanical systems. State-variable Analysis of Linear Dynamic Systems: Matrix representation of state equations, State transition matrix, State transition equation, relationship between state equations and high-order differential equations, relationship between state equations and transfer functions, Characteristic equation, eigen values and eigen vectors.

### Module – 3

**Time-Domain Analysis of Control Systems:** Typical test signals for the time response of control systems, Time- domain performance of control systems- The steady- state error, Time-domain performance of control systems- Stability of control systems- stability, Characteristic equation and the state transition matrix, Methods of determining stability of linear control systems, Routh- Hurwitz criterion.

### Module - 4

**Frequency-domainAnalysisofControlSystems:**Introduction,Nyquiststabilitycriterion,Application of the Nyquist criterion, Stability of multi loop systems, Stability of linear control systems with time delays.

Text Books:

1. Automatic Control Systems, by Benjamin C. Kuo. PHIPublication
2. Control Systems Engineering by Nagrath/Gopal ,New ageinternational.

UPEME705 Advanced Manufacturing Processes

**Prerequisite:** Basic Manufacturing Process

### Module-1

Non-traditional machining processes – classification.

Chemical and electrochemical processes - material removal - maskants and etchants – types of chemical material removal - application and limitations - Electrochemical material removal. Thermo-electrial

processes-types-electricaldischargingmachining,electronbeammachining,ionbeammachiningand plasma arc machining. Mechanical processes - ultrasonic machining abrasive jet machining - abrasive flow machining - water jetcutting.

### Module-2

SpecialMachiningProcesses-polygonalturninganddrillingdeepholedrillingandtrepanning-shaped tube electrolytic machining - thread rolling - roller burnishing – electrical discharge wire cutting - thermal deburring - orbital grinding micromachining – Numerical control and automatedprocesses.

### Module-3

Introduction to nano-technology processes.

### Books:

1. Production Technology by HMT, Tata McGraw Hill,2002.
2. Wellar, P.C., Non-Traditional Machining Processes, SME, Michigan,1984.
3. Pandey, P.C., Modern Machining Processes, Tata McGraw Hill Company,2004.
4. Serope Kalpakjian, Manufacturing Processes for Engineering Materials, 3rd ed., Addison Wesicy Publishing Company,19

UPEME706 Micro Electro Mechanical System (MEMS)

### Course objectives:

To gain basic knowledge on overview of Micro electro Mechanical System (MEMS) with emphasis on basic principles, limitations and application in various fields. And to introduce the students various opportunities in the emerging field of MEMS.

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

* 1. Be fluent with the design, analysis and testing the MEMS basedcomponents.
	2. Explore the applications of MEMS in variousfields.
	3. UnderstandthebasicprincipleofMicrosensorsandactuatorsandbefamiliarwiththeimportant concepts applicable to MEMS, theirfabrication.

### Course Content:

**Module – 1 (10 hours)**

Introduction to MEMS and Micro-systems and their products: History of MEMS Development, Microsystems, Characteristics of MEMS, miniaturization, microelectronics integration, applications. Micro-system Modeling and Design: Mechanics of deformable bodies, Energy method, Estimation of stiffness and damping for different micro-structures, Modeling of electro-mechanical systems, Pull-in voltage.

### Module - 2 (12 hours)

ElectricalandmechanicalpropertiesofMEMSmaterials:Conductivityofsemiconductors,crystalplane and orientation, stress and stain- definition- relationship between tensile stress and stain- mechanical properties of silicon and thin films, Flexural beam bending analysis under single loading condition- Typesofbeam-deflectionofbeam-longitudinalstainunderpurebendingspringconstant,torsional

deflection, intrinsic stress, resonance and quality factor.

### Module - 3 (17 hours)

MEMSApplications:Mechanicalsensor,Principlesofsensingandactuation,Chemicalsensors,Optical sensors, Pressure sensors, Thermal sensors- thermopiles, thermistors, micro-machined thermocouple probes, thermal flow sensors, MEMS magnetic sensor, Piezoelectric material as sensing and actuating elements-capacitance, piezo mechanics, Piezo actuators as grippers, microgrippers, micromotors, microvalves, micropumps, micro accelerometers, microfluidics, shape memory alloy based optical switch, thermally activated MEMS relay, micro spring thermal actuator, data storage cantilever.Radio frequency MEMS: Inductor, Varactor, Filter, Resonator.bio and chemodevices

### Module - 4 (8 hours)

Microsystems designand packaging: Design considerations,Mechanical Design, Processdesign, Realization of MEMScomponents using intellisuite.Micro system packaging, PackingTechnologies, Assembly ofMicrosystems, Reliability inMEMS.

### Books:

1. Foundations of MEMSby Chang Liu, Pearson International Edition,2006.
2. Microsensors, MEMS and Smart devices Julian by W.Gardner and Vijay K Varadhan. John Wiley & sons,2001.
3. Micro and Smart Systems by G.K. Ananthsuresh, K.J. Vinoy, S. Gopalakrishnan, K.N.Bhatand

V.K. Atre. Wiley India, New Delhi, 2010.

1. MEMS by N.P. Mahalik, Tata McGraw-Hill, New Delhi,2007.
2. MEMS and Microsystems: Design and Manufacture by T. Hsu, Tata McGraw-Hill, NewDelhi, 2002.

### Course Outcomes:

UPEME707 Ergonomics

On completing this course successfully, the student will be able to:

1. Apply ergonomic principles to the creation of safer, healthier and more efficient and effective activities in theworkplace;
2. Conduct ergonomic risk assessments;
3. Develop appropriate control measures for ergonomic riskfactors;
4. Design a workplace according to good ergonomic principles;
5. Assess ergonomic aspects of the working environment and workorganization.

### Course Content:

**Module 1**

Introduction: The evolution of Ergonomics, reasons to use ergonomics, micro- and macro- ergonomics, performing ergonomics, judging the effectiveness of ergonomics intervention. Discipline approach: Ergonomics/ Human factors: Mutual task comfort: two-way dialogue, communication model, Ergonomics/ human Factors fundamentals, Physiology (work physiology) and stress.

### Module 2

ErgonomicsMethodsandTechniques:Observationalexperimentalmethodsidentifiedwhichcanbeused for investigation,sothat work, equipment and planned systems can be improved for humanuse.

Work Design: Task analysis and allocation of functions, User trials, problem solving-scientific method.

Ergonomicriskassessment:Definitionsofhazardandrisk,priorities,riskevaluationquantityandquality of risk, overall ergonomic approach, control measures monitoring andfeedback

### Module-3

Workplace, Job and Product Design:Important aspects in the design of workplaces, jobs and their results

-productsandservices-areoutlined,sothatmoreeffectiveandhealthierworkcanbeachieved.Existing data and routes to further sources of information areemphasized.

Workspace layout and equipment design:Principles of workstation and system design, space and workstation design principle, risk to health: Musculoskeletal problems, visual fatigue, mental stress, requirement fors eye tests.

### Module-4

Design considerations for visual display unit (VDU) stations: Ergonomic factors, workstations, design of work and practice, carrying out assessments of risk at VDU workstation

Controls, Display and information: Visual, auditory and other display, Quantitative and qualitative information,Warning,signsandlabels,sourcesandselectionofdata,principlesofsoftwareergonomics.

Relevant physical factors of the work environment: Lightning- visual acuity and color vision, lightning levels and contracts, reflection and flicker fusion, Noise- noise induced hearing loss, distraction, annoyance and emergency signal, Thermal environment- body temperature regulation, subjective assessment, thermal comfort and discomfort.

### Books:

1. Bridger, RS: Introduction to Ergonomics, 2nd Edition, Taylor &Francis,2003.
2. Dul, J. and Weerdmeester, B. Ergonomics for beginners, a quick reference guide, Taylor & Francis, 1993.
3. Green, W.S. and Jordan, P .W, Human Factors in Product Design, Taylor & rancis,1999.
4. D. Chakrabarti, Indian Anthropometric Dimensions for ergonomic designpractice, National Institute of Design, Ahmedabad, 1997
5. G. Salvendy (edit), Handbook of Human Factors and ergonomics, John Wiley & Sons,Inc.,1998
6. Singh, S (Edt), Ergonomics Interventions for Health and Productivity,Himanshu Publications, Udaipur, New Delhi,2007

UPEME708 Product Design & Production Tooling

### Course objectives:

To introduce students Design for Manufacturing and Assembly, analytical tools for developmentas well as conceptualize, design, and manufacture competitively-priced quality products.

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

* 1. Identify appropriate combination of tools, jigs and fixture, suitable for a particular machining operation
	2. Identify press tool requirements to build concepts pertaining to design of presstools
	3. Design the forging machinedies
	4. learn the modern tools inmanufacturing

### Course Content

**Module– 1: (14 Hours)**

Product Design-Product design considerations, product planning, product development, value analysis, product specification. Role of computer in product design. Process Planning – selection of processes, machines and tools. Design of sequence of operations, Time & cost estimation

### Module – 2: (14 Hours)

Forging design- allowances, die design for drop forging, design of flash and gutter, upset forging die design. Sheet metal working- Design consideration for shearing, blanking piercing, deep drawing operation, Die design for sheet metal operations, progressive and compound die, strippers , stops, strip layout.

### Module – 3: (14 Hours)

Design of jigs and fixtures, principle of location and clamping, clamping methods, locating methods, Drill Jig bushing, Indexing type drilling Jig. Design of single point cutting tool, broach and form tool. Tooling design for turret lathe and automats. Design of limit gauges.

### Books:

1. Product Design & Manufacturing, A K Chitale, R C Gupta, Eastern Economy Edition,PHI.
2. Product Design & Development, Karl T Ulrich, Steven D Eppinger, Anita Goyal, Mc GrawHill.
3. A Textbook of Production Engineering, P.C. Sharma, S. Chand &Co
4. Fundamentals of Tool Engineering design, S.K. Basu, S.N. Mukherjee, R. Mishra, Oxford & IBH Publishingco.
5. Technology of Machine Tools, Krar, Gill, Smid, Tata Mc GrawHill
6. Jigs & Fixture Design, Edwrd G Hoffman, CengaeLearning.

UHSMH701 EntrepreneurshipDevelopment

### Module-I: (10 Hours)

Entrepreneurship:ConceptofEntrepreneurshipandintrapreneurship,TypesofEntrepreneur,Natureand Importance, Entrepreneurial Motivation and Achievement, Entrepreneurial Personality & Traits and EntrepreneurialSkills.

### Module - 2: (10 Hours)

Entrepreneurial Environment, Identification of Opportunities, Converting Business opportunities into reality. Start-ups and business incubation, Skill Development. Setting up a Small Enterprise. Issues relating to location, Environmental Problems and Industrial Policies and Regulations.

### Module - 3: (10 Hours)

BasicsofAccounting,Terms:Assets,Liabilities,Equity,Revenue,Expense,Workingcapital,Marketing Mix andSTP

HRM: Concepts and Function, Labour Laws- Factories Act, Organizational support services – Central and State Government, Incentives and Subsidies.

### Module-4: (10 Hours)

Sickness of Small-Scale Industries, Causes and symptoms of sickness, cures of sickness, Role of Banks and Government in reviving sick industries.

### Recommended Books:

1. Entrepreneurship Development and Management, Vasant Desai,HPH
2. Entrepreneurship Management, BholanathDutta, ExcelBooks
3. Entrepreneurial Development, Sangeeta Sharma,PHI
4. Entrepreneurship, Rajeev Roy, Oxford UniversityPress

# 8thSemester

### Module – 1 [12 Hours]

UPEME801 Mechanical Vibration

1. INTRODUCTION & IMPORTANCE OF MECHANICALVIBRATION:

Brief history of Mechanical Vibration, Types of Vibration, Simple Harmonic Motion (S.H.M.),

PrincipleofsuperpositionappliedtoS.H.M.,Beats,FourierAnalysis,Conceptofdegreeoffreedomfor different vibratingsystems.

1. UNDAMPED FREE VIBRATION OF SINGLE DEGREE FREEDOM SYSTEMS: Modeling of Vibrating Systems, Evaluation of natural frequency – differential equation, Energy & Rayleigh’s methods, Equivalentsystems.
2. DAMPED FREE VIBRATION OF SINGLE DEGREE FREEDOM SYSTEMS: Different types of damping,Equivalentviscousdamping,structuraldamping,Evaluationofdampingusingfreeandforced Vibration technique, Concept of critical damping and its importance, study of vibration response of viscous damped systems for cases of under damping, critical damping and over damping, Logarithmic decrement.

### Module – 2 [12 Hours]

1. FORCED VIBRATION OF SINGLE DEGREE FREEDOM SYSTEMS: Steady state solution with viscous damping due to harmonic force, reciprocating and rotating unbalance mass, vibration isolation and transmissibility due to harmonic force excitation and support motion. Vibration measuring instruments–vibrometerandaccelerometer.Whirlingofshaftwithsinglediscandwithourdamping,

Concept of critical speed and its effect on the rotating shaft.

### Module – 3 [10 Hours]

1. UNDAMPED VIBRATION OF TWO DEGREE FREEDOM SYSTEMS: Free vibration of spring coupled and mass coupled systems, Longitudial, Torsional and transverse vibration of two degree freedom systems, influence coefficient technique, Un-damped vibrationAbsorber.
2. INTRODUCTION TO MULTI-DEGREE FREEDOM SYSTEMS: Normal mode vibration, Co- ordinate coupling-close coupled and far coupled systems,
3. CONTINOUS SYSTEMS: Vibration of strings, longitudinal vibration of rods, torsional vibration of rods, transverse vibration of Euler-beams.

### Text Books:

1. Theory of vibration with Applications: W.T. Thomson and Marie Dillon Dahleh, PearsonEducation
2. IntroductoryCourseontheoryandPracticeofMechanicalVibrations.J.S.Rao&K.Gupta,NewAge International Publication, New Delhi,2007.

### Reference Books:

1. Mechanical Vibrations: S.S. Rao, Prarson EducationInc
2. Mechanical Vibrations: S. Graham Kelly, Schaum’s outline series, Tata McGraw Hill,Special Indian ed., 2007
3. Mechanical Vibrations: V.P. Singh, Dhanpat Rai & company Pvt.Ltd.
4. Elements of vibration Analysis: Leonard Meirovitch, Tata McGraw Hill, Special Indian ed.

### Module - 1

UPEME802 Finite Element Methods

FundamentalConcepts:Introduction,Historicalbackground,Outlineofpresentation,Generalprocedure for FEA, Stresses and Equilibrium, Boundary conditions, StrainDisplacement relations, Stress-Strain relations,Planestress,Planestrainproblems,Temperatureeffects,Potentialenergyandequilibrium.The Rayleigh-Ritz method, Hamilton's principle.Galerkin's method, Saint Venant'sprinciple.

### Module - 2

One-dimensional Problems: Introduction, Finite element modeling, Coordinates and Shape functions. The potential energy approach.TheGalerkin approach, Assembly of the global stiffness matrix- mass matrix and load vector, Treatment of boundary conditions, Quadraticshape functions, Temperature effects. Trusses: Introduction, Plane trusses, Three-dimensional trusses, Assembly of global stiffness matrix for the Banded and Skyline solutions.

### Module - 3

Two-dimensional Problems Using Constant Strain Triangles: Introduction, Finite element modeling, Constant strain triangle, In plane and Bending, problem modeling and boundary conditions.

Axisymmetric Solids Subjected to Axisymmetric Loading: Introduction, Axisymmetric formulation, Finite element modeling, Triangular element, Problem modeling and boundary conditions.

### Module - 4

Two-dimensional Isoparametric Elements and Numerical Integration: Introduction, The four-node quadrilateral, Numerical integration, requirements, h-refinement and p-refinement, Higher-order elements, Convergence

Beams and Frames: Introduction, Finite element formulation, Load vector, Boundary considerations, Shear force and bending moment, Beams on elastic supports, Plane frames.

### Text Book:

* 1. IntroductiontoFiniteElementsinEngineering,byTirupathiR.Chandrupatla,AshokD.Belegundu

### References:

1. Introduction to Finite Element Method, byS.S.Rao
2. Finite Element Method, by O.C.Zienkiewicz.
3. Concepts and Applications of Finite Element Analysis, by Robert D.Cook.
4. Introduction to Finite Element Method, byJ.N.Reddy.

**Course Objective:**

UPEME803Mechatronics

1. To understand the structure of microprocessors and their applications in mechanicaldevices
2. Tounderstandtheprincipleofautomaticcontrolandrealtimemotioncontrolsystems,withthehelp of electrical drives andactuators
3. To understand the use of micro-sensors and their applications in variousfields

**Course Outcomes:**

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

**Course Contents:**

**Module 1 (10 Hours)**

Evolution of Mechatronics, components of mechatronic system, types of mechatronic products,

Signaltheory,signalanalysisandprocessing,Laplacetransformation,Z-transformationmodulationand de-modulation.

ElectricalcomponentsandElectronicdevice–Resister,inductorandcapacitor,reactanceandimpedance. Basic electronics devices junction diodes, Bipolartransistors

### Module - 2 (10 Hours)

BasicDigitalTechnology:Digitalnumbersystem,Binarynumbersystem,Hexadecimalnumbersystem, Binary addition, Boolean Algebra, Logic function, Universal GATES, FLIP-FLOP, Registerscounters.

System modeling : Frequency response, Mechanical system, electrical system, Thermal system, Fluid system.

### Module - 3 (16 Hours)

Actuators- Electric motors; D.C. Motors, Stepper motor, , Hydraulic actuators, Pneumatic actuators

TransducerandSensors:Principles,differencebetweentransducerandsensors,transducertypes–photo emissive, photo conductive, photovoltaic, thermistors, Thermocouple, Inductive, capacitive, Peizoelectric,Halleffecttransducers,Ionizationtransducer,Encoders-Incrementalencoder,Optical

encoder, Bimetallic strip, Strain gauge, load cell.

Programmable Logic controller : Basic Structure - Programming : Ladder diagram Timers, Internal Relays and Counters - Shift Registers - Master and Jump Controls, data handling , Analog input / output

, PLC Selection &Application.

Microprocessor ad Microcontroller: Microprocessor based Digital control, registers, Program counter, Intel -8085 microprocessor

### Text Books

1. A Text Books of Mechatronics, R.K.Rajput, S.Chand &company
2. Mechatronics: A Multidisciplinary Approach, William Bolton, PearsonEducation
3. Mechatronics, N.G. P.C Mahalik, Tata McGrawHill
4. Mechatronics, D.G. Alciator, M.B. Histand, Tata McGrawHill

### Reference Books :

1. Mechatronics, A.Smaili & F Mrad, Oxford UniversityPress
2. Mechatronics, K.P.ramchandran, G,K Vijay Raghavan, M. SBalachandran
3. Mechatronics An Intigrated approach, Clarence W de Sliva, CRCPress

UPEME804 Robotics

**Prerequisites** Engineering Mathematics

### Course objectives:

* 1. To introduce the history, constructional features and other basic information onrobotics
	2. To introduce to the sensors used inrobotics
	3. To do the mathematical modelling
	4. To teach robot programming of a typical robot as also the concepts of path planning and applications

### Course Outcome

On successful completion of this course the students should be able to:

1. Have an awareness of basics ofrobotics
2. Do robotprogramming
3. Appreciate the applications of robotics and be able to apply economic measures to justify advantages of robots inindustry

### Course Content:

**Module – 1 (12 hours)**

1. Fundamentals of Robotics: Evolution of robots and robotics, Definition of industrial robot, Laws of Robotics, Classification, Robot Anatomy, Work volume and work envelope, Human arm characteristics, Design and control issues, Manipulation and control, Resolution; accuracy and repeatability, Robot configuration, Economic and social issues, Present and futureapplication.
2. Mathematical modeling of a robot: Mapping between frames, Description of objects inspace,

Transformationofvectors.DirectKinematicmodel:MechanicalStructureandnotations,Description of links and joints, Kinematic modeling of the manipulator, Denavit-Hartenberg Notation,Kinematic relationship between adjacent links, Manipulator Transformation matrix.

### Module – 2 (12 hours)

1. Inverse Kinematics: Manipulator workspace, Solvable of inverse kinematic model, Manipulator Jacobian, Jacobian inverse, Jacobian singularity, Staticanalysis.
2. Dynamic modeling: Lagrangian mechanics, 2D- Dynamic model, Lagrange-Euler formulation, Newton-Euler formulation.
3. Robot Sensors and Actuators: Internal and external sensors, force sensors, Thermocouples, Performance characteristic of a robot. Hydraulic and pneumatic actuators, Electrical actuators, Brushless permanent magnet DC motor, Servomotor, Stepper motor, Micro actuator, Micro gripper, Micro motor, Driveselection.

### Module 3 (12 hours)

1. Robot Programming: Methods – Languages – Capabilities and limitation – Artificial intelligence – Knowledge representation –Search techniques in A I andRobotics
2. Trajectory Planning: Definition and planning tasks, Joint space planning, Cartesian spaceplanning.
3. Applications of Robotics: Capabilities of robots, Material handling, Machine loading and unloading, Robot assembly, Inspection, Welding, Obstacleavoidance.

### Text Books

* 1. Robotics and Control, R.K. Mittal and I.J. Nagrath, Tata McGrawHill
	2. Introduction to Robotics: Mechanics and control, John J Craig,PHI
	3. Robotics Technology and Flexible Automation, S.R.Deb and S. Deb,TMH
	4. Introduction to Robotics, S. K. Saha, Tata McGrawHill

### Reference

* + 1. Robotic Engineering: An Integrated Approach, R.D. KLAFTER, T. A. Chmielewski,and
		2. Industrial Robotics Technology –Programming and Applications, Mikell P. Groover, Mitchell Weiss, McGraw Hill InternationalEdition.
		3. Foundation of Robotics: Analysis and Control, Yoshikawa, Prentice Hall ofIndia.
		4. Robotics: Control, Sensing, Vision and Intelligence, K.S.Fu, R.C.Gonzalez and C.S.G.Lee, McGraw Hill
		5. Robot Dynamics and Control, M.W.Spong and M. Vidyasagar , WileyIndia.
		6. Industrial Robotics Technology, programming and application, M.P.Groover,TMH.
		7. Introduction to Robotics: Analysis, Systems, Applications, S.B.Niku,PHI
		8. Robotics: Fundamental Concepts and Analysis, A. Ghosal, Oxford UniversityPress
		9. Fundamentals of Robotics: Analysis and Control, R. J. Schilling,PHI
		10. Robot Technology: Fundamentals: J. G. Keramas, CengageLearning

OPEN ELECTIVES

(Offered by Mechanical Engineering for all B.Tech Programmes)

Module1

UOEME501 Thermodynamics and Heat Transfer

Thermodynamic systems. Temperature and the zeroth law of thermodynamics. Thermodynamic scales. Ideal gas. Simple, compressible pure substances: gasses and steam. Expansion work. Friction work. Internal energy. Heat. Enthalpy. Specific heats of gasses. Adiabatic, isothermal, isochoric and isobaric processes. Polytropic processes. First law of thermodynamics. Open and closed systems. Entropy and irreversibilities. Second law of thermodynamics. Thermal engine. Carnot's efficiency.

Module 2

Steam, Steam power plant, boilers, nozzles, turbine, condenser.

Gas turbine: Brayton's cycle. Steam turbine: Rankine cycle. Steam compression refrigeration systems.

Refrigeration-Definition-Unitofrefrigeration-Coefficientofperformance(COP)-Vapourcompression refrigeration with flow diagram-Vapour absorption refrigeration with flow diagram-Refrigerants

Module3

General differential equation for conduction heat transfer. Conduction in a flat wall. Conduction in a cylindric wall. Thermal resistance. Overall heat transfer coefficient.

Free and forced convection mechanism. Interior and exterior convection. Convection over flat surfaces. Convection over cylinders. Convections in pipe flow. Empirical correlations.

Electromagnetic spectrum and radiation physics. Kirchoff's law. Black-body radiation. Grey and real bodies. Radiation functions.

### Text books

P.K. Nag, Engineering Thermodynamics, Tata McGraw-Hill Education Rajput. R. K., Thermal Engineering, S.Chand Publishers

Rajput. R. K., Heat Transfer, S.Chand Publishers

Çengel, Yunus A., Boles, Michael A., Thermodynamics, An Engineering Approach, McGraw Hill Çengel, Yunus A., Heat Transfer, A Practical Approach, McGraw Hill

Module 1

UOEME502 Applied Thermal Engineering

Thermodynamic systems. Temperature and the zeroth law of thermodynamics. Thermodynamic scales. Ideal gas. Simple, compressible pure substances: gasses and steam. Expansion work. Friction work. Internal energy. Heat. Enthalpy. Specific heats of gasses. Adiabatic, isothermal, isochoric and isobaric processes. Polytropic processes. First law of thermodynamics. Open and closed systems

Steam boiler-Concept-definition-Indian Boilers Regulation (IBR)- Classification of boiler – function of boiler-Lowpressureboilers-SketchandworkingofCochranboiler-BabcockandWilcoxboiler-Merits and demerits- High pressure boilers- Sketch and working of Lamont and Benson boiler- Merits and demerits- Comparison of water tube and fire tube boilers- Boiler mountings and accessories, Boiler draught system-concept and classification -steam jet draught.

Module 2

Air compressor-concepts, functions, classification and applications- Single stage reciprocating air compressor-constructionandworking(withlinediagram)Expressionforworkdoneandpowerrequired bysinglestagereciprocatingcompressor(withoutderivation),Simpleproblemsonworkdoneandpower required. Multi stage compression – advantages of multistage compression-Rotary Compressors - working of rotary Compressor-Difference between reciprocating and rotary compressors - concept of screw compressor (oilfree).

Refrigeration-Definition-Unitofrefrigeration-Coefficientofperformance(COP)-Vapourcompression refrigeration with flow diagram-Vapour absorption refrigeration with flow diagram- Refrigerants–

Types- Factors affecting the choice of refrigerants- properties of good refrigerants. Psychrometry- definition-Psychrometric terms - dry air, saturated air, dry bulb temperatureWet bulb temperature, dew point temperature, relative humidity, absolute humidity, specific humidity. Air Conditioning- classification-winter Air Conditioning-Summer Air conditioning-Year round air conditioning

Module 3

Internalcombustionengines,Classification–Componentsandtheirfunction.Valvetimingdiagramand port timing diagram – actual and theoretical p-V diagram of four stroke and two stroke engines. Simple andcompleteCarburettor.MPFI,Dieselpumpandinjectorsystem.BatteryandMagnetoIgnitionSystem

– Principles of Combustion and knocking in SI and CI Engines. Lubrication and Cooling systems. Performance calculation.

Otto,Diesel,Dual,Braytoncycles,Calculationofmeaneffectivepressure,andairstandardefficiency– Comparison ofcycles.

### Text books

P.K. Nag, Engineering Thermodynamics, Tata McGraw-Hill Education Rajput. R. K., Thermal Engineering, S.Chand Publishers

Rajput. R. K., Heat Transfer, S.Chand Publishers

Çengel, Yunus A., Boles, Michael A., Thermodynamics, An Engineering Approach, McGraw Hill Çengel, Yunus A., Heat Transfer, A Practical Approach, McGraw Hill

### Course objectives:

UOEME601 Basic Manufacturing Process

To provide clear view on theory of metal cutting and tool geometry and to impart knowledge about mechanisms involved in the conventional and Non-conventional machines.

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

* 1. Interpret and design the geometry of single point cutting tool and multi point cuttingtools
	2. Acquire the mechanisms involved in lathe, shaper, drilling, milling, planermachines
	3. Understand the working principle of USM, LBM, ECM, EDM, AJM,EDM

### Course objectives:

To study various casting, welding and forming methods including advanced techniques, with emphasis on basic principles, limitations and application areas.

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

1. Identify types of pattern, core, core print and gating system in metal castingprocesses.
2. To obtain knowledge of various metal joiningprocesses.
3. Acquire the knowledge of Powder metallurgy and its application.
4. Understand and apply process-maps for metal forming processes using plasticityprinciples

### Module-1 (14 hours)

Conventional Machine Tools:Lathe: Principles, construction, types, production machine tools Capstan & Turret lathe, single point cutting tool layout, Calculations of cutting velocity, feed and depth of cut.

Shaper, Planer: Construction, Operations, Quick return mechanism.

Milling: Construction, milling cutters, up milling & down milling, Gear shaper and Gear hobbing machines

Drilling and Boring: Construction, classifications, drilling and boring tools

Grinding and super finishing: Grinding wheels, abrasive & bonds, cutting action, classification of grinding- surface and cylindrical grinding, center less grinding.

Super finishing: Honing, lapping & polishing

Introduction to non-conventional machining process: Ultrasonic machining (USM), Laser Beam Machining (LBM), Electro Discharge Machining (EDM), Electro Chemical Machining (ECM),

### Module-2 (12 hours)

Casting methods: continuous casting, centrifugal casting, die casting; Casting defects. Types of patterns, Pattern materials and Pattern allowances.

Molding Materials - sand molding, metal molding, investment molding, shell molding Melting furnaces - cupola, resistance furnace, induction and arc furnace

Solidification of castings, use of risers and runners

Classification of welding processes, gas welding, electric arc welding, resistance welding Power sources: constant current and constant voltage power sources;

ISI classification of coated electrodes; Brazing and soldering

### Module-3 (14 hours)

Hotandcoldworkingofmetals,classificationofmetalformingprocesses.Rolling:typesofrollingmills Forging: Smith Forging, Drop and Press forging, Machineforging

Extrusions: Direct, Indirect, Impact and Hydrostatic extrusion and their applications, Extrusion of tubes, Wire drawing methods

Brief introduction to sheet metal working: Bending, Forming and Deep drawing, shearing Brief introduction to powder metallurgy processes.

### Books:

1. Manufacturing Technology by P.N.Rao, Tata McGraw Hillpublication.
2. Welding Technology by R.A. Little,TMH
3. Manufacturing Science by A.Ghosh and A K Malick,EWP
4. Fundamentals of metal casting technology by P.C. Mukherjee, OxfordPIBI.
5. A Text Book of Production Engineering by P.C.Sharma,S.Chand

UOEME701 Project and Production Management

### Course Objective:

The course aims at acquainting all engineering graduates irrespective of their specializations the basic

issues and tools of managing production and operations functions of an organization.

### Module - 1 (12 Hours)

1. Operations Function in an Organization, Manufacturing Vrs Service Operations, System view of Operations, Strategic Role of Operations, Operations Strategies for Competitive Advantage, Operations Quality and Productivity Focus, Meeting Global Challenges of Production and OperationsImperatives.
2. Designing Products, Services and Processes: New Product Design- Product Life Cycle, Product Development Process, Types of Production Systems: Jobshop, Batch, Mass Production; Process Technology Trends, FMS, CIM, CAD, CAM; Design for Services, Services ProcessTechnology.
3. LocationandLayoutPlanning:FactorInfluencingPlantandWarehouseLocations,ImpactofLocation on cost and revenues. Layout Planning: Process Layout, Product Layout, Fixed Position Layout, Line balancing, computerized layout planning- overview, GroupTechnology
4. Work Study: Methods Study- Techniques of Analysis, recording, improvement and standardization; Work Measurement : Work Measurement Principles using Stopwatch Time Study, Predetermined Motion Time Standards and Work Sampling, Standard TimeEstimation.

### Module - 2 (12 Hours)

1. Forecasting : Principles and Method, Moving Average, weighted Moving Average, Exponential Smoothing, Winter’s Method for Seasonal Demand, ForecastingError.
2. Manufacturing Planning and Control: Aggregate Planning, Master Production Scheduling, Material Requirements Planning, Capacity RequirementsPlanning.
3. Sequencing and Scheduling: Single Machine Sequencing : Basics and Performance Evaluation Criteria,MeanFlowTime,Flowshopsequencing:2and3machinescases:Johnson’sRuleandJobshop Scheduling: Priority dispatchingRules.
4. Inventory Control: Relevant Costs, Basic EOQ Model, Model with Quantity discount, Economic Batch Quantity, Periodic and Continuous Review Systems, Safety Stock, Reorder Point and Order Quantity Calculations. ABCAnalysis.
5. ModernTrendsinManufacturing:OverviewofJustinTime(JIT)System,TotalQualityManagement, Total Productive Maintenance, ISO 9000, Quality Circle, Kaizen, PokaYoke, Supply Chain Management.

### Module - 3 (8 Hours)

1. Attributes of a Project, Project LifeCycle
2. Project feasibility Analysis: Technical feasibility, commercial and financial visibility, Environment Analysis. BreakevenAnalysis
3. Project Execution: work breakdown structure, Network Techniques: AOA and AON, CPM and PERT, Resource allocation, Crashing and ResourceSharing

### Text Books:

1. S.N.Chary, “Production and Operations Management”, Tata McGrawHill.
2. R. Paneerselvam, “Production and Operations Management, Prentice Hall of India.
3. Aswathappa & Bhatt – Production & Operations Management, HPH.
4. Gaither & Frazier - Operations Management, CengagePublication
5. Russell & Taylor - Operations Management, PHIPublication
6. Chase, Aquilanno, Jacob & Agarwal - Operations Management, TMHPublication.
7. E.E. Adam and R.J. Ebert “Production and Operations Management”, Prentice Hall ofIndia

UOEME702 Mechanics of Solids

**Prerequisites:** (i) Physics 1, (ii) Mathematics course with ordinary differential equations and (iii) Engineering Mechanics

### Module – 1

SIMPLE STRESSES & STRAINS : Elasticity and plasticity – Types of stresses & strains–Hooke’s law

–stress–straindiagramformildsteel–Workingstress–Factorofsafety–Lateralstrain,Poisson’sratio &volumetricstrain– Barsofvaryingsection–compositebars–Temperaturestresses-Principalplanes and principal stresses -Mohr’s circle - Relation between elastic constants, Strain energy – Resilience – Gradual, sudden, impact and shockloadings.

SHEARFORCEANDBENDINGMOMENT:Definitionofbeam–Typesofbeams–Conceptofshear force and bending moment – S.F and B.M diagrams for cantilever, simply supported and overhanging beamssubjectedtopointloads,u.d.l,uniformlyvaryingloads andcombinationoftheseloads–Pointof contra flexure – Relation between S.F., B.M and rate of loading at a section of abeam.

### Module – 2

FLEXURAL STRESSES : Theory of simple bending – Assumptions – Derivation of bending equation,

Determination bending stresses – section modulus of rectangular and circular sections (Solid and Hollow), Angle and Channel sections – Design of simple beam sections.

SHEAR STRESSES: Derivation of formula – Shear stress distribution across various beams sections like rectangular, circular, triangular, I, T angle sections.

DEFLECTION OF BEAMS : Bending into a circular arc – slope, deflection and radius of curvature – Differentialequationfortheelasticlineofabeam–Determinationofslopeanddeflectionforcantilever andsimplysupportedbeamssubjectedtopointloads,-U.D.Luniformlyvaryingload.Mohr’stheorems

– Moment area method – application to simple cases including overhanging beams, Statically Indeterminate Beams and solution methods.

### Module – 3

THIN CYLINDERS: Thin seamless cylindrical shells – Derivation of formula for longitudinal and circumferentialstresses–hoop,longitudinalandVolumetricstrains–changesindia,andvolumeofthin cylinders – Riveted boiler shells – Thin sphericalshells.

THICKCYLINDERS:–lame’sequation–cylinderssubjectedtoinside&outsidepressures–compound cylinders.

TORSION: Introduction-Derivation- Torsion of Circular shafts- Pure Shear-Transmission of power by circular shafts, Shafts in series, Shafts in parallel.

COLUMNS:

Buckling and Stability, Columns with Pinned ends, Columns with other support Conditions, Limitations of Euler’s Formula, Rankine’s Formula,

### Text Books:

1. Strength of materials /GH Ryder/ Mc Millan publishers IndiaLtd
2. Solid Mechanics, byPopovMechanics of Materials/Gere and Timoshenko, CBS Publishers

### References:

1. Strength of Materials -By Jindal, UmeshPublications.
2. Analysis of structures by Vazirani andRatwani.
3. Mechanics of Structures Vol-III, byS.B.Junnarkar.
4. Strength of Materials byS.Timoshenko
5. Strength of Materials by Andrew Pytel and Ferdinond L. SingerLongman.

## UOEME801 Fluid Mechanics & Hydraulic Machines

### Module: 1 (12 Hour)

Introduction and Fluid Statics- properties of fluids, concept of continuum, pressure and stress tensor Brief description of Newtonian and Non Newtonian fluids, Pascal’s Law of Hydrostatics, Pressure and its measurement by different manometers, force on submerged surfaces (Inclined), Buoyancy and stability of floating and submerged bodies.

Fluid Kinematics - Lagrangian and Eulerian description, streamline, streakline and pathline, continuity equation(Onlythe3D generalformforCartesianandcylindricalcoordinates),streamfunction,rotation and angular deformation, irrotational flow, velocitypotential

### Module II: (13 Hour)

Inviscid flow - Euler equation, Bernoullis equation and its applications to venture meter, orifice meter and siphons, Reynolds transport theorem, conservation of mass, Linear and angular momentum, linear andangularmomentum,StokeslawofviscosityandNavier-Stokesequations(Onlythe3Dgeneralform for Cartesian and cylindrical coordinates), some exact solutions such as, Flow in straight channel and Hagen Poiseuille Flow, Dimensional analysis and similarity - Buckingham Pitheorem.

### Module III: (15Hours)

Internal flows: Pipe flows, friction factor, Moody Diagram, major and minor losses, pipe networks Externalflows:Prandtl’sBoundarylayerequationoveraflatplate(OnlyEquations),momentumintegral method, and flowseparation

Potential Flow - elementary plane flow in 2D Plane (Uniform flow and Vortex flow), Flow about a cylinder without circulation, Drag and lift of cylinder without circulation.

Fluid Machinery - similarity, Euler equation for turbo machines, Pelton wheel, Francis and Kaplan Turbines, centrifugal

### Books:

* 1. S. K. Som, G. Biswas, S. Chakraborty, Introduction to fluid Mechanics and Fluid Machines, 3rdEdition,McGrawhill.
	2. Y.Cengel,J.M.Cimbala,FluidMechanics,3e(Sie)-FundamentalsandApplications,McGraw Hill
	3. K. Subramanya, Hydraulic Machines, McgrawHill
	4. [Robert W. Fox](https://www.flipkart.com/books/robert-w-fox~contributor/pr?sid=bks), [Alan T. Mcdonald](https://www.flipkart.com/books/alan-t-mcdonald~contributor/pr?sid=bks), Fluid Mechanics,Wiley
	5. Ethirajan Rathakrishnan, Fluid Mechanics,PHI
	6. P. N. Modi, S. M. Seth, Hydraulics and Fluid Mechanics Including Hydraulics Machines, Standard BookHouse.

UOEME802 Mechanism of Machines

### Mechanism of Machines Module-1:

**Introduction of Mechanisms and Machines**

Concepts of Kinematics and Dynamics, Mechanisms and Machines, Planar and Spatial Mechanisms, Kinematic Pairs, Kinematic Chains, Kinematic Diagrams, Kinematic Inversion, Four bar chain and Slider Crank Mechanisms and their Inversions, Degrees of Freedom, Straight line mechanisms

### Graphical and Analytical Linkage Synthesis

Synthesis, Function, Path, and Motion Generation, Dimensional synthesis (Graphical): Two position synthesis, Three Position synthesis, Coupler curves, Position Analysis: Graphical position analysis of linkages, Algebraic position analysis of linkages, Four bar slider crank position solution

### Module-2:

**Velocity and Acceleration Analysis**

Graphical and analytical velocity analysis of fourbar pin jointed linkages and fourbar slider crank linkages,Instantcentersofvelocity,Graphicalandanalyticalaccelerationanalysisoffourbarpinjointed linkages and fourbar slider crank linkages, Graphical velocity and acceleration analysis of quick return mechanisms

### Cams

Types of cams, Types of followers, Follower displacement programming, Derivatives of follower Motion, Motions of follower, Layout of cam profiles

### Module-3:

**Belt, Ropes and Chains**

Types of belt drive, Velocity ratio, Slip, Pulley arrangement, Length of belt, Law of belting, Ratio of frictiontension,Powertransmitted,Maximumpowertransmitted,Creep,Chains,Chainlength,Angular speedratio

### Gears and Gear Trains

Terminology, Law of Gearing, Characteristics of involute and cycloidal action, Interference and undercutting, contact ratio, Types of gears: spur, helical, spiral bevel and worm gears, Gear Trains: Simple, compound & reverted gear trains, epicyclic gear trains

### Clutch and Brake

Inclinedplane,PivotandCollars,Frictionclutches,Typesofbrakes,BlockandShoebrakes,Differential band brake, Internal expanding shoe brake, Braking effect invehicle

**Course Outcome**

* Understand basic structure and elements ofmachines
* Identify functional characteristics of various machineelements
* Synthesize various mechanisms based on position, velocity and accelerationrequirement
* Determine position, velocity and acceleration of linkages in mechanism at anyinstant
* Understand basics related to friction and its practical application in mechanicalengineering

### Books

1. Kinematics and Dynamics of Machinery by R L Norton, Tata MacGrawHill
2. Theory of Machines and Mechanisms by John J. Uicker Jr., Gordon R. Pennock and JosephE. Shigley, Oxford UniversityPress
3. Theory of Machines by S.S.Rattan, Tata MacGrawHill
4. Theory of Machines by Thomas Bevan, CBSPublications
5. Kinematics and Dynamics of Machinery by Charles E. Wilson and J.Peter Saddler, Pearson Education
6. Mechanism and Machine Theory by J.S.Rao and R.V.Dukipatti, New AgeInternational.
7. Theory of Mechanisms and Machines by A. Ghosh & A. K. Mallick, East WestPress.
8. Kinematics and Dynamics of Machines by G.H. Martin,McGraw-Hill.
9. Mechanisms and Dynamics of Machinery by Hamilton H Mabie and Charles F Reinholtz, John- Wiley andSons.
10. Kinematics, Dynamics, and Design of Machinery by Kenneth J Waldron and Gary L Kinzel, John-Wiley andSons.

UOEME803 Quality Engineering and Management

Module -1

Attributes of quality, Evolution of philosophy of Quality Management, Economics of quality and measurement of cost of quality, Data presentation techniques for quality analysis,

Statistical process control, Use of control charts and process engineering techniques for implementing quality plan, Machine and process capability analysis, statistical tolerance analysis, Acceptance sampling: Single, double and multiple sampling plans, Acceptance sampling for variables

Module - 2

Reliabilityanalysisandpredictions,Bath-TubCurve,ExponentialandWeibulldistributioninmodelling reliability, Systemreliability

Experimental designs and factorial experiments: 2k factorial experiments, Taguchi philosophy; Loss function; Signal to noise ratio, Orthogonal arrays for parameter and tolerance design.

Module - 3

Fundamentals of TQM: Customer orientation, Continuous improvement, Total participation; Some importantphilosophiesandtheirimpactonquality(Deming,Juran,Crossby),QCTools,Componentsof Total Quality System (TQS), Qualityaudit,

Introduction to ISO 9000 and 14000 standards.

### Books:

1. Fundamental of Quality Control and Improvement, Mitra A,PHI
2. Quality Planning and Analysis, Juran J M and Gryna F M, Tata McGrawHill”