# FACULTY OF ENGINEERING

## Scheme of Instruction & Examination

(AICTE Model Curriculum for the Academic Year 2018-2019)

and

## Syllabi

## B.E. I and II Semesters (Group-A)

## of

## Four Year Degree Programme

## in

## B.E. (Common to All Branches)

(With effect from the Academic Year 2018– 2019)
(As approved in the Faculty Meeting held on 26th June 2018)

Issued by

**Dean, Faculty of Engineering**

**Osmania University, Hyderabad**

**2019**

# GROUP DISTRIBUTION

**B.E. (I, II – Semesters)**

**NUMBER OFDIVISIONS PER COURSE OF**
**O.U. AFFILIATED RESPECTIVE ENGINEERING COLLEGES**

| *S. No* | *COLLEGE NAME* | *GROUP – A* | | | | | *No. of Div.* | *GROUP – B* | | | | *No. of Div.* | *Total No. of Div.* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ECE | IT | ME | PE | AE | | CSE | CE | EEE | EIE | | |
| *1* | MVSR | 3 | 2 | 2 | - | 1 | 8 | 3 | 2 | 2 | - | 7 | 15 |
| *2* | MJCET | 2 | 2 | 2 | 1 | - | 7 | 2 | 2 | 1 | 1 | 6 | 13 |
| *3* | DCET | 2 | 1 | 2 | 1 | - | 6 | 2 | 2 | 1 | 1 | 6 | 12 |
| *4* | ISL | 2 | 1 | 1 | - | - | 4 | 2 | 2 | 1 | - | 5 | 9 |
| *5* | METHODIST | 2 | - | 2 | - | - | 4 | 2 | 2 | 1 | - | 5 | 9 |
| *6* | MEC | 2 | - | 1 | - | - | 3 | 2 | 1 | 1 | - | 4 | 7 |
| *7* | SWATHI | 1 | - | 1 | - | - | 2 | 1 | 1 | - | - | 2 | 4 |
| *8* | STANLEY | 2 | 1 | - | - | - | 3 | 3 | - | 1 | - | 4 | 7 |
| *9* | NGIT | - | 2 | - | - | - | 2 | 3 | - | - | - | 3 | 5 |
| *10** | NSAKCET | 2 | 1 | 4 | - | - | 7 | 2 | 3 | 1 | - | 6 | 13 |
| *11** | LORDS | 1 | 1 | 4 | - | - | 6 | 2 | 3 | 1 | - | 6 | 12 |
| | TOTAL | 19 | 11 | 19 | 2 | 1 | 52 | 24 | 18 | 10 | 2 | 54 | 106 |

**Note: * Applied to OU for Affiliation from the academic year 2019-2020**

## Group – A

ECE : Electronics & Communications Engineering
IT : Information Technology
ME : Mechanical Engineering
PE : Production Engineering
AE : Automobile Engineering

**SCHEME OF INSTRUCTION & EXAMINATION**
**B.E. (All Branches) I - Semester**
**(Group A – ECE, IT, ME, PE, AE)**

| S. No. | Course Code | Course Title | Scheme of Instructions | | | | Scheme of Examination | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P/D | Contact Hours/Week | CIE | SEE | Duration in Hours | |
| **MC: Three Week Induction Programme** | | | | | | | | | | |
| **Theory Course** | | | | | | | | | | |
| 1 | MC111PO | Indian Constitution | 2 | - | - | 2 | 30 | 70 | 3 | - |
| 2 | BS102MT | Mathematics-I | 3 | 1 | - | 4 | 30 | 70 | 3 | 4 |
| 3 | BS104PH | Physics | 3 | 1 | - | 4 | 30 | 70 | 3 | 4 |
| 4 | ES106EE | Basic Electrical Engineering | 3 | 1 | - | 4 | 30 | 70 | 3 | 4 |
| Practical / Laboratory Course | | | | | | | | | | |
| 5 | BS152PH | Physics Lab | - | - | 3 | 3 | 25 | 50 | 3 | 1.5 |
| 6 | ES154EE | Basic Electrical Engineering Lab | - | - | 2 | 2 | 25 | 50 | 3 | 1 |
| 7 | ES156CE | Engineering Graphics & Design | 1 | - | 4 | 5 | 50 | 50 | 3 | 3 |
| Total | | | 12 | 03 | 09 | 24 | 220 | 430 | | 17.5 |

**MC**: Mandatory Course **BS**: Basic Science **ES:** Engineering Science

**L**: Lecture **T**: Tutorial **P**: Practical **D**: Drawing
**CIE:** Continuous Internal Evaluation **SEE:** Semester End Examination (Univ. Exam)

**PO**: Political Science **MT**: Mathematics **PH**: Physics
**EE**: Electrical Engineering **CE**: Civil Engineering

**Note**:
1. Each contact hour is a Clock Hour.
2. The duration of the practical class is two hours, however it can be extended wherever necessary, to enable the student to complete the experiment.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **MC111PO** | **Indian Constitution (Common to All Branches)** | | | | | | Mandatory Course |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **2** | **-** | **-** | **-** | **30** | **70** | **-** |

**Course Objectives**

- To create awareness among students about the Indian Constitution.
- To acquaint the working conditions of union, state, local levels, their powers and functions.
- To create consciousness in the students on democratic values and principles articulated in the constitution.
- To expose the students on the relations between federal and provincial units.
- To divulge the students about the statutory institutions.

**Course Outcomes**

After completing this course, the student will

1. Know the background of the present constitution of India.
2. Understand the working of the union, state and local levels.
3. Gain consciousness on the fundamental rights and duties.
4. Be able to understand the functioning and distribution of financial resources between the centre and states.
5. Be exposed to the reality of hierarchical Indian social structure and the ways the grievances of the deprived sections can be addressed to raise human dignity in a democratic way.

**UNIT-I**

**Evolution of the Indian Constitution:** 1909 Act, 1919 Act and 1935 Act. Constituent Assembly: Composition and Functions; Fundamental features of the Indian Constitution.

**UNIT-II**

**Union Government:** Executive-President, Prime Minister, Council of Minister
**State Government:** Executive: Governor, Chief Minister, Council of Minister
**Local Government:** Panchayat Raj Institutions, Urban Government

**UNIT-III**

**Rights and Duties:** Fundamental Rights, Directive principles, Fundamental Duties

**UNIT-IV**

**Relation between Federal and Provincial units:** Union-State relations, Administrative, legislative and Financial, Inter State council, NITI Ayog, Finance Commission of India

**UNIT-V**

**Statutory Institutions:** Elections-Election Commission of India, National Human Rights Commission, National Commission for Women

***Suggested Readings:***

1. D.D. Basu, Introduction to the constitution of India, Lexis Nexis, New Delhi
2. Subhash Kashyap, Our Parliament, National Book Trust, New Delhi
3. Peu Ghosh, Indian Government &Politics, Prentice Hall of India, New Delhi
4. B.Z. Fadia & Kuldeep Fadia, Indian Government &Politics, Lexis Nexis, New Delhi

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **BS102MT** | **Mathematics - I (Common to All Branches)** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| - | 3 | 1 | - | - | **30** | **70** | 4 |

**Course Objectives**

- To introduce the concepts of sequences, series and their properties
- To introduce the concepts of functions of several variables and multiple integrals
- To study vector differential and integral calculus

**Course Outcomes**

The students will able to

1. Find the nature of sequences and series
2. Evaluate multiple integrals
3. Apply this knowledge to solve the curriculum problems

**Unit-I**

**Sequences and Series:** Sequences, Series, General properties of series, Series of positive terms, Comparison tests, tests of Convergence D'Alembert's ratio test, Cauchy's $n^{th}$ root test, Raabe's test, Logarithmic test, Alternating series, Series of positive and negative terms, Absolute convergence and Conditional convergence.

**Unit-**II:

**Calculus of one Variable:** Rolle's theorem, Lagrange's, Cauchy's mean value theorems, Taylor's series, Curvature, Radius of curvature, Circle of curvature, Envelope of a family of curves, Evolutes and Involutes.

**Unit-III**

**Multivariable Calculus (Differentiation):** Functions of two variables, Limits and continuity, Partial derivatives, Total differential and differentiability, Derivatives of composite and implicit functions (Chain rule), Change of variables, Jacobian, Higher order partial derivatives, Taylor's series of functions of two variables, Maximum and minimum values of functions of two variables, Lagrange's method of undetermined multipliers.

**Unit-IV**

**Multivariable Calculus (Integration):** Double integrals, Change of order of integration, Change of Variables from Cartesian to plane polar coordinates, Triple integrals.

**Unit-V**

**Vector Calculus:** Scalar and vector fields, Gradient of a scalar field, Directional derivative, Divergence and Curl of a vector field, Line, Surface and Volume integrals, Green's theorem in a plane, Gauss's divergence theorem, Stoke's theorem (without proofs) and their verification.

***Suggested Readings:***

1. R.K. Jain & S.R.K Iyengar, *Advanced Engineering Mathematics*, Narosa Publications, 2014.
2. Erwin Kreyszig, *Advanced Engineering Mathematics*, John Wiley, 9th Edition, 2012.
3. B.S. Grewal, *Higher Engineering Mathematics*, Khanna Publications, 43rd Edition, 2014.
4. G.B. Thomas, Maurice Weir and Joel Hass, *Thomas' Calculus*, Peterson, 12th Edition,2010.
5. B.V. Ramana, Higher Engineering Mathematics, 23rd reprint, 2015.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **BS104PH** | **Physics (Common to All Branches)** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| - | 3 | 1 | - | - | **30** | **70** | 4 |

**Course Objectives**

- Aware of limits of classical free electron free theory and to apply band theory of solids
- Acquire knowledge on various properties of semiconductors.
- Grasp the intricacies in semiconductor-optical interaction

**Course Outcomes**

1. Distinguish materials based on band theory of solids
2. Classify semiconductors on the basis doping and to estimate conductivity and learn transport phenomenon in semiconductors
3. Appreciate use of optical absorption by semiconductors.

**Unit – I**

**Crystallography:** Introduction, Types of crystal systems, Bravais lattices, Lattiee planes and Miller Indices (Cubic system), Inter planar spacing (Cubic system), Bragg's law, Powder diffraction method.
**Crystal Defects:** Classification of point defects, Concentration of Schottky defects in metals and ionic crystals, Concentration of Frankel defects, Line defects, Screw and Edge dislocations, Burger's vector

**Unit – II**

**Band Theory of Solids & Semiconductors:** Classical free electron theory (qualitative), Kronig Penney model (qualitative treatment), Energy band formation in solids, Intrinsic and Extrinsic semiconductors, Concept of a hole, Carrier concentration and conductivity in intrinsic semiconductors, Formation of P-N junction diode and its I – V characteristics, Thermistor and its characteristics, Hall effect and its applications.
**Dielectric Materials:** Dielectrics, Types of polarizations, Electronic, Ionic, Orientational and Space charge polarizations, Expression for Electronic polarizability, Frequency and temperature dependence of dielectric polarizations, Determination of dielectric constant by capacitance Bridge method, Ferro electricity, Barium titanate, Applications of Ferroelectrics.

**Unit – III**

**Wave Mechanics:** Matter waves –de-Broglie wavelength, properties of wave function, Physical significance, Schrodinger time dependent and time in-dependent wave equation. Particle in a 1-D box.
**Electromagnetic theory:** Basic laws of electricity and magnetism, Maxwell's equations in integral and differential forms, Conduction and displacement current, Relation between D, E and P – **Electromagnetic waves:** Equation of plane wave in free space, Poynting theorem.

**Unit – IV**

**Magnetic Materials:** Classification of magnetic materials: dia, para, ferro, antiferro and ferrimagnetic materials, Weiss molecular field theory of ferromagnetism, Magnetic domains, Hysteresis curve, soft and hard magnetic materials, Ferrites: Applications of ferrites.
**Superconductivity:** Introduction, General properties of super conductors, Meissner effect, Type I and Type II superconductors, BCS theory (qualitative), Introduction to High $T_c$ superconductors, Applications of superconductors.

**Unit – V**

**Lasers:** Characteristics of Lasers, spontaneous and stimulated emission of radiation, Einstein's Coefficients, population inversion, Ruby Laser, Helium Neon Laser, Semi-Conductor Laser and applications of lasers.

**Fiber Optics:** Introduction, Propagation of light through an optical fiber, Acceptance angle, Numerical aperture (NA), Types of Optical fibers and Refractive index profiles, Fiber drawing process (double Crucible Method), Losses in optical fibers, applications of optical fibers.

**Suggested Reading:**

1. B.K. Pandey and S. Chaturvedi Engineering Physics Cengage Learning 2012
2. A.K. Bhandhopadhya, Nano Materials, New Age International, 1st Edition, 2007
3. M.S. Avadhanulu and P.G. Kshirusagar, Engg. Physics, S. Chand & Co. 1st Edition, 1992.
4. C.M. Srivastava and C. Srinivasan – Science of Engg Materials, New Age International.
5. R.K Gaur and S.L Gupta- Engineering Physics, Dhanpathrai Publications, New edition.
6. Sanjay D Jain & Girish G Sahasrabudhe -Engineering Physics, University Press

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **ES106EE** | **Basic Electrical Engineering (Common to All Branches)** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| - | 3 | 1 | - | - | **30** | **70** | 4 |

**Course Objectives**

- To provide an understanding of basics in Electrical circuits.
- To explain the working principles of Electrical Machines and single phase transformers.

**Course Outcomes**

- To analyze Electrical circuits to compute and measure the parameters of Electrical Energy.
- To comprehend the working principles of Electrical DC Machines.
- To Identify and test various Electrical switchgear, single phase transformers and assess the ratings needed in given application.
- To comprehend the working principles of electrical AC machines.

**Unit-I**

**DC Circuits:** Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff current and voltage laws, analysis of simple circuits with dc excitation. Superposition, Thevenin and Norton Theorems.

**Unit-II**

**AC Circuits:** Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, and RL, RC, RLC combinations (series only). Three phase balanced circuits, voltage and current relations in star and delta connections.

**Unit-III**

**Transformers and 3-ph Induction Motors: Transformers:** Electromagnetic induction, Faradays laws, statically induced emf, Lenz law, BH characteristics, ideal and practical transformer, losses and efficiency, Auto-transformer and three-phase transformer connections.

**Three Phase Induction motor:** Generation of rotating magnetic fields, Construction and working of a three-phase induction motor, squirrel cage IM, slip-ring IM, Applications.

**Unit-IV**

**Single-phase induction motor & DC Machines: Single-phase induction motor:** Construction and principle of operation, Capacitor start & capacitor run motor, applications

**DC Generators:** Dynamically induced emf, Flemming's Right hand and Left hand rules, Construction and principle of operation of DC generator, EMF equation, Types of DC Generators, OCC characteristics, applications

**DC Motors:** principle of operation of DC Motor, Types of DC motors, applications.

**Unit-V**

**Electrical Installations:** Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption, power factor improvement and battery backup.

**Suggested Reading:**

1. N.K. De, "Basic Electrical Engineering", Universities Press, 2015.
2. J.B. Gupta, "Fundamentals of Electrical Engineering and Electronics" S.K. Kataria & Sons Publications, 2002.

3. J.B. Gupta, “Utilization of Electric Power and Electric Traction” S.K. Kataria & Sons Publications, 2010
4. Abhijit Chakrabarti, Sudipta Nath, Chandan Kumar Chanda, “Basic Elactrical Engineering” Tata McGraw Hill, Publications,2009
5. Hughes, "Electrical Technology", VII Edition, International Student -on, Addison Welsey Longman Inc., 1995.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **BS152PH** | **Physics Lab (Common to All Branches)** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| - | - | - | - | 3 | **25** | **50** | 1.5 |

**Course Objectives**

- Make precise measurements using basic physical principles and acquire skills to handle the instruments
- Relates the theoretical Knowledge to the behavior of Practical Physical world.
- Analyze errors in the experimental data.
- Plot graphs between various physical parameters.

**Course Outcomes**

1. Conduct experiments, take measurements independently.
2. Write appropriate laboratory reports.
3. Compute and compare the experimental results and draw relevant conclusions.
4. Use the graphical representation of data and estimate results from graphs

**List of Experiments:**

1. To determine the Dielectric constant and Phase transition temperature of Lead Zirconium Titanate (PZT).
2. To draw the I - V Characteristics of P-N Junction diode and to evaluate the resistance.
3. To find the values of Electrical conductivity and energy gap of Ge crystal.
4. Determination of rigidity of modulus of Torsion pendulum.
5. Determination of carrier concentration, Mobility and Hall Coefficient of Ge crystal using Hall Effect Experiment.
6. To determine the constants of A, B and $\alpha$ using Thermistor characteristics.
7. To draw the curve between the magnetizing field and the intensity of magnetization of the specimen (soft iron rod) and to find out
   i) Coercivity ii) Retentivity and iii) Hysteresis loss.
8. To draw the I - V Characteristics of a solar cell and to calculate the
   i) Fill factor Efficiency and ii) Series resistance.
9. To Determine the Numerical aperture (NA) of Optical fiber.
10. To determine the wave length of the given Laser source.

**Note:** Minimum eight experiments should be conducted in the semester

**Suggested Reading:**

1. N.K. De, "Basic Electrical Engineering", Universities Press, 2015.
2. J.B. Gupta, "Fundamentals of Electrical Engineering and Electronics" S.K. Kataria & Sons Publications, 2002.
3. J.B. Gupta, "Utilization of Electric Power and Electric Traction" S.K. Kataria & Sons Publications, 2010

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **ES154EE** | **Basic Electrical Engineering Lab (Common to All Branches)** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| - | - | - | - | 2 | **25** | **50** | 1 |

**Course Objectives**

- To impart the practical knowledge on testing of DC and AC Machines and the usage of common electrical measuring instruments

**Course Outcomes**

1. Get an exposure to common electrical components and their ratings.
2. Analyze the performance of DC and AC Machines.
3. Comprehend the usage of common electrical measuring instruments.
4. Test the basic characteristics of transformers and electrical machines.

**Suggested List of Laboratory Experiments/Demonstrations**:

Dem1. Basic safety precautions. Introduction and use of measuring instruments – voltmeter, ammeter, multi-meter, oscilloscope. Real-life resistors, capacitors and inductors.
Exp 1. Verification of KVL and KCL, superposition theorem (with DC excitation)
Exp 2 Verification of Thevinens and Nortons theorems (with DC excitation)
Exp 3. Sinusoidal steady state response of R-L, and R-C circuits – impedance calculation and verification. Observation of phase differences between current and voltage. Power factor calculation
Exp 4. Transformers: Observation of the no-load current waveform on an oscilloscope (nonsinusoidal wave-shape due to B-H curve nonlinearity should be shown along with a discussion about harmonics).
Exp 5. Loading of a transformer: measurement of primary and secondary voltages and currents, and power.
Exp 6. Three-phase transformers: Star and Delta connections. Voltage and Current relationships (line-line voltage, phase-to-neutral voltage, line and phase currents).
Exp 7. Measurement of phase voltage/current, line voltage/current and power in a balanced three-phase circuit connected in star and delta
Dem2. Demonstration of cut-out sections of machines: dc machine (commutator-brush arrangement), induction machine (squirrel cage rotor), synchronous machine (field winging - slip ring arrangement) and single-phase induction machine.
Exp 8. OCC characteristics of DC Generator
Exp 9. Synchronous speed of two and four-pole, three-phase induction motors. Direction reversal by change of phase-sequence of connections.
Exp 10. Power factor improvement of Induction Motor using static capacitors
Exp 11. Load Test of DC Motor

**Note - 1:**

(i) List of Experiments and Demonstrations suggested above are already available in the Laboratory of the electrical department. No need to purchase any extra equipment except Demonstration2 equipments

(ii) Procurement of Demonstration 2 equipments can be done during the course work of that semester. It can be included in the laboratory.

**Note - 2:**

(i) Experiments 9, 10 and Demonstration 3 can be incorporated in the Lab syllabus if the topics concerned to the above experiments are considered in new BEE syllabus.

**Suggested Reading:**

1. J.B. Gupta, “Fundamentals of Electrical Engineering and Electronics” S.K. Kataria & Sons Publications, 2002.
2. J.B. Gupta, “Utilization of Electric Power and Electric Traction” S.K. Kataria & Sons Publications,2010
3. Abhijit Chakrabarti, Sudipta Nath, Chandan Kumar Chanda, “Basic Elactrical Engineering” Tata McGraw Hill, Publications,2009
4. Hughes, "Electrical Technology", VII Edition, International Student -on, Addison Welsey Longman Inc., 1995.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **ES156CE** | **Engineering Graphics & Design (Common to All Branches)** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| - | 1 | - | 4 | - | **50** | **50** | 3 |

**Course Objectives**

- To prepare you to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- To prepare you to communicate effectively
- To prepare you to use the techniques, skills, and modern engineering tools necessary for engineering practice.

**Course Outcomes**

The students will able to

1. Introduction to engineering design and its place in society
2. Exposure to the visual aspects of engineering design
3. Exposure to engineering graphics standards
4. Exposure to solid modeling
5. Exposure to computer-aided geometric design
6. Exposure to creating working drawings
7. Exposure to engineering communication

| Sheet No | Description of the Topic | Contact Hours | |
|---|---|---|---|
| | | Lecture | Drawing |
| 1 | Principles of Engineering Graphics and their significance, usage of drawing instruments. | 1 | |
| 2 | **Conic Sections – I** Construction of ellipse, parabola and hyperbola given focus and eccentricity. | 1 | 2 |
| 3 | **Conic Sections – II** Construction of ellipse (given major and minor axis), parabola (given base and height), rectangular hyperbola. | | 2 |
| 4 | **Cycloids** (cycloid & epicycloid) | 1 | 2 |
| 5 | **Involutes** (involute of triangle, square & circle) | | 2 |
| 6 | **Scales** (plain & diagonal scales) | 1 | 2 + 2 |
| 7 | **Introduction to AutoCAD** Basic commands and simple drawings. | | 2 + 2 |
| 8 | **Orthographic Projection** Projections of points situated in different quadrants. | 1 | 2 |
| 9 | **Projections of straight lines – I** Line parallel to both the reference planes, line perpendicular or inclined to one reference plane. | 1 | 2 |
| 10 | **Projections of straight lines – II** Line inclined to both the reference planes. | 1 | 2 |
| 11 | **Projections of planes – I** Perpendicular planes | 1 | 2 |

| | | | |
|---|---|---|---|
| 12 | **Projections of planes – II**<br>Oblique planes | | 2 |
| 13 | **Projections of solids – I**<br>Polyhedra and solids of revolution, Projections of solids in simple position. | 1 | 2 |
| 14 | **Projection of solids – II**<br>Projections of solids when the axes inclined to one or both the reference planes. | 1 | 2 + 2 |
| 15 | **Section of solids – I**<br>When the sectional plane is parallel or perpendicular to one reference plane. | 1 | 2 |
| 16 | **Section of solids – II**<br>When the sectional plane is inclined to one reference plane. | | 2 |
| 17 | **Development of surfaces – I**<br>Prisms and Cylinders | 1 | 2 |
| 18 | **Development of surfaces – II**<br>Pyramids and Cones | | 2 |
| 19 | **Intersection of surfaces – I**<br>Intersection of cylinder and cylinder | 1 | 2 |
| 20 | **Intersection of surfaces – II**<br>Intersection of cylinder and cone | | 2 |
| 21 | **Isometric projection – I**<br>planes and simple solids | 1 | 2 |
| 22 | **Isometric projection – II**<br>combination of two or three solids | | 2 |
| 23 | Conversion of Isometric Views to Orthographic Views | 1 | 2 |
| 24 | **Floor plans** of 2 or 3 rooms including windows, doors, and fixtures such as WC, bath, sink, shower, etc. | 1 | 2 |

**Suggested Text:**

1. Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House
2. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education
3. S.N Lal, Engineering Drawing with Introduction to Auto CAD, Cengage Learning India Pvt Lid, New Delhi, 2018.
4. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication
5. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers
6. (Corresponding set of) CAD Software Theory and User Manuals

**NOTE:**

1. At least 20 sheets must be covered.
2. Sheet number 1 to 6 (Graph sheets / drawing sheets)
3. Sheet number 7 to 24 (AutoCAD drawings)

**SCHEME OF INSTRUCTION & EXAMINATION**
**B.E. (All Branches) II - Semester**
**(Group A – ECE, IT, ME, PE, AE)**

| S.No. | Course Code | Course Title | Scheme of Instructions | | | | Scheme of Examination | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P / D | Contact Hours/Week | CIE | SEE | Duration in Hours | |
| **Theory Course** | | | | | | | | | | |
| 1 | MC112CE | Environmental Science | 2 | - | - | 2 | 30 | 70 | 3 | - |
| 2 | MC113PY | Essence of Indian Traditional Knowledge | 2 | - | - | 2 | 30 | 70 | 3 | - |
| 3 | HS101EG | English | 2 | - | - | 2 | 30 | 70 | 3 | 2 |
| 4 | BS103MT | Mathematics-II | 3 | 1 | - | 4 | 30 | 70 | 3 | 4 |
| 5 | BS105CH | Chemistry | 3 | 1 | - | 4 | 30 | 70 | 3 | 4 |
| 6 | ES107CS | Programming for Problem Solving | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| **Practical / Laboratory Course** | | | | | | | | | | |
| 7 | HS151EG | English Lab | | | 2 | 2 | 25 | 50 | 3 | 1 |
| 8 | BS153CH | Chemistry Lab | | | 3 | 3 | 25 | 50 | 3 | 1.5 |
| 9 | ES155CS | Programming for Problem Solving Lab | | | 4 | 4 | 25 | 50 | 3 | 2 |
| 10 | ES157ME | Workshop / Manufacturing Process | 1 | - | 4 | 5 | 50 | 50 | 3 | 3 |
| | | **Total** | **16** | **02** | **13** | **31** | **305** | **620** | | **20.5** |

**HS**: Humanities and Social Sciences **BS**: Basic Science **ES:** Engineering Science
**MC**: Mandatory Course

**L**: Lectures **T**: Tutorials **P**: Practical **D**: Drawing
**CIE:** Continuous Internal Evaluation **SEE:** Semester End Examination (Univ. Exam)

**PY**: Philosophy **EG**: English **MT**: Mathematics **CH**: Chemistry
**CE**: Civil Engineering, **CS**: Computer Science and Engineering, **ME**: Mechanical Engineering.

**Note:**

1. Each contact hour is a Clock Hour.
2. The students have to undergo a Summer Internship of Rural Agriculture Work Experience **(RAWE)** of one week duration after II-Semester and credits will be awarded in VII semester after evaluation.
3. Rural Agriculture Work Experience helps the students primarily to understand the rural situations, status of Agricultural Technologies adopted by farmers and village development plans and to develop skills & attitude of working with farm families for overall development in rural area.
4. The main objectives of RAWE component are:
   - To make the students familiar with socio-economic conditions of the farmers.
   - To develop communication skills in students using extension teaching methods in transfer of Technology.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **MC112CE** | **Environmental Science (Common to All Branches)** | | | | | | Mandatory Course |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **2** | **-** | **-** | **-** | **30** | **70** | **-** |

**Course Objectives**

- To create awareness and impart basic knowledge about the environment and its allied problems.
- To know the functions of ecosystems.
- To understand importance of biological diversity.
- To study different pollutions and their impact on environment.
- To know social and environment related issues and their preventive measures.

**Course Outcomes**

After completing this course, the student will be able to:

1. Adopt environmental ethics to attain sustainable development.
2. Develop an attitude of concern for the environment.
3. Conservation of natural resources and biological diversity.
4. Creating awareness of Green technologies for nation's security.
5. Imparts awareness for environmental laws and regulations.

**UNIT-I**

**The Multidisciplinary Nature of Environmental Studies:** Definition, scope and importance, need for public awareness.

**Natural Resources:** Water Resources – Use and over utilization of surface and ground water, flood, drought, conflicts over water, Dams: Benefits and Problems. Food Resources –World Food Problems, effects of modern agriculture, fertilizer-pesticides problems, water logging, salinity, Forest Resources – Use and over exploitation, deforestation & its effect on tribal people.Land Resources –Land Degradation, environmental effect of mining, man induced landslides, soil erosion and desertification**.** Energy Resources –Growing energy needs, Renewable and Non-renewable energy resources.

**UNIT-II**

**Ecosystems:** Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in ecosystem, food chains, ecological pyramids, ecological succession, types of ecosystems (marine, pond, river, forest, grassland, desert)

**UNIT-III**

**Biodiversity:** Levels of Biodiversity, Bio-geographical classification of India, Value of biodiversity, Threats to biodiversity, endangered and endemic species of India, Conservation of biodiversity, global and national efforts.

**UNIT-IV**

**Environmental Pollution:** Definition, Causes, effects and control measures of air pollution, water pollution, soil pollution, noise pollution, thermal pollution, solid waste management.

**Environment Protection Act:** Air, water, forest and wildlife Acts, issues in the enforcement of environmental legislation.

**UNIT-V**

**Social Issues and the Environment:** Watershed management and environmental ethics. Climate change, global warming, acid rain, ozone layer depletion.

**Environmental Disaster Management:** Types of disasters, impact of disasters on environment, infrastructure, and development. Basic principles of disaster mitigation, disaster management, and methodology. Disaster management cycle and disaster management in India.

**Field Work:**

- Visit to a local area to document environmental issues- agricultural area/ pond/lake/terrestrial ecosystem
- Visit to a local polluted area- market/slum area/Industrial area/traffic area

***Suggested Reading:***

1. A.K. De, *Environmental Chemistry,* Wiley Eastern Ltd.
2. E.P. Odum, *Fundamentals of Ecology,* W.B. Sunders Co., USA.
3. M.N. Rao and A.K. Datta, *Waste Water Treatment,* Oxford and IBK Publications.
4. Benny Joseph, *Environmental Studies,* Tata McGraw Hill, 2005.
5. V.K. Sharma, *Disaster Management,* National Centre for Disaster Management, IIPE,1999.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **MC113PY** | **Essence of Indian Traditional Knowledge (Common to All Branches)** | | | | | | Mandatory Course |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **2** | **-** | **-** | **-** | **30** | **70** | **-** |

**Course Objectives**

The course will introduce the students to

- To get a knowledge in Indian Culture
- To Know Indian Languages and Literature and the fine arts in India
- To explore the Science and Scientists of Medieval and Modern India

**Course Outcomes**

After successful completion of the course the students will be able to

1. Understand philosophy of Indian culture.
2. Distinguish the Indian languages and literature.
3. Learn the philosophy of ancient, medieval and modern India.
4. Acquire the information about the fine arts in India.
5. Know the contribution of scientists of different eras.

**UNIT - I**

**Introduction to Culture:** Culture, civilization, culture and heritage, general characteristics of culture, importance of culture in human literature, Indian Culture, Ancient India, Medieval India, Modern India

**UNIT - II**

**Indian Languages, Culture and Literature:** Indian Languages and Literature-I: the role of Sanskrit, significance of scriptures to current society, Indian philosophies, other Sanskrit literature, literature of south India

**Indian Languages and Literature-II**: Northern Indian languages & literature

**UNIT - III**

**Religion and Philosophy:** Religion and Philosophy in ancient India, Religion and Philosophy in Medieval India, Religious Reform Movements in Modern India (selected movements only)

**UNIT – IV**

**Fine Arts in India (Art, Technology& Engineering):** Indian Painting, Indian handicrafts, Music, divisions of Indian classic music, modern Indian music, Dance and Drama, Indian Architecture (ancient, medieval and modern), Science and Technology in India, development of science in ancient, medieval and modern India

**UNIT – V**

**Education System in India:** Education in ancient, medieval and modern India, aims of education, subjects, languages, Science and Scientists of Ancient India, Science and Scientists of Medieval India, Scientists of Modern India

***Suggested Reading:***

1. Kapil Kapoor, "Text and Interpretation: The India Tradition",ISBN: 81246033375, 2005
2. "Science in Samskrit", Samskrita Bharti Publisher, ISBN 13: 978-8187276333, 2007
3. NCERT, "Position paper on Arts, Music, Dance and Theatre", ISBN 81-7450 494-X, 200

4. S. Narain, "Examinations in ancient India", Arya Book Depot, 1993
5. Satya Prakash, "Founders of Sciences in Ancient India", Vijay Kumar Publisher, 1989
6. M. Hiriyanna, "Essentials of Indian Philosophy", Motilal Banarsidass Publishers, ISBN 13: 978-8120810990, 2014

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **HS101EG** | **English (Common to All Branches)** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| - | 2 | - | - | - | **30** | **70** | 2 |

**Course Objectives:** To enhance the English language abilities of Engineering students, especially in reading and writing, by

- Using authentic material for language learning
- Exposing them to a variety of content-rich texts
- Strengthening their grammar and vocabulary
- Improving their reading and comprehension skills
- Honing their writing skills
- Encouraging them to think creatively and critically

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

1. Read, understand, and interpret a variety of written texts
2. Use appropriate vocabulary and correct grammar
3. Undertake guided and extended writing with confidence.

**Unit – I**
**Reading**: RK Narayan, "A Horse and Two Goats"
**Vocabulary**: Word formation—Prefixes, Suffixes, Root Words
**Grammar**: Articles, Prepositions, Determiners

**Unit – II**
**Reading**: Rudyard Kipling, "If"
**Vocabulary**: Word formation—Compounding and Blending, Contractions
**Grammar**: Transitions, Connectives
**Writing**: Paragraph Writing

**Unit – III**
**Reading**: Martin Luther King Jr., "I Have a dream"
**Vocabulary**: Synonyms, Antonyms, One Word Substitutes
**Grammar**: Voice
**Writing**: Letter Writing

**Unit – IV**
**Reading**: Robert Frost, "Road Not Taken"
**Vocabulary**: Homophones, Homonyms, Homographs
**Grammar**: Narration (Direct-Indirect Speech)
**Writing**: Report Writing

**Unit – V**
**Reading**: George Orwell, "The Sporting Spirit" (Excerpt)
**Vocabulary**: Inclusive Language, Euphemisms
**Grammar:** Tense
**Writing**: SOP

***Suggested Readings:***

1. Board of Editors. Language and Life: A Skills Approach. Orient Black Swan, 2018.
2. Sudharshana, NP and C Savitha. English for Engineers. Cambridge University Press, 2018.
3. Kumar, Sanjay and Pushp Lata. English Language and Communication Skills for Engineers, Oxford University Press, 2018.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **BS103MT** | **Mathematics – II (Common to All Branches)** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| - | 3 | 1 | - | - | **30** | **70** | 4 |

**Course Objectives**

- To study matrix algebra and its use in solving system of linear equations and in solving eigen value problems
- To provide an overview of ordinary differential equations
- To study special functions like Legendre and Beta Gamma functions
- To learn Laplace Transforms and its properties

**Course Outcomes**

*The students will able to*

1. Solve system of linear equations and eigen value problems
2. Solve certain first order and higher order differential equations
3. Solve basic problems of Beta Gamma and Legender's Function.
4. Apply Laplace Transforms; solve ordinary Differential Equations by using it.

**Unit-I**

**Matrices:** Rank of a matrix, Echelon form, System of linear equations, Linearly dependence and independence of vectors, Linear transformation, Orthogonal transformation, Eigen values, Eigenvectors, Properties of eigen values, Cayley - Hamilton theorem, Quadratic forms, Reduction of quadratic form to canonical form by orthogonal transformation, Nature of quadratic forms.

**Unit-II**

**Differential Equations of First Order:** Exact differential equations, Integrating factors, Linear differential equations, Bernoulli's, Riccati's and Clairaut's differential equations, Orthogonal trajectories of a given family of curves.

**Unit-III**

**Differential Equations of Higher Orders:** Solutions of second and higher order linear homogeneous equations with constants coefficients, Method of reduction of order for the linear homogeneous second order differential equations with variable coefficients, Solutions of non-homogeneous linear differential equations, Method of variation of parameters, solution of Euler-Cauchy equation.

**Unit-IV**

**Special Function:** Gamma Functions, Beta Functions, Relation Between Beta and Gamma Function, Error Functions. Power Series Method, Lengender's Differential Equations and Legender's Polynomial $P_n(x)$, Rodrigue's Formula (without proof).

**Unit-V**

**Laplace Transforms:** Laplace Transforms, Inverse Laplace Transforms, Properties of Laplace Transforms and inverse Laplace Transforms, Convolution Theorem (without proof). Solution of ordinary Differential Equations using Laplace Transforms.

**Suggested Readings:**

1. R.K. Jain & S.R.K. lyengar, *Advanced Engineering Mathematics*, Narosa Publications, 4th Edition,2014.
2. Erwin Kreyszig, *Advanced Engineering Mathematics*, John Wiley, 9th Edition, 2012.
3. Dr.B.S. Grewal, *Higher Engineering Mathematics*, Khanna Publications, 43rd Edition,2014.

4. B.V. Ramana, *Higher Engineering Mathematics*, 23rd reprint, 2015.
5. N. Bali, M. Goyal, A text book of Engineering *Mathematics*, Laxmi publications,2010
6. H.K. Dass, Er. Rajnish Varma, *Higher Engineering Mathematics*, Schand Technical Third Edition.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **BS105CH** | **Chemistry (Common to All Branches)** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| - | 3 | 1 | - | - | **30** | **70** | 4 |

**Course Objectives**

- Correlate the properties of materials with their internal structure and use the for Engineering applications
- Apply the principals of electrochemistry in storage of electrical energy in batteries.
- Gains knowledge in causes of corrosion and its prevention.
- Attains knowledge about the disadvantages of hard water for domestic and industrial purposes. Also learns the techniques of softening of hard water and treatment of water for drinking purpose.
- Exposed to qualitative and quantitative parameters of chemical fuels.
- Aware eco-friendly materials and processes.

**Course Outcomes**

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

1. Apply concept of electrode potential in identifying feasibility of electrochemical reaction; illustrate electro analytical techniques and working of batteries.
2. Identify the mechanism of corrosion of materials on basis of electrochemical approach and devise corrosion control methods.
3. Estimate the physical & chemical parameters of quality of water and explain the process of water treatment.
4. Explain the influence of chemical structure on properties of materials and their choice in engineering applications.
5. Classify chemical fuels and grade them through qualitative analysis.
6. Relate the concept of green chemistry to modify engineering processes and materials.

**UNIT-I**

**Electrochemistry and Battery Chemistry: Electrochemistry:** Electrochemical cells, Electrolytic and Galvanic cells-notation, cell reaction and cell potentials. Types of electrodes, Calomel Quinhydrone and Glass electrodes. Determination of pH of a solution by using Quinhydrone electrode. Thermodynamics of emf of cells, Nernst equation and its derivation. Applications of Nernst equation to electrode potential and emf of cells. Numerical problems.

**Batteries: Primary batteries**: Zn - Carbon battery. **Secondary batteries**: Pb-Acid battery and Li-Ion battery, Applications. **Flow batteries (Fuel cells):** Methanol-Oxygen fuel cells, Construction, Applications.

**UNIT-II**

**Water Chemistry and Corrosion: Water Chemistry**: Hardness of Water-Types and units of hardness, estimation of temporary and permanent hardness of water by EDTA method. Alkalinity of water and its determination. Water softening by Ion exchange and Reverse Osmosis methods. Numerical problems. Specifications of potable water. Sterilization by Chlorination. Break Point Chlorination.

**Corrosion:** Causes and its effects. Types of Corrosion-Dry or Chemical corrosion and Wet or Electrochemical corrosion and their mechanism. Electrochemical corrosion –Waterline and Pitting Corrosion. Factors influencing rate of corrosion.

**Corrosion control methods:** Cathodic protection methods - Sacrificial anodic and impressed current methods. Surface coating methods: Hot Dipping-Galvanizing.

**UNIT-III**

**Engineering Materials: Polymers:** Basics of terms polymers: Monomer and its functionality, Polymers and degree of polymerization. Classification of polymers - Thermoplastics & Thermosetting resins.

Types of Polymerization (i) Addition (ii) Condensation (iii) Co-Polymerization. Mechanism of free radical polymerization

**Preparation, Properties & Uses of the following polymers**: Plastics - PVC and Bakelite, Fibres - Nylon 6:6, and Kevlar, Elastomers - Buna-S, Butyl and Silicone Rubbers.

**Conducting polymers :** Introduction, Classification and Mechanism of conduction in Poly-acetylene, Applications of conducting polymers.

**Biodegradable polymers:** Introduction preparation, properties and applications of polylactic acid

**UNIT-IV**

**Chemical Fuels: Classification of fuels:** Introduction, definition and classification of chemical fuels- Primary and secondary fuels. Solid, liquid and gaseous fuels. Requirements of a good fuel. Calorific Value – HCV and LCV. Theoretical calculations of calorific value by Dulong's formula – Numerical problems.

**Solid Fuels:** Coal and its Ranking. Analysis of coal - Proximate and Ultimate analysis.

**Liquid Fuels:** Fractionation of Petroleum. Composition and uses of Gasoline, Diesel and Kerosene. Cracking & its Significance- Catalytic cracking by moving bed method, Knocking. Fuel rating – Octane and Cetane numbers.

**Gaseous Fuels:** LPG, CNG -Composition and Uses.

**Combustion:** Ignition temperature of a fuel, calculation of air quantities by weight and volume required for combustion of a fuel- Numerical problems.

**UNIT-V**

**Green Chemistry and Composites: Green Chemistry:** Concept, Principles of green chemistry – Atom Economy, Catalysis. and examples of clean technology.

**Biodiesel:** Sources, Concept of Trans esterification and carbon neutrality. Properties and significance

**Composites:** Introduction to composites, composition and characteristic properties of composites. Classification of composites based on matrix, reinforcement and ply. Applications of composites.

**Suggested Readings:**

1. Principles of Physical Chemistry by Puri, Sharma and Pathania S.N. Chand & Co. New Delhi (Latest edition).
2. Engineering Chemistry by P C Jain and M Jain Dhanpat Rai & Sons (15th Edn), New Delhi.
3. Chemistry in Engineering and Technology by J C Kuriacose and J Rajaram, TMH, New Delhi.
4. Engineering Chemistry by O G Palanna, TMH, and New Delhi.
5. Engineering Chemistry by S S Dara, S Chand & Sons, New Delhi.
6. Engineering Chemistry by Sashi Chawla. Dhanpat Rai & Sons, New Delhi.
7. Engineering Chemistry by Shikha Agrawal, Cambridge, New Delhi.
8. Engineering Chemistry by Prasanta Rath, Cengage Learning India Pvt. Ltd.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **ES107CS** | **Programming for Problem Solving (Common to All Branches)** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| - | 3 | - | - | - | **30** | **70** | 3 |

**Course Objectives**

- To introduce the basic concepts of Computing environment, number systems and flowcharts
- To familiarize the basic constructs of C language – data types, operators and expressions
- To understand modular and structured programming constructs in C
- To learn the usage of structured data types and memory management using pointers
- To learn the concepts of data handling using pointers

**Course Outcomes**

The students will able to

1. Formulate simple algorithms for arithmetic and logical problems.
2. Translate the algorithms to programs (in c language).
3. Test and execute the programs and correct syntax and logical errors.
4. Implement conditional branching, iteration and recursion.
5. Decompose a problem into functions and synthesize a complete program using divide and conquer approach.
6. Use arrays, pointers and structures to formulate algorithms and programs.
7. Apply programming to solve matrix addition and multiplication problems and searching and sorting problems.
8. Apply programming to solve simple numerical method problems, namely rot finding of function, differentiation of function and simple integration.

**Unit - I**

**Introduction to Programming:** Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.).
**Idea of Algorithm:** steps to solve logical and numerical problems.
**Representation of Algorithm:** Flowchart / Pseudocode with examples. From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code.

**Unit - II**

**Control Structures:** Arithmetic expressions and precedence, Conditional Branching and Loops**,** Writing and evaluation of conditionals and consequent branching.
**Arrays:** Arrays (1-D, 2-D), Character arrays and Strings

**Unit - III**

**Basic Algorithms:** Searching, Basic Sorting Algorithms (Bubble and Selection), Finding roots of Equations. **Functions:** Functions (including using built in libraries), Parameter passing in functions, call by value. **Passing arrays to functions:** idea of call by reference

**Unit - IV**

**Recursion:** Recursion, as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series. **Structure:** Structures, Defining structures and Array of Structures

**Unit - V**

**Pointers -** Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation), **Introduction to File Handling.**

**Suggested Readings:**

1. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill
2. A.K. Sharma, Computer Fundamentals and Programming in C, Universities Press, 2nd Edition, 2018.
3. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill
4. Brian W. Kernighan and Dennis M. Ritchie, the C Programming Language, Prentice Hall of India.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **HS151EG** | **English Lab (Common to All Branches)** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| - | - | - | - | 2 | **25** | **50** | 1 |

**Course Objectives**

To enhance the listening and speaking skills of students by

- Giving them sufficient practice in listening with comprehension
- Providing them ample opportunities to improve their public speaking skills
- Training them in the use of correct pronunciation, stress, and intonation
- Sensitizing them to the use of verbal and non-verbal communication appropriate to the context
- Encouraging them to learn the art of conversation to suit formal and informal situations
- Preparing them to make formal presentations and face interviews

**Course Outcomes**

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

1. Listen, understand, and interpret formal and informal spoken language
2. Speak English with acceptable pronunciation, stress, and intonation
3. Present themselves with confidence in formal situations
4. Participate in individual and group activities with relative ease

**List of Experiments:**

1. Listening for Comprehension
2. Pronunciation, Intonation, Stress, and Rhythm
3. Conversation Skills
4. Introducing Oneself and Others
5. Asking for and Giving Information
6. Making Requests and Responding to them Appropriately
7. Giving Instructions and Responding to them Appropriately
8. Making Formal Announcements and Emceeing
9. Group Discussions
10. JAM
11. Role Play
12. Debate
13. Public Speaking Skills and Body Language
14. Interviews
15. Formal Presentations

**Suggested Readings:**

1. Board of Editors.Language and Life: A Skills Approach. Orient Black Swan, 2018.
2. Balasubramanian, T. A Textbook of English Phonetics for Indian Students. Macmillan, 1981.
3. CIEFL.Exercises in Spoken English. Parts. I-III. Oxford University Press.
4. Pillai, Radhakrishna G. Spoken English For You - Level II. 8th Edition. Emerald Publishers, 2014.
5. Sethi, J and PV Dhamija. A Course in Phonetics and Spoken English. 2nd Edition, Prentice Hall India Learning Private Limited, 1999.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **BS 153 CH** | **Chemistry Lab (Common to All Branches)** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| - | - | - | - | 3 | **25** | **50** | 1.5 |

**Course Objectives**

- Conduct experiments, take measurements and analyze the data though hands-on experience in order to demonstrate understanding of the theoretical concepts of quantitative Analysis while working in small group.
- Interpret the electro analytical principles with experimental results graphically
- Demonstrate writing skills through clear laboratory reports

**Course Outcomes**

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

1. Apply the principles of Colourimetry and Electrochemistry in quantitative estimations.
2. Estimate the rate constants of reactions from concentration of reactants/ products as a function of time.
3. Synthesize small drug molecules.

**List of Experiments:**

1. Introduction to Chemical Analysis.
2. Techniques of Weighing.

**Volumetric Analysis:**

3. Preparation of Standard Mohr's salt solution, Standardization of $KMnO_4$ and estimation ferrous ion.
4. Estimation Iron(II) by Dichromatometry

**Water Analysis:**

5. Preparation of Standard Magnesium sulphate solution, standardization of EDTA and Estimation of Total Hardness.
6. Preparation of Standard Sodium Carbonate Solution, Standardization of HCl and Estimation of Carbonate and Bicarbonate Alkalinity.

**Conductometry:**

7. Estimation of HCl
8. Estimation of $CH_3COOH$ and mixture of acids

**Potentiometry**

9. Estimation of HCl
10. Estimation of Iron

**pH Metry:**

11. Estimation of HCl

**Colorimetry:**

12. Verification of Beer-Lambert's law and estimation of Manganese.

**Chemical Kinetics:**

13. Determination of rate constant of acid catalyzed hydrolysis of methyl acetate.

**Drug Synthesis**

Preparation of Aspirin

**Note**: Minimum ten experiments should be conducted in the semester

**Suggested Readings:**

1. Senior Practical Physical Chemistry, B.D. Khosla, A. Gulati and V.Garg (R. Chand & Co., Delhi)
2. An Introduction to Practical Chemistry, K. K. Sharma and D.S. Sharma (Vikas publishing, N. Delhi)

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **ES 155 CS** | **Programming for Problem Solving Lab (Common to All Branches)** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| - | - | - | - | 4 | **25** | **50** | 2 |

**Course Objectives**

- Understand the fundamentals of programming in C Language.
- Write, compile and debug programs in C.
- Formulate solution to problems and implement in C.
- Effectively choose programming components to solve computing problems

**Course Outcomes**

*The students will able to*

- Choose appropriate data type for implementing programs in C language.
- Design and implement modular programs involving input output operations, decision making and looping constructs.
- Implement search and sort operations on arrays.
- Apply the concept of pointers for implementing programs on dynamic memory management and string handling.
- Design and implement programs to store data in structures and files.

**Programming Exercise:**

1. Finding maximum and minimum of given set of numbers, finding roots of quadratic equation.
2. Sin x and Cos x values using series expansion.
3. Conversion of binary to decimal, octal, hexadecimal and vice versa.
4. Generating Pascal triangle, pyramid of numbers.
5. Recursion: factorial, Fibonacci, GCD.
6. Matrix addition and multiplication using arrays, linear search and binary search using recursive and non-recursive procedures.
7. Bubble sort and selection sort.
8. Programs on pointers: pointer to arrays, pointer to functions.
9. Functions for string manipulations.
10. Programs on structures and unions.
11. Finding the number of characters, words and lines of given text file.
12. File handling programs

**Suggested Readings:**

1. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill
2. A.K. Sharma, Computer Fundamentals and Programming in C, Universities Press, 2018.
3. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill
4. Brian W. Kernighan and Dennis M. Ritchie, the C Programming Language, Prentice Hall of India.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **ES 157 ME** | **Workshop/ Manufacturing Process (Common to All Branches)** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| - | 1 | - | - | 4 | **50** | **50** | 3 |

**Course Objectives**

- Identify and use marking out tools, hand tools, measuring equipment and to work to prescribed tolerances.
- To provide hands on experience about use of different engineering materials, tools, equipments and processes those are common in the engineering field.
- To gain a good basic working knowledge required for the production of various engineering products.
- To Study different hand operated power tools, uses and their demonstration.
- Adopt safety practices while working with various tools

**Course Outcomes**

*The students will able to*

1. Demonstrate an understanding of and comply with workshop safety regulations.
2. Identify and apply suitable tools for different trades of Engineering processes including drilling, material removing, measuring, chiseling.
3. Study and practice on machine tools and their operations
4. Undertake jobs connected with Engineering Workshop trades including fitting, carpentry, sheet metal, house wiring, welding, smithy and foundry.
5. Apply basic electrical engineering knowledge for house wiring practice

**A. TRADE FOR EXERCISES:**

1. Carpentry
2. Fitting
3. House wiring
4. Sheet metal working
5. Smithy
6. Welding
7. Plumbing

**B. TRADES FOR DEMONSTRATION AND EXPOSURE:**

1. Machining (Lathe & Drilling)
2. Injection molding
3. Mould making and casting
4. Basic Electronics lab instruments

**C. PRESENTATIONS AND VIDEO LECTURES**

1. Manufacturing Methods
2. Rapid Prototyping
3. Glass Cutting
4. 3D printing
5. CNC LATHE

D. **IT WORKSHOP**: Computer hardware, identification of parts, Disassembly, Assembly of computer to working condition, operating system installation.

**Suggested Reading:**

1. Venugopal, K, "Workshop manual", Anuradha Publications, Kumbakonam, TN, 2012
2. K.C. John, "Mechanical Workshop" 2nd Edn., PHI, 2010.
3. Hajra Choudary, "Elements of Workshop Technology" Vol. 1, Asian Publishers, Edn., 1993.
4. G.S. Sawhney, "Mechanical Experiments and Workshop Practice", I.K. International Publishing House, New Delhi, 2009.

**Note:** At least two exercises from each trade.

# FACULTY OF ENGINEERING

## Scheme of Instruction & Examination

(AICTE Model Curriculum for the Academic Year 2019-2020)

and

## Syllabi

## B.E. III and IV Semester

## of

## Four Year Degree Programme

## in

## Mechanical Engineering

(With effect from the academic year 2019– 2020)
(As approved in the faculty meeting held on 25-06-2019)

Issued by

**Dean, Faculty of Engineering**

**Osmania University, Hyderabad – 500 007**

**2019**

## SCHEME OF INSTRUCTION & EXAMINATION
## B.E. (Mechanical Engineering) III – SEMESTER

| S. No. | Course Code | Course Title | Scheme of Instruction | | | | Scheme of Examination | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P/D | Contact Hrs/Wk | CIE | SEE | Duration in Hrs | |
| **Theory Courses** | | | | | | | | | | |
| 1 | MC111PO | Indian Constitution | 2 | - | - | 2 | 30 | 70 | 3 | - |
| 2 | HS201EG | Effective Technical Communication in English | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 3 | HS202CM | Finance and Accounting | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 4 | BS205MT | Mathematics-III (PDE, Probability & Statistics) | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 5 | ES211CE | Engineering Mechanics | 2 | 1 | - | 3 | 30 | 70 | 3 | 3 |
| 6 | ES214EC | Basic Electronics | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 7 | PC221ME | Metallurgy and Material Science | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 8 | PC222ME | Thermodynamics | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| **Practical/ Laboratory Courses** | | | | | | | | | | |
| 9 | PC251ME | Metallurgy and Material Testing Lab | - | - | 2 | 2 | 25 | 50 | 3 | 1 |
| 10 | PC252ME | Machine Drawing and Modelling Lab | - | - | 2 | 2 | 25 | 50 | 3 | 1 |
| | | | **22** | **01** | **04** | **27** | **290** | **660** | | **23** |

HS: Humanities and Social Sciences BS: Basic Science ES: Engineering Science
MC: Mandatory Course PC: Professional Core
L: Lecture T: Tutorial P: Practical D: Drawing
CIE: Continuous Internal Evaluation SEE: Semester End Evaluation (Univ. Exam)
PO: Political Science, EG: English, CM: Commerce, MT: Mathematics, CE: Civil Engineering,
EC: Electronics and Communication Engineering, ME: Mechanical Engineering.

**Note:**

1. Each contact hour is a clock hour
2. The duration of the practical class is two hours, however it can be extended wherever necessary, to enable the student to complete the experiment.
3. All the mentioned **Mandatory Courses** should be offered either in I–Semester or II–Semester only **from the academic year 2019-2020**.
4. For those of the students admitted during the academic year 2018-2019, since the Mandatory Courses were not offered during the I–Semester or II–Semester, they should be offered either in III–Semester or IV–Semester of the **academic year 2019-2020.**

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **MC111PO** | **Indian Constitution** | | | | | | **Mandatory** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| - | **2** | **-** | **-** | **-** | **30** | **70** | **-** |

**Course Objectives**

- To create awareness among students about the Indian Constitution.
- To acquaint the working conditions of union, state, local levels, their powers and functions.
- To create consciousness in the students on democratic values and principles articulated in the constitution.
- To expose the students on the relations between federal and provincial units.
- To divulge the students about the statutory institutions.

**Course Outcomes**

After completing this course, the student will

1. Know the background of the present constitution of India.
2. Understand the working of the union, state and local levels.
3. Gain consciousness on the fundamental rights and duties.
4. Be able to understand the functioning and distribution of financial resources between the centre and states.
5. Be exposed to the reality of hierarchical Indian social structure and the ways the grievances of the deprived sections can be addressed to raise human dignity in a democratic way.

**UNIT-I**

**Evolution of the Indian Constitution:** 1909 Act, 1919 Act and 1935 Act. Constituent Assembly: Composition and Functions; Fundamental features of the Indian Constitution.

**UNIT-II**

**Union Government:** Executive-President, Prime Minister, Council of Minister
**State Government:** Executive: Governor, Chief Minister, Council of Minister
**Local Government:** Panchayat Raj Institutions, Urban Government

**UNIT-III**

**Rights and Duties:** Fundamental Rights, Directive principles, Fundamental Duties

**UNIT-IV**

**Relation between Federal and Provincial units:** Union-State relations, Administrative, legislative and Financial, Inter State council, NITI Ayog, Finance Commission of India

**UNIT-V**

**Statutory Institutions:** Elections-Election Commission of India, National Human Rights Commission, National Commission for Women

***Suggested Readings:***

1. Abhay Prasad Singh & Krishna Murari, Constitutional Government and Democracy in India, Pearson Education, New Delhi, 2019
2. D.D. Basu, Introduction to the constitution of India, Lexis Nexis, New Delhi
3. Subhash Kashyap, Our Parliament, National Book Trust, New Delhi
4. Peu Ghosh, Indian Government &Politics, Prentice Hall of India, New Delhi
5. B.Z. Fadia & Kuldeep Fadia, Indian Government &Politics, Lexis Nexis, New Delhi

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **HS201EG** | **Effective Technical Communication in English** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

To expose the students to:

- Features of technical communication
- Types of professional correspondence
- Techniques of report writing
- Basics of manual writing
- Aspects of data transfer and presentations.

**Course Outcomes**

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

1. Handle technical communication effectively
2. Use different types of professional correspondence
3. Use various techniques of report writing
4. Acquire adequate skills of manual writing
5. Enhance their skills of information transfer and presentations

**UNIT I**

**Definition and Features of Technical communication:** Definition and features of technical communication (precision, relevance, format, style, use of visual aids), Differences between general writing and technical writing, Types of technical communication (oral and written)

**UNIT II**

**Technical Writing-I (Official correspondence):** Emails, IOM, Business letters, Business proposals.

**UNIT III**

**Technical writing-II (Reports):** Project report, Feasibility report, Progress report, Evaluation report.

**UNIT IV**

**Technical writing- III (Manuals):** Types of manuals, User manual, Product manual, Operations manual.

**UNIT V**

**Information Transfer and Presentations:** Non-verbal (bar diagram, flow chart, pie chart, tree diagram) to verbal (writing), Verbal (written) to non-verbal, Important aspects of oral and visual presentations.

***Suggested Readings:***

1. Raman, Meenakshi& Sharma, Sangeeta. (2015). *Technical Communication: Principles and Practice*(3rd ed.). New Delhi.
2. Rizvi,Ashraf, M. (2017). *Effective Technical Communication*(2nd ed.). New Delhi, Tata McGraw Hill Education.
3. Sharma, R. C., & Mohan, Krishna. (2017). *Business Correspondence and Report Writing: A Practical Approach to Business & Technical Communication* (4th ed.). New Delhi, Tata McGraw Hill Education.
4. Tyagi, Kavita & Misra, Padma. (2011). *Advanced Technical Communication.* New Delhi, PHI Learning.
5. Jungk, Dale. (2004).*Applied Writing for Technicians.* New York, McGraw-Hill Higher Education.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **HS202CM** | **Finance and Accounting** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| - | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

The course will introduce the students

- To provide basic understanding of Financial and Accounting aspects of a business unit
- To provide understanding of the accounting aspects of business
- To provide understanding of financial statements
- To provide the understanding of financial system
- To provide inputs necessary to evaluate the viability of projects
- To provide the skills necessary to analyse the financial statements

**Course Outcomes**

After successful completion of the course the students will be able to

1. Evaluate the financial performance of the business unit.
2. Take decisions on selection of projects.
3. Take decisions on procurement of finances.
4. Analyse the liquidity, solvency and profitability of the business unit.
5. Evaluate the overall financial functioning of an enterprise.

**UNIT-I**

**Basics of Accounting:** Financial Accounting–Definition- Accounting Cycle – Journal - Ledger and Trial Balance-Cash Book-Bank Reconciliation Statement (including Problems)

**UNIT-II**

**Final Accounts**: Trading Account-Concept of Gross Profit- Profit and Loss Account-Concept of Net Profit-Balance Sheet (including problems with minor adjustments)

**UNIT-III**

**Financial System and Markets:** Financial System-Components-Role-Considerations of the investors and issuers- Role of Financial Intermediaries. Financial Markets-Players- Regulators and instruments - Money Markets Credit Market- Capital Market (Basics only)

**UNIT-IV**

**Basics of Capital Budgeting techniques:** Time Value of money- Compounding- Discounting- Future Value of single and multiple flows- Present Value of single and multiple Flows- Present Value of annuities- Financial Appraisal of Projects– Payback Period, ARR- NPV, Benefit Cost Ratio, IRR (simple ratios).

**UNIT-V**

**Financial statement Analysis:** Financial Statement Analysis- Importance-Users-Ratio Analysis-liquidity, solvency, turnover and profitability ratios.

***Suggested Readings:***

1. Satyanarayana. S.V. and Satish. D., Finance and Accounting for Engineering, Pearson Education
2. Rajasekharan, Financial Accounting, Pearson Education
3. Sharma.S.K. and Rachan Sareen, Financial Management, Sultan Chand
4. Jonathan Berk, Fundamentals of Corporate Finance, Pearson Education
5. Sharan, Fundamentals of Financial Management, Pearson Education

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **BS205MT** | **Mathematics – III (PDE, Probability & Statistics)** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| - | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- To introduce the solution methodologies for second order Partial Differential Equations with applications in engineering
- To provide an overview of probability and statistics to engineers

**Course Outcomes**

After completing this course, the student will be able to:

1. Solve field problems in engineering involving PDEs.
2. They can also formulate and solve problems involving random variables and apply statistical methods for analysing experimental data.

**UNIT-I:** Formation of Partial Differential Equations, First order partial differential equations, solutions of first order linear Partial Differentiation Equations, Lagranges's equation, Non-linear First Order equations, Charpit's method.

**UNIT-II:** Second-order linear equations and their classification, Method of separation of variables, vibration of stretched string wave equation, one dimensional heat equation, two dimensional heat equation, solution of Laplace's equation.

**UNIT-III:** Probability distributions: Poisson, Uniform and Normal distributions, Mean, variance, moment generating function and evaluation of statistical parameters for these distributions, Moments, Skewness and Kurtosis.

**UNIT-IV:** Curve fitting by the method of least squares: Fitting of straight lines, second degree parabolas and more general curves, Correlation, regression and Rank correlation. Test of significance: Large sample test for single proportion, difference of proportions, single mean, difference of means, and difference of standard deviations.

**UNIT-V :** Test for single mean, difference of means and correlation coefficients, test for ratio of variances , Chi-square test for goodness of fit and independence of attributes.

***Suggested Readings:***

1. R.K.Jain & Iyengar, "Advanced Engineering Mathematics", Narosa Publications.
2. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 2000.
3. P.Sivaramakrishna Das & C.Vijaya Kumar, "Engineering Mathematics" , Pearson India Education Services Pvt. Ltd.
4. N.P. Bali & M. Goyal, "A Text Book of Engineering Mathematics", Laxmi Publications, 2010.
5. S.C.Gupta & V.K.Kapoor, "Fundamentals of Mathematical Statistics" , S.Chand Pub.
6. P. G. Hoel, S. C. Port & C. J. Stone, "Introduction to Probability Theory", Universal Book Stall, 2003.
7. W. Feller, "An Introduction to Probability Theory and its Applications", Vol. 1, Wiley, 1968.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **ES211CE** | **Engineering Mechanics** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **2** | **1** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

The objectives of this course is to impart knowledge of

- Resolution of forces, equilibrium of force systems consisting of static loads
- Obtaining centroids and moments of inertia for various regular and irregular areas.
- Various forces in the axial force members, and to analyse the trusses using various methods,
- Concept of friction for single and connected bodies.
- Basic concepts of dynamics, their behaviour, analysis and motion bodies
- Work energy principles and impulse momentum theory and applications to problem solving

**Course Outcomes**

After completing this course, the student will be able to:

1. Apply the fundamental concepts of forces, equilibrium conditions for static loads.
2. Determine the centroid and moment of inertia for various sections.
3. Analyse forces in members of a truss using method of joints and method of sections, analyse friction for single and connected bodies.
4. Apply the basic concepts of dynamics, their behaviour, analysis and motion bodies.
5. Solve problems involving work energy principles and impulse momentum theory.

**UNIT – I**

**Introduction to Engineering Mechanics:** Basic Concepts

**System of Forces:** Coplanar Concurrent Forces, Components in Space – Resultant of coplanar and spatial systems, Moment of Force and Couple and its Application to coplanar system

**Equilibrium of Systems of Forces:** Free Body Diagrams, Equations of Equilibrium and applications to Coplanar System.

**UNIT – II**

**Centroid:** Centroid of simple areas (from basic principles), Centroid of Composite areas.

**Area Moment of Inertia**: Definition, Moment of inertia of simple areas (from basic principles), Polar Moment of Inertia, Transfer formula, Moment of Inertia of Composite areas.

**Centre of Gravity & Mass moment of Inertia:** Centre of gravity and Mass moment of inertia of simple bodies (from basic principles).

**UNIT-III**

**Friction:** Theory of friction, Laws of friction, Friction connected to single and connected bodies. Wedge friction.

**Analysis of Perfect Frames:** (Analytical Method) Types of Frames, Assumptions for forces in members of perfect frame, Method of joints and Method of sections for Cantilever Trusses, simply supported Trusses.

**UNIT –IV**

**Kinematics:** Introduction, Motion of particle, Rectilinear and Curvilinear motions, Velocity and Acceleration, Types of Rigid body, Angular motion, Fixed axis rotation.

**Kinetics:** Introduction, fundamental equation of kinetics for a particle, D' Alembert's principle for particle motion, connected system and Fixed Axis Rotation.

**UNIT – V**

**Work - Energy Method:** Introduction, Equations for Translation, Work-Energy Applications to Particle Motion, Connected System and Fixed Axis Rotation.

**Impulse Momentum Method:** Linear impulse momentum, law of conservation of momentum, coefficient of restitution, Elastic impact**.**

***Suggested Readings:***

1. Ferdinand L. Singer, *Engineering Mechanics*, Collins, Singapore, 1975.
2. Reddy Vijay Kumar K. and K. Suresh Kumar, Singer's Engineering Mechanics, 2010.
3. S.S Bhavakatti, *Engineering Mechanics*, New age International publishers.
4. Rajeshakharam, S. and Sankarasubrahmanyam, G.,*Mechanics,* Vikas Publications, 2002.
5. Junarkar, S.B. and H.J. Shah., *Applied Mechanics*, Publishers, 2001.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **ES214EC** | **Basic Electronics** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

The objectives of this course is to impart knowledge of

- To understand the characteristics of diodes and transistor configurations
- To understand the design concepts of biasing of BJT and FET
- To understand the design concepts of feedback amplifiers and oscillators
- To study the design concepts of OP Amp and data converters

**Course Outcomes**

After completing this course, the student will be able to:

1. Study and analyse the rectifiers and regulator circuits.
2. Study and analyse the performance of BJTs, FETs on the basis of their operation and working.
3. Ability to analyse & design oscillator circuits.
4. Ability to analyse different logic gates & multi-vibrator circuits.
5. Ability to analyse different data acquisition systems

**UNIT-I**

**PN Junction Diode:** Characteristics, Half wave rectifier, Full wave rectifier, filters, ripple, regulation, TIF and efficiency, Zener diode and Zener diode regulators. CRT construction and CRO applications

**UNIT-II**

**Transistors:** BJT construction and working, modes of operation, configurations of BJT (CB, CE, CC), small signal h-parameter model of CE, CE amplifier analysis. Construction and working of JFET, V-I characteristics of JFET.

**UNIT-III**

**Feedback concepts:** Types of negative feedback – modification of gain, bandwidth, input and output impedances, applications.

**Oscillators:** RC Phase shift, Wein bridge, LC and crystal Oscillators (Qualitative treatment only).

**UNIT-IV**

**Operational Amplifier:** OP-AMP Block diagram, Ideal OP-AMP, DC and AC Characteristics, Inverting and Non-Inverting Amplifiers, Adder/Subtractor, Integrator, Differentiator.

**Logic gate circuits -** Introduction to Digital systems- AND, NAND, NOR, XOR gates, Binary half adder, full adder.

**UNIT-V**

**Data Acquisition Systems:** Construction and Operation of transducers- Strain gauge LVDT, Thermocouple, Instrumentation systems.

**Data Converters:** R-2R Ladder DAC, Successive approximation and Flash ADC.

***Suggested Readings:***

1. Robert Boylestad L. and Louis Nashelsky, *Electronic Devices and Circuit Theory*, PHI, 2007
2. Helfrick D and David Cooper, *Modern Electronic Instrumentation and Measurements Techniques,* 1st edition, Prentice Hall of India, 2006.
3. Salivahanan, Suresh Kumar and Vallavaraj, *Electronic Devices and Circuits*, 2nd edition, Tata McGraw-Hill, 2010.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **PC221ME** | **Metallurgy and Material Science** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- Enable to understand structure property relations, analyse the failures of metals and their prevention.
- To broad understanding of phase diagrams.
- Acquire basic knowledge in various heat treatment operations, their purpose and applications.
- Expose to various methods of extractive metallurgy techniques.
- Understand various modes of failure and suggest mechanisms for preventions of failures.
- Understand applications of conventional metals and alloys.

**Course Outcomes**

1. Know the fundamental science and engineering principles relevant to material.
2. Suggest appropriate physical metallurgical methods (phase diagrams).
3. The type of heat treatment operation to be given to any metal in order to improve desired Mechanical properties.
4. Basic ability to plan an extraction process for given ore.
5. Suggest the appropriate methods for prevention of failures.
6. Analyse the applications of conventional metals and alloys.

**UNIT-I**

Introduction to Materials engineering, classification of materials- metals and alloys, ceramics, polymers and composites,

Space lattice, unit cell, crystal structure, crystal directions and planes, crystal imperfections- point defects, line defects, surface defects, volume defects. Types of dislocations, Effect of slip and twinning on the plastic deformation, Jogs and its effect on yield phenomenon, Hall-Petch equation, Orange peel effect, cold and hot working, strain hardening and Bauchinger effect. Recovery, Recrystallisation, Grain growth and its effect on mechanical properties of metals.

Mechanical properties of materials- Tensile properties, stress-strain diagrams, elasticity, plasticity, ductility, toughness, modulus of elasticity, resolved shear stress, tensile and compression test, hardness and its measurement

**UNIT-II**

**Fracture:** Ductile and Brittle fracture, modes of fracture, ductile to brittle transition, crack initiation and propagation.

**Fatigue:** S-N curve, Structure of fatigue fracture specimen, Fatigue crack propagation, Effect of metallurgical variables on fatigue of metal, Experimental determination of fatigue strength (RR-Moore Test).

**Creep:** Creep strength, Creep curve, Creep deformation mechanisms, Creep Test, Differences between creep curve and stress rupture curve.

**UNIT-III**

**Structure of Alloys:** Types of solid solution, Substitutional and Hume Rothary's rules for solid solution, Construction and interpretation of Binary equilibrium diagram, Isomorphous, Eutectic and Peritectic diagrams, Intermediate phases and phase rule, Iron-Iron Carbide equilibrium diagram, construction and interpretation. Types of Plain Carbon Steels, Cast Iron and their properties and Characteristics.

**UNIT-IV**

**Alloy Steels:** Effects of alloying elements like Nickel, Chromium, Manganese, Silicon and Tungsten. Titanium. Study about Stainless steels, HSS, Maraging steels, Brass, Bronze, Muntz Metal, Invar, Duralumin and Ti Alloy (Ti-6Al-4V) – their composition and Properties.

**Heat Treatment:** Annealing, Normalising, Hardening, Tempering, Construction and interpretation of T.T.T Curve. Austempering and Martempering. Case Hardening: Carburising, Nitriding, Carbo-nitriding, Flame Hardening, Induction Hardening. Brief introduction of Age Hardening.

**UNIT-V**

Non-ferrous metals and alloys: Properties and applications of –Cu and its alloys, Al and its alloys, Age hardening, Ti and its alloys, Ni- based alloys

Ceramics, Polymers and Composites: Ceramics, crystalline ceramics, glasses, properties and applications of ceramics, polymers-polymerization, thermoplastics and thermosetting plastics, properties and applications of polymers. Composites: concept of composites, matrix and reinforcement, rule of mixtures, classification of composites, applications of composites.

***Suggested Readings:***

1. V.Raghavan, Material Science and Engineering, Prentice Hall of India Ltd., 4th Edition, 1994.
2. S.H. Avner, Introduction to Physical Metallurgy, Tata McGraw Hill, 2nd Edn.1997.
3. S.P. Nayak, Engineering Metallurgy and Material Science, Charotar Publishing House, 6th Edition, 1995.
4. E. Dieter, Mechanical Metallurgy, Metric Editions, Tata McGraw Hill, 3rd Edn,1997.
5. Robert M Jones, Mechanics of Composite Materials, Taylor and Francis.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **PC222ME** | **Thermodynamics** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- Basic definitions of thermodynamics and significance of Zeroth law of thermodynamics.
- The importance and application of first law of thermodynamics.
- The various laws associated with second law of thermodynamics.
- Properties of pure substances and use of Mollier diagram.
- Various air standard cycles, their importance and their comparison.
- Calculation procedures of the air-fuel ratio.

**Course Outcomes**

1. Correlate the study of thermodynamics with the fundamental conceptual terminologies and Distinguish the different forms of energy
2. Analyse the Laws of Thermodynamics and correlate them for real life problem solving.
3. Read data from the chart of Mollier diagram and its applications.
4. Assess the importance of entropy and recognize the various curves of phase transformation
5. Identify the various air standard cycles, gas cycles and gas laws toward solving practical applications.

**UNIT-I**

**Introduction:** Definition and Concept of Thermodynamics, Microscopic and Macroscopic approach of thermodynamics, system, surroundings and property, intensive and extensive properties, Measurement of temperature, Zeroth law of thermodynamics, Temperature Scales, ideal gas and ideal gas thermometer, Reversibility and irreversibility quasi– static process, Specific heats for ideal gases, Thermodynamic Equilibrium, Mole fraction and mass fraction, Partial pressure and Dalton's Law, Amagat-Leduc Law of Partial volumes.

**UNIT-II**

**First law of Thermodynamics:** Statement of First Law, Heat and work interactions, Thermodynamics work and Internal energy, Energy as property of system, First Law applicable to Closed system, Thermodynamic processes and calculation of work, Heat transfer, and internal energy, Heat as Path Function, first law analysis of flow processes and limitation, Calculation of work done during flow processes.

**UNIT-III**

**Second Law of Thermodynamics:** Physical description of second law, Kelvin– Planck and Clausius statement of Second Law of thermodynamics, Equivalence of Kelvin– Planck and Clausius statement, Reversible and irreversible processes, Carnot Theorem, Clausius Inequality, Calculation of entropy change during various thermodynamic processes, principle of Entropy increase, T– S diagram, Available and Unavailable energies in steady flow, Second Law Analysis of Control Volume, Helmholtz and Gibb's functions, Available function for flow and non– flow processes and applications.

**UNIT-IV**

**Thermodynamic properties of Fluids:** Properties of pure substances, Concept of phase change, Graphical representation of pressure, Volume and Temperature, (PVT)– T and H diagrams, Properties of steam, Use of steam Tables and Mollier diagram, Thermodynamic relations involving entropy, Enthalpy, Internal Energy, Maxwell relations and Clapeyron equation.

**UNIT-V**

**Analysis of Thermodynamic Cycles:** Air standard cycles: Otto, Diesel, Dual Combustion Cycle, Joule/ Brayton cycle. Vapour Power cycles: Rankine cycle and Modified Rankine cycle. Refrigeration cycles: Reversed Carnot cycle, Bell Coleman cycle, Vapour compression refrigeration cycle.

***Suggested Readings:***

1. P.K. Nag, Basic & Applied Thermodynamics, Tata McGraw Hill, 2nd Edn., 2008.
2. Yunus A Cengel & Michael A Boles, Thermodynamics- An Engineering Approach, Tata McGraw-Hill, 7th Edition in SI Units (Special Indian Edition),2011
3. Y.V.C.Rao, An Introduction to Thermodynamics, Universities Press, 2nd Edn., 2010.
4. P.L Ballaney, Thermal Engineering, Khanna Publishers 2004.
5. E. Rathakrishnan, Fundamentals of Engineering Thermodynamics, PHI Learning Pvt. Ltd, 2005.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **PC251ME** | **Metallurgy and Material Testing Lab** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **-** | **-** | **-** | **2** | **25** | **50** | **1** |

**Course Objectives**

- Acquire basic knowledge by understanding iron-carbide diagram and its application in engineering.
- Expose to Metallographic study and analysis of various metals.
- Acquire knowledge in determining the hardness of metals before and after various Heat treatment operations.
- Understand differences between different heat treatment methods.
- Expose to T-T-T curve and its application in engineering metallurgy.
- Understand the relation between micro structure and properties.

**Course Outcomes**

After completing this course, the student will be able to:

1. Prepare specimen for metallographic observation
2. Analyse and identify low, medium and high carbon steels, different types of cast irons, non-ferrous alloys, from the study of their microstructure
3. Underlines the importance of grain size in evaluating the desired mechanical properties.
4. Correlate the heat treatment methods and the mechanical properties obtained.
5. Analyse and identify microstructures after annealing, normalizing, hardening and tempering Relate the properties of the materials using image analyser

**List of Experiments:**

**A: Metallurgy Experiments:**

1. Study of: Metallurgical Microscope, Iron-Iron Carbide diagram, Procedure for specimen preparation
2. Metallographic Study of Pure Iron& Low carbon steel
3. Metallographic Study of Medium carbon steel, Eutectoid steel& Hyper Eutectoid steel
4. Metallographic Study of Grey cast-iron, White cast-iron, & Black heart Malleable cast iron
5. Metallographic Study of Aluminium, Brass & Bronze
6. Jominy Quench test or Study of microstructure after heat treatment

**B: Materials testing Lab**

1. Uni-axial tension test, to draw stress- strain diagram, and estimate modulus of elasticity, % of elongation and toughness.
2. Compression test on bricks and Impact test
3. Hardness test: Brinell & Vickers
4. Shear force & bending moments tests.
5. Bending test on fixed beam, simply supported beam
6. Spring test and torsion test

**Note:** At least ten experiments should be conducted

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **PC252ME** | **Machine Drawing and Modelling Lab** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| - | - | - | - | **2** | **25** | **50** | **1** |

**Course Objectives**

- To understand format of drawing sheet, angle of projections, isometric projections and practice on simple machine elements
- To practice free hand sketching of machine elements
- To understand Modelling of assembly drawings of typical machine parts.

**Course Outcomes**

At the end of the course, the student

1. Will be able to draw isometric and orthogonal projections and sectional views of various mechanical components.
2. Will be able to draw free hand sketches of various mechanical components
3. Will be able to understand the shape and structure of different types of joints, screws, keys and Couplings
4. Will be sufficiently knowledgeable to use both the software and drafter to produce assembly views of various mechanical components from part drawings.

**List of Experiments:**

**I. Machine Drawing (AutoCAD):**

1. Format of drawing sheet & title block,
2. Conventions of drawing lines and dimensions,
3. Convention for sectional views.
4. Simple machine elements.
5. Riveted and screwed fastenings.
6. Joints and coupling.

**II. Assembly drawing (SOLIDWORKS/ CATIA/ PRO-E):**

7. Connecting rod.
8. Eccentric.
9. Cross head.
10. Stuffing box.
11. Lathe Tool Post.
12. Revolving centre.
13. Pedestal bearing (Plummer block).
14. Screw Jack.

**Note:** The test is for the ability of the student to read and interpret drawing. The drawing should include part list in standard format.

***Suggested Readings:***

1. N.D. Bhatt, Machine Drawing, Charotar Publishing house, Anand, New Delhi, 28th edition, 1994.
2. K.L. Narayana, P. Kannaiah, K. Venkat Reddy, Machine Drawing, New Age International (P) Ltd., 2nd edition 1999.
3. N. Siddeshwar, Machine Drawing, Tata McGraw Hill Publishing Co. Ltd., 5th edition, 1994
4. K. C. John, Text book of Machine Drawing, PHI Learning,

## SCHEME OF INSTRUCTION & EXAMINATION
## B.E. (Mechanical Engineering) IV – SEMESTER

| S. No. | Course Code | Course Title | Scheme of Instruction | | | | Scheme of Examination | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P/D | Contact Hrs/Wk | CIE | SEE | Duration in Hrs | |
| **Theory Courses** | | | | | | | | | | |
| 1 | MC112CE | Environmental Science | 2 | - | - | 2 | 30 | 70 | 3 | - |
| 2 | MC113PY | Essence of Indian Traditional Knowledge | 2 | - | - | 2 | 30 | 70 | 3 | - |
| 3 | HS213MP | Industrial Psychology | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 4 | BS206BZ | Biology for Engineers | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 5 | ES213ME | Energy Sciences and Engineering | 2 | - | - | 2 | 30 | 70 | 3 | 2 |
| 6 | PC231ME | Mechanics of Materials | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 7 | PC232ME | Applied Thermodynamics | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 8 | PC233ME | Kinematics of Machinery | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 9 | PC234ME | Manufacturing Processes | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| **Practical/ Laboratory Courses** | | | | | | | | | | |
| 10 | PC261ME | Thermal Engineering Lab – I | - | - | 2 | 2 | 25 | 50 | 3 | 1 |
| 11 | PC262ME | Manufacturing Processes Lab | - | - | 2 | 2 | 25 | 50 | 3 | 1 |
| | | | **24** | **-** | **04** | **28** | **320** | **730** | | **22** |

HS: Humanities and Social Sciences BS: Basic Science ES: Engineering Science
MC: Mandatory Course PC: Professional Core
L: Lecture T: Tutorial P: Practical D: Drawing
CIE: Continuous Internal Evaluation SEE: Semester End Evaluation (Univ. Exam)
PY: Philosophy, BZ: Biology/ Life Sciences, CE: Civil Engineering
MP: Mechanical / Production Engineering, ME: Mechanical Engineering.

**Note:**

1. Each contact hour is a clock hour
2. The duration of the practical class is two hours, however it can be extended wherever necessary, to enable the student to complete the experiment.
3. All the mentioned **Mandatory Courses** should be offered either in I–Semester or II–Semester only **from the academic year 2019-2020**.
4. For those of the students admitted during the academic year 2018-2019, since the Mandatory Courses were not offered during the I–Semester or II–Semester, they should be offered either in III–Semester or IV–Semester of the **academic year 2019-2020.**
5. The students have to undergo a Summer Internship of two-week duration after IV – Semester and credits will be awarded in V – Semester after evaluation.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **MC112CE** | **Environmental Science** | | | | | | **Mandatory** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| - | **2** | **-** | **-** | **-** | **30** | **70** | **-** |

**Course Objectives**

- To create awareness and impart basic knowledge about the environment and its allied problems.
- To know the functions of ecosystems.
- To understand importance of biological diversity.
- To study different pollutions and their impact on environment.
- To know social and environment related issues and their preventive measures.

**Course Outcomes**

After completing this course, the student will be able to:

1. Adopt environmental ethics to attain sustainable development.
2. Develop an attitude of concern for the environment.
3. Conservation of natural resources and biological diversity.
4. Creating awareness of Green technologies for nation's security.
5. Imparts awareness for environmental laws and regulations.

**UNIT-I**

**The Multidisciplinary Nature of Environmental Studies:** Definition, scope and importance, need for public awareness.

**Natural Resources:** Water Resources – Use and over utilization of surface and ground water, flood, drought, conflicts over water, Dams: Benefits and Problems. Food Resources –World Food Problems, effects of modern agriculture, fertilizer-pesticides problems, water logging, salinity, Forest Resources –Use and over exploitation, deforestation & its effect on tribal people. Land Resources –Land Degradation, environmental effect of mining, man induced landslides, soil erosion and desertification**.** Energy Resources –Growing energy needs, Renewable and Non-renewable energy resources.

**UNIT-II**

**Ecosystems:** Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in ecosystem, food chains, ecological pyramids, ecological succession, types of ecosystems (marine, pond, river, forest, grassland, desert)

**UNIT-III**

**Biodiversity:** Levels of Biodiversity, Bio-geographical classification of India, Value of biodiversity, Threats to biodiversity, endangered and endemic species of India, Conservation of biodiversity, global and national efforts.

**UNIT-IV**

**Environmental Pollution:** Definition, Causes, effects and control measures of air pollution, water pollution, soil pollution, noise pollution, thermal pollution, solid waste management.

**Environment Protection Act:** Air, water, forest and wildlife Acts, issues in the enforcement of environmental legislation.

**UNIT-V**

**Social Issues and the Environment:** Watershed management and environmental ethics. Climate change, global warming, acid rain, ozone layer depletion.

**Environmental Disaster Management:** Types of disasters, impact of disasters on environment, infrastructure, and development. Basic principles of disaster mitigation, disaster management, and methodology. Disaster management cycle and disaster management in India.

**Field Work:**

- Visit to a local area to document environmental issues- agricultural area/ pond/lake/terrestrial ecosystem
- Visit to a local polluted area- market/slum area/Industrial area/traffic area

***Suggested Readings:***

1. A.K. De, *Environmental Chemistry*, Wiley Eastern Ltd.
2. E.P. Odum, *Fundamentals of Ecology,* W.B. Sunders Co., USA.
3. M.N. Rao and A.K. Datta, *Waste Water Treatment,* Oxford and IBK Publications.
4. Benny Joseph, *Environmental Studies,* Tata McGraw Hill, 2005.
5. V.K. Sharma, *Disaster Management*, National Centre for Disaster Management, IIPE,1999.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **MC113PY** | **Essence of Indian Traditional Knowledge** | | | | | | **Mandatory** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| - | **2** | **-** | **-** | **-** | **30** | **70** | **-** |

**Course Objectives**

The course will introduce the students to

- To get a knowledge in Indian Philosophical Foundations.
- To Know Indian Languages and Literature and the fine arts in India & Their Philosophy.
- To explore the Science and Scientists of Medieval and Modern India

**Course Outcomes**

After successful completion of the course the students will be able to

1. Understand philosophy of Indian culture.
2. Distinguish the Indian languages and literature among difference traditions.
3. Learn the philosophy of ancient, medieval and modern India.
4. Acquire the information about the fine arts in India.
5. Know the contribution of scientists of different eras.
6. The essence of Yogic Science for Inclusiveness of society.

**UNIT – I**

**Introduction to Indian Philosophy:** Basics of Indian Philosophy, culture, civilization, culture and heritage, general characteristics of culture, importance of culture in human literature, Indian culture, Ancient Indian, Medieval India, Modern India.

**UNIT – II**

**Indian Philosophy & Literature:** Vedas Upanishads, schools of Vedanta, and other religion Philosophical Literature. Philosophical Ideas the role of Sanskrit, significance of scriptures to current society, Indian Philosophies, literature of south India.

Indian languages and Literature-II: Northern Indian languages & Philosophical & cultural & literature.

**UNIT – III**

**Religion and Philosophy:** Religion and Philosophy in ancient India, Religion and Philosophy in Medieval India, Religious Reform Movements in Modern India (selected movements only)

**UNIT – IV**

**Indian Fine Arts & Its Philosophy (Art, Technology & Engineering):** Indian Painting, Indian handicrafts, Music, divisions of Indian classic music, modern Indian music, Dance and Drama, Indian Architecture (ancient, medieval and modern), Science and Technology in Indian, development of science in ancient, medieval and modern Indian.

**UNIT – V**

**Education System in India:** Education in ancient, medieval and modern India, aims of education, subjects, languages, Science and Scientists of Ancient India, Scientists of Medieval India, Scientists of Modern India. The role Gurukulas in Education System, Value based Education.

***Suggested Readings:***

1. Kapil Kapoor, "Text and Interpretation: The India Tradition'', ISBN: 81246033375, 2005
2. "Science in Samskrit", Samskrita Bharti Publisher, ISBN-13:978-8187276333,2007
3. NCERT, "Position paper on Arts, Music, Dance and Theatre'', ISBN 81-7450-494-X, 2006
4. S. Narain, "Examination in Ancient India", Arya Book Depot, 1993
5. Satya Prakash, "Founders of Sciences in Ancient India", Vijay Kumar Publisher, 1989
6. M.Hiriyanna, "Essentials of Indian Philosophy", Motilal Banarsidass Publishers, ISBN-13: 978-8120810990,2014
7. Chatterjee. S & Dutta "An Introduction to Indian Philosophy"

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **HS213MP** | **Industrial Psychology** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| - | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

The course will introduce the students to

- To Know Industry Structures and functions.
- Develop an awareness of the major perspectives underlying the field of Industrial Psychology
- Understanding for the potential Industrial Psychology has for society and organizations now and in the future.

**Course Outcomes**

After completing this course, the student will be able to:

1. Understanding of key concepts, theoretical perspectives, and trends in industrial psychology.
2. Evaluate the problems thorough and systematic competency model.
3. Analyse the problems present in environment and design a job analysis method.
4. Create a better work environment for better performance.
5. Design a performance appraisal process and form for the human behaviour.

**UNIT-I**

**Industrial Engineering**: Meaning, Definition, Objective, Need, Scope, Evolution and developments. Concept of Industrial Engineering, Historical development of Industrial Engineering, main departments of Industry.

**Organization Structure:** Introduction, Principles of Organization, Organizational theories, Departmentalism, Authority, power, Organizational effectiveness, structuring the Organization, Organizational change, Organization charts.

**UNIT-II**

**Motivation, Morale and Behavioural Science**: Motivation, Characteristics, Kinds of motivation, Thoughts of motivational philosophy, Human needs, Incentive as motivators, Managing Dissatisfaction and frustration, Morale, Absenteeism, Behavioural Science.

**Social environment:** Group dynamics in Industry Personal psychology, Selection, training, placement, promotion, counselling, job motivations, job satisfaction. Special study of problem of fatigue, boredom and accidents.

**UNIT-III**

**Understanding Consumer Behaviour:** Consumer behaviour, study of consumer preference, effects of advertising, Industrial morale: The nature and scope of engineering psychology, its application to industry

**UNIT-IV**

**Work Methods:** Efficiency at work, the concept of efficiency, the work curve, its characteristics, the work methods; hours of work, nature of work, fatigue and boredom, rest pauses. The personal factors; age abilities, interest, job satisfaction, the working environment, noise, illumination, atmospheric conditions, increasing efficiency at work; improving the work methods, Time and motion study, its contribution and failure resistance to time and motion studies, need for allowances in time and motion study.

**UNIT-V**

**Work and Equipment Design**: Criteria in evaluation of job-related factor, job design, human factors, Engineering information, input processes, mediation processes, action processes, methods design, work space and its arrangement, human factors in job design. Accident and Safety: The human and economic costs of accidents, accident record and statistics, the causes of accidents situational and individual factors related to accident reduction.

***Suggested Readings:***

1. TR Banga and SC Sharma, *Industrial Engineering and Management*, Khanna Publishers, 11th Edn., 2014.
2. Tiffin, J and McCormic E.J., *Industrial Psychology*, Prentice Hall, 6th Edn., 1975.
3. McCormic E.J., *Human Factors Engineering and Design*, McGraw Hill, 4th Edn.,1976.
4. Mair, N.R.F., *Principles of Human relations*
5. Gilmer, *Industrial Psychology*
6. Ghiselli & Brown, *Personnel and Industrial Psychology.*
7. Myer, *Industrial Psychology.*
8. Dunnete, M.D., *Handbook of Industrial and Organizational Psychology.*
9. Blum & Taylor, *Industrial Psychology*

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **BS206BZ** | **Biology for Engineers** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| - | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

Gain vivid knowledge in the fundamentals and uses of biology, human system and plant system.

**Course Outcomes**

After completing this course, the student will be able to:

1. Apply biological engineering principles, procedures needed to solve real-world problems.
2. Understand the fundamentals of living things, their classification, cell structure and biochemical constituents.
3. Apply the concept of plant, animal and microbial systems and growth in real life situations.
4. Comprehend genetics and the immune system.
5. Know the cause, symptoms, diagnosis and treatment of common diseases.
6. Apply basic knowledge of the applications of biological systems in relevant industries.

**UNIT-I**

**Introduction to Life:** Characteristics of living organisms, Basic classification, cell theory, structure of prokaryotic and eukaryotic cell, Introduction to Biomolecules: definition, general classification and important functions of carbohydrates, lipids, proteins, vitamins and enzymes.

**UNIT-II**

**Biodiversity:** Plant System: basic concepts of plant growth, nutrition, photosynthesis and nitrogen fixation. Animal System: Elementary study of digestive, respiratory, circulatory, excretory systems and their functions. Microbial System: History, types of microbes, economic importance and control of microbes.

**UNIT-III**

**Genetics and Evolution:** Theories of evolution and Evidences; cell division–mitosis and meiosis; evidence of laws of inheritance; variation and speciation; nucleic acids as a genetic material; central dogma; Mendel laws, gene and chromosomes.

**UNIT-IV**

**Human Diseases:** Definition, causes, symptoms, diagnosis, treatment and prevention of diabetes, cancer, hypertension, influenza, AIDS and Hepatitis. Immunity immunization, antigen – antibody immune response.

**UNIT-V**

**Biology and its Industrial Applications:** Transgenic plants and animals, stem cell and tissue engineering, bioreactors, bio pharming, recombinant vaccines, cloning, drug discovery, biological neural networks, bioremediation, biofertilizer, biocontrol, biofilters, biosensors, biopolymers, bioenergy, biomaterials, biochips, basic biomedical instrumentation.

***Suggested Readings:***

1. A Text book of Biotechnology, R.C.Dubey, S. Chand Higher Academic Publications, 2013
2. Diseases of the Human Body, Carol D. Tamparo and Marcia A. Lewis, F.A. Davis Company, 2011.
3. Biomedical instrumentation, Technology and applications, R. Khandpur, McGraw Hill Professional, 2004
4. Biology for Engineers, Arthur T. Johnson, CRC Press, Taylor and Francis, 2011
5. Cell Biology and Genetics (Biology: The unity and diversity of life Volume I), Cecie Starr, Ralph Taggart, Christine Evers and Lisa Starr, Cengage Learning, 2008
6. Biotechnology Expanding horizon, B.D. Singh, Kalyani Publishers, 2012.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **ES213ME** | **Energy Sciences and Engineering** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **2** | **-** | **-** | **-** | **30** | **70** | **2** |

**Course Objectives**

The objectives of this course is to impart knowledge of

- Able to identify various sources of energy.
- Understand the difference between Conventional and renewable energy sources.
- Identify various storage devices of Energy.
- Able to estimate the costing of power plant.

**Course Outcomes**

After completing this course, the student will be able to:

1. Understand the basics of various sources of energy
2. Analyse the present status of conventional energy sources.
3. Understand the working principles of Renewable Energy systems
4. Design and develop waste heat recovery systems.
5. Relate energy economics, standards and future challenges.

**UNIT-I**

**Introduction:** Various sources of energy, relative merits and demerits, Statistics and prospects of conventional and Renewable energy sources.

**UNIT-II**

**Conventional Energy Sources:** Fossil Fuels: Power generation using steam turbine and gas turbine power plants, Nuclear Fuels: Parts of reactor core, Nuclear power plant outline, Methods to dispose radioactive waste. Hydro Energy: Spillways, Hydroelectric power plant outline.

**UNIT-III**

**Renewable Energy Systems:** Solar Energy – Types of collectors and concentrators, Solar Photo Voltaic Cell. Wind Energy – Types of Wind Turbines and their working, geothermal power plant, Biomass conversion, Wave Energy power plant, Tidal Energy power plant, Ocean thermal energy power plant.

**UNIT-IV**

**Storage:** Methods to store Mechanical Energy, Electrical Energy, Chemical Energy and Thermal Energy. Co-generation &Tri-generation: Definition, application, advantages, classification, saving Potential. Energy waste, waste heat recovery classification, advantages and applications, commercially viable waste heat recovery devices.

**UNIT-V**

**Power Plant Economics and Environmental Considerations:** Costing, Estimation of power production - Pollutants and Pollution Standards -Methods of pollution control. Energy Efficiency rating and BEE standards, Future energy needs and challenges.

***Suggested Readings:***

1. Wakil MM, *Power Plant Technology*, McGraw Hill
2. P.K. Nag, *Power Plant Engineering*, McGraw-Hill
3. G.D. Rai, *Non-Conventional Energy Sources*, Khanna Publishers
4. Mili Majumdar, *Energy Efficient Buildings in India*, Ministry of Non-Conventional Energy Sources.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **PC231ME** | **Mechanics of Materials** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- To understand the basic concept of stress and strains for different materials.
- To know the mechanism of the development of shear force and bending moment in beams and the stresses in thin cylinders & spheres.
- To know the theory of simple bending, direct & bending stress and distribution of shear stress.
- To analyse and understand shear stress, torsional stress and spring applications.
- To study the deflections and its applications.

**Course Outcomes**

1. To understand the theory of elasticity and Hooke's law
2. To analyse beams to determine shear force and bending moments
3. Analyse shear stress distribution in different sections of beams.
4. To analyse and design structural members subjected to combined stresses
5. To solve problems on bars and to determine deflections at any point of the beams

**UNIT – I**

**Simple Stresses & Strains:** Types of stresses & strains, Stress-Strain relations (Hooke's law), Relation between elastic constants, Volumetric strain, Composite bars, Temperature stresses. **Strain energy:** Gradual, Sudden, Impact and Shock loading.

**Compound Stresses:** Stresses on oblique planes, Principal stresses and Principal planes. Mohr's circle and ellipse of stresses & strains.

**UNIT – II**

**Shear Force and Bending Moment:** Construction of S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, uniformly distributed loads, uniformly varying loads and combination of these loads, Point of contra flexure and Relation between S.F & B.M.

**Thin Cylinders & Spheres:** Derivation of formulae for longitudinal stress, Circumferential (hoop) stress, Volumetric strains, Changes in diameter and volume.

**UNIT – III**

**Bending stresses in Beams:** Assumptions made in pure bending, Derivation of bending moment equation, Modulus of section, Moment of resistance, Determination of bending stresses. Direct and Bending Stresses: Basic concepts, Core of sections for square, rectangular, solid and hollow circular.

Distribution of shear stress: Equation of shear stress, Distribution across rectangular section.

**UNIT – IV**

**Torsion of Circular Shafts:** Theory of pure torsion, Assumptions made, Derivation of basic torsion equation, Torsional moment of resistance, Polar section modulus, Power transmitted by shafts, Combined bending and torsion.

**Helical Springs:** Close and open coiled helical springs subjected to axial loads, axial couples, Strain energy in springs.

**UNIT - V**

**Deflection of Beams:** Deflections of cantilever and simply supported beams including overhanging beams for point loads and uniformly distributed loads by Double integration method, Macaulay's method, Strain energy method, Moment area method, Conjugate beam method and Maxwell reciprocal theorem.

***Suggested Readings:***

1. S. Ramamrutham, Strength of Materials, Dhanpat Rai & Sons, 1993.B.C. Punmia, Strength of Materials and Theory of Structures, Laxmi Publishers, Delhi, 2000.
2. R.K. Rajput, Strength of Materials, S. Chand & Co., 2003.
3. EgorP.Popov,EngineeringMechanicsofSolids,PrenticeHallofIndia,NewDelhi,2001.
4. Gere & Timoshenko, Mechanics of Materials, 2nd Edition, CBS Publishers and Distributors Pvt. Ltd.
5. Ferdinand P. Beer et.al., Mechanics of Materials, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2005.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **PC232ME** | **Applied Thermodynamics** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- To study the application of thermal science in mechanical engineering, consisting of the fundamental laws and processes for energy conversion.
- To understand thermal design aspects of reciprocating machinery-reciprocating compressors and IC Engines.
- To analyse Rankine cycle applied to thermal power plants and its improvements.
- To gain the knowledge on the power plant thermal Devices-Boilers, Condensers, Pumps &Nozzles.

**Course Outcomes**

1. Expected to be able to quantify the behaviour of reciprocating compressors.
2. Expected to be able to explain thermal design and working principles of IC Engines, their supporting systems and Combustion chambers.
3. Expected to be able to quantify the behaviour of power plants based on the Rankine cycle, including the effect of enhancements such as superheat, reheat and regeneration.
4. Expected to be able to explain the thermal design and working principles of Power plant devices.
5. Expected to be able to explain working principles of Boilers, Condensers, Pumps &Nozzles.

**UNIT-I**

**Reciprocating Air Compressors:** Classification and applications. Ideal and actual P-V diagrams, work input and efficiency relations for single and multi-stage compressors. Effect of clearance volume on work input and efficiency. Inter cooling and after cooling concepts.

**UNIT-II**

**Internal Combustion Engines:** Classification and applications. Working principles of four stroke and two stroke engines, Spark Ignition and Compression ignition engines. Deviation of actual cycles from Air Standard cycles. Performance parameters of I.C. Engines. Heat balance sheet of I. C. Engine. Overview of Engine supporting systems- Cooling Systems, Lubrication systems- Wet sump, Dry sump and Mist Systems. Working principles of S.I. Engine fuel systems- Carburettors, Battery and Magneto Ignition systems. Working principles of C.I. Engine fuel systems- Fuel pump and Fuel injector.

**UNIT-III**

**I.C. Engine Combustion phenomena:** Stages of combustion in S.I. Engines- Ignition delay, Flame front propagation and After burning. Abnormal combustion- Pre-ignition and Knocking.

Factors affecting Knocking. Stages of combustion in C.I. Engines, Delay period, Period of Uncontrolled Combustion, Period of Controlled Combustion and after burning. Abnormal Combustion-Knocking. Factors affecting Knocking. Octane and Cetane rating of fuels. Design considerations for combustion chamber and cylinder head. Type of combustion chambers of S.I. engines and C.I. engines.

**UNIT-IV**

**Steam Boilers:** Classification and Working Principles. Water tube boilers- Babcok & Wilcox and Stirling boilers. Fire tube boilers- Cornish, Cochran, Locomotive and Lancashire boilers. High Pressure boilers / Supercritical boilers: La-mont, Benson boiler, Loeffler boiler and Velox boiler. Boiler Mountings and Accessories. Boiler Draught. Calculation of Chimney height.

**Steam Condensers:** Jet and Surface condensers, Principle of Operation and Applications.

**UNIT-V**

**Steam Power Plant Cycles:** Carnot and Rankine cycles of operation and their efficiencies. Analysis of Rankine cycle with superheating, reheating and regeneration (Direct and Indirect types).

**Steam Nozzles:** Flow of steam through convergent - divergent nozzles, velocity of steam flowing through the nozzle, mass of steam discharge through the nozzle, condition for maximum discharge, critical pressure ratio and nozzle efficiency. Super saturated expansion of steam through nozzles. General relationship between area, velocity and pressure in Nozzle flow.

***Suggested Reading:***

1. R.K. Rajput, " Thermal Engineering", Laxmi Publications, 9th Edn., 2013
2. V. Ganesan, "Internal Combustion Engines", Tata McGraw Hill Publishing, 2007
3. P.L. Ballaney, "Thermal Engineering", Khanna Publishers, 19th Edn., 1993.
4. Richard Stone, "Introduction to I.C. Engines", Mac Millan, 2nd Edn., 1997

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **MC233ME** | **Kinematics of Machinery** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

The objectives of this course is to impart knowledge of

- Analysis of mechanisms.
- Drawing displacement diagrams for followers with various types of motions.
- Cam profile drawing for various followers.
- Estimation of transmission of power by belts and application of various gears and gear trains.

**Course Outcomes**

After completing this course, the student will be able to:

1. Understand the principles of kinematic pairs, chains and their classification, DOF, inversions, equivalent chains and planar mechanisms.
2. Analyse the planar mechanisms for position, velocity and acceleration.
3. Design frictional systems like belt drives, rope drives, clutches, bearings and screw threads
4. Design cams and followers for specified motion profiles.
5. Evaluate gear tooth geometry and select appropriate gears for the required applications.

**UNIT-I**

Definition of link, pair, kinematic chain, mechanism and machine, Kutzbach and Grubler criterion, Grashoff's law, inversions of quadratic cycle chain, inversions of single and double slider crank chains. Fundamentals of coupler curves, Robert's law, Pantograph, Geneva mechanism, Hooke's joint, Davis and Ackerman's Steering gear mechanisms.

Introduction to Type, Number and Dimensional synthesis of four bar planar mechanisms

**UNIT-II**

**Analysis of Mechanisms:** Instantaneous centre, body centrode and space centrode, Kennedy's theorem, Graphical methods (relative velocity method, instantaneous center method) to find velocities and accelerations including Coriolis component of acceleration of planar mechanisms. Angular velocity theorem.

**UNIT-III**

**Laws of Friction:** Friction in screw threads, pivots, collars and clutches, friction axis of link and friction circle

**Belts and Rope drives:** Open and closed belt drives, length of belt, ratio of tensions, effect of centrifugal tension and initial tension on power transmission, condition for maximum power transmission

**Brakes**: Block or shoe brake, internal expanding shoe brake, disc brake, belt brakes

**Dynamometers:** Rope brake, belt transmission and Torsion type dynamometers

**UNIT-IV**

**Cams:** Types of cams and followers, Displacement, velocity, acceleration and jerk (SVAJ) diagrams for follower motion, Analysis of uniform motion, parabolic motion, simple harmonic motion and cycloidal motion profiles. Graphical synthesis of planar cams with knife edge, roller and flat face followers. Eccentric circle cam with translating roller follower.

**UNIT-V**

**Gears:** Classification of gears. Spur gears- Nomenclature, law of gear tooth action, involute as gear tooth profile, interference of involute gears, minimum number of teeth to avoid interference, contact ratio, cycloidal tooth profile, comparison of involute and cycloidal tooth profile.

**Helical gears:** Helical gear tooth relations, contact of helical gear teeth.

**Gear trains**- Simple, compound, reverted, and epi cyclic gear trains.

***Suggested Readings:***

1. S.S. Rattan, Theory of Machines, Tata McGraw-Hill, 3rd Edition,2009.
2. J. E. Shigley, Theory of Machines and Mechanisms, McGraw-Hill Publications,2005.
3. Thomas Bevan, Theory of Machines, Pearson Education
4. Norton RL, Kinematics and Dynamics of Machinery, McGraw-Hill Publications
5. Amitabha Ghosh and Ashok Kumar Mallik, Theory of Mechanisms and Machines, East West Press Pvt. Ltd,2008

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **MC234ME** | **Manufacturing Process** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- To understand the basic principles of major manufacturing processes such as metal casting, welding and forming of engineering materials.
- To know the advantages and limitations of each process.
- To be able to select the optimal process to produce a product.
- To know the basic principle of advanced forming processes.

**Course Outcomes**

1. Describe the concepts of Foundry Technologies consisting of pattern making, mould making, gating design and solidification.
2. Discuss the importance of special casting processes, categorize various casting defects and describe the processing of plastics.
3. Classify and differentiate various Arc welding, Gas welding and Advanced welding processes, discuss their advantages, applications and limitations.
4. Differentiate various Solid State welding and Resistance welding processes, discuss their applications, and identify various welding defects.
5. Describe various forming processes, sheet metal operations and discuss the importance of unconventional forming processes.

**UNIT-I**

**Casting Process :** Casting terms, pattern materials, types of patterns, pattern allowances, colour code for patterns, Moulding sands, core sands, properties of moulding sand and its ingredients, different types of moulding machines, Directional solidification, use of chaplets, chills, riser and gating design.

**UNIT-II**

**Special Casting Processes:** Shell moulding, $Co_2$ moulding, die casting, centrifugal casting, investment or lost wax process; Casting defects, causes and remedies, Inspection and testing of castings. **Processing of Plastics** - Extrusion, Injection moulding, Blow moulding and Thermoforming. **Introduction to Powder Metallurgy**- Process, Production of powders, blending, mixing, compaction techniques and finishing operations employed in powder metallurgy processes.

**UNIT-III**

**Welding Processes:** Introduction, Classification of welding processes, principle of gas welding, equipment and techniques, types of flames and applications, advantages, limitations and applications of Gas welding; Arc welding equipment electrode materials and specifications, polarity, types of arc welding.- SMAW, SAW, GMAW, GTAW, PAW, Atomic hydrogen welding, principle of Electro slag welding, Soldering and Brazing, Gas cutting.

**UNIT-IV**

**Solid State Welding Process:** Forge Welding, Friction Welding, Friction Stir Welding, and Explosive Welding.

**Resistance welding processes** - Spot welding, Projection welding, Percussion welding, Seam welding, Butt welding, weldability, Welding defects

**UNIT-V**

**Forming Processes:** Cold & Hot working, Yield criteria, Process description of Forging, Rolling, Extrusion, Wire drawing.

**Sheet Metal Operations:** Blanking, Piercing, Bending, Deep drawing, Stretch forming, Spinning.

**Advance Forming Processes**- High energy rate forming processes such as Explosive forming, Electro-magnetic forming and Electro-hydraulic forming; Rubber pad forming

***Suggested Readings:***

1. P.N. Rao, "Manufacturing Technology," Vol. 1, Tata McGraw Hill Publ., 3nd Ed., 2011
2. Amitabh Ghosh & Mallick, "Manufacturing Science", Assoc. East west Press Pvt. Ltd. 4th Ed., 2011
3. Roy A. Lindberg, "Processes and Materials of Manufacture", 3rd Edition, Pearson Education, 2015.
4. Serope Kalpakjian, "Manufacturing Engineering and Technology", Pearson Education, 2018
5. George. E. Dieter, "Mechanical Metallurgy", SI Metric Edition McGraw-Hill Book Company
6. J.P.Kaushish, "Manufacturing Processes", PHI Learning Pvt. Ltd., 2nd, 2010

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **MC261ME** | **Thermal Engineering Lab - I** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **-** | **-** | **-** | **2** | **25** | **50** | **1** |

**Course Objectives**

- To understand applications of thermal engineering concepts through experimentation.
- To provide knowledge in testing of properties of fuels and lubricating oils
- To demonstrate and conduct experiments, Interpret and analyse data and report results of IC engine testing

**Course Outcomes**

1. Perform experiments to find the efficiency of Petrol and Diesel engines.
2. Find the properties of unknown fuels/lubricants.
3. Perform experiments on CI and SI engines.
4. Perform experiments on Reciprocating Air Compressor.

**List of Experiments:**

1. To determine volumetric efficiency, isothermal efficiency and mass flow rate of a two stage reciprocating air compressor.
2. To determine valve timing diagram of a Petrol/Diesel engine.
3. To determine port timing diagram of a Petrol/Diesel engine.
4. To conduct performance test on single cylinder Diesel engine.
5. To conduct heat balance test on a Diesel engine.
6. To conduct Morse test on multi cylinder Petrol engine.
7. To conduct performance test on multi cylinder Petrol engine.
8. To conduct performance test on a two-stroke Petrol engine.
9. To conduct performance test on multi cylinder Diesel engine.
10. To study the performance of a Petrol engine under different compression ratios.
11. Exhaust gas analysis of Petrol engine for carbon-monoxide and unburnt hydrocarbons.
12. Exhaust gas analysis of Diesel engine for carbon deposits using smoke meter.
13. Determination of viscosity of lubricating oil.
14. Determination of flash and fire points of a fuel
15. Study of Boiler Models

**Note:** At least ten experiments should be conducted in the Semester

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **PC262ME** | **Manufacturing Processes Lab** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **-** | **-** | **-** | **2** | **25** | **50** | **1** |

**Course Objectives**

- To gain knowledge and skill in various manufacturing processes such as casting, welding and forming.
- To understand and perform operations like pattern making, sand testing and casting.
- To join metal pieces by various welding techniques and gain hands on experience.
- To understand the working principle and produce some components by various metal forming techniques.

**Course Outcomes**

1. Conduct experiments and put hands-on experience on various processes in foundry, welding, forging, forming and plastic manufacturing technologies.
2. Demonstrate the understanding of the theoretical concepts of above technologies while working in small groups.
3. Demonstrate writing skills through clear laboratory reports
4. Identity the defects / imperfections and discuss their causes and suggest remedies to eliminate them.
5. Transfer group experience to individual performance of exercises and demonstrate effective oral communication skills.

**List of Experiments:**

**Foundry**

1. Single piece pattern making with wood as material considering allowances (Draft, Shrinkage and Machining)
2. Green sand mould making processes with complete sprues, gates, riser design.
3. Testing of green sand properties
4. Melting and casting of aluminium metal.

**Welding**

I. Evaluation of strength and hardness of a
   1. Butt Joint prepared by gas welding using different types of flames
   2. Lap joint by resistance welding process
   3. V-Joint by Arc welding process

II. Exercises using TIG and MIG welding processes.

**Forming:**

1. Evaluation of formability using Erichsen cupping test
2. Performing wire drawing operation on different materials (ex. Cu, Al, etc)
3. Performing blanking and piercing operations using hydraulic/fly presses.
4. Manufacturing of a simple component using Plastic Injection moulding machine

**Note:** Minimum ten experiments should be conducted in the semester

# FACULTY OF ENGINEERING

## Scheme of Instruction & Examination

(AICTE Model Curriculum for the Academic Year 2020-2021)

and

## Syllabi

## B.E. V and VI Semester

## of

## Four Year Degree Programme

## in

# Mechanical Engineering

(With effect from the academic year 2020– 2021)
(As approved in the faculty meeting held on - -2020)

Issued by

**Dean, Faculty of Engineering**

**Osmania University, Hyderabad – 500 007**

**2020**

## SCHEME OF INSTRUCTION & EXAMINATION
## B.E. (Mechanical Engineering) V – SEMESTER

| S.No. | Course Code | CourseTitle | SchemeofInstructions | | | | SchemeofExamination | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P/D | Contact Hours/ Week | CIE | SEE | Durationin Hours | |
| **Theory Course** | | | | | | | | | | |
| 1 | PC501ME | Fluid Mechanics and Hydraulic Machinery | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 2 | PC502ME | Design of Machine Elements | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 3 | PC503ME | Dynamics of Machines | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 4 | PC504ME | Metal Cutting and Machine Tools | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 5 | PC505ME | Heat Transfer | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| **LaboratoryCourse** | | | | | | | | | | |
| 6 | PC591ME | Thermal Engineering Lab-2 | - | - | 2 | 2 | 25 | 50 | 3 | 1 |
| 7 | PC592ME | Dynamics of Machines Lab | - | - | 2 | 2 | 25 | 50 | 3 | 1 |
| 8 | PC593ME | Fluid Mechanics and Hydraulic Machinery Lab | - | - | 2 | 2 | 25 | 50 | 3 | 1 |
| | | Total | 15 | - | 06 | 21 | | | | 18 |

PC: Professional Core PE: Professional Elective OE: Open Elective
L: Lecture T: Tutorial P: Practical D: Drawing
CIE: Continuous Internal Evaluation SEE: Semester End Evaluation (Univ. Exam)

## SCHEME OF INSTRUCTION & EXAMINATION
## B.E. (Mechanical Engineering) VI – SEMESTER

| S.No. | Course Code | CourseTitle | SchemeofInstructions | | | | SchemeofExamination | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P/D | Contact Hours/ Week | CIE | SEE | Durationin Hours | |
| **Theory Course** | | | | | | | | | | |
| 1 | PC601ME | Machine Design | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 2 | PC602ME | Metrology and Instrumentation | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 3 | PC603ME | Finite Element Analysis | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 4 | PEME - 1 | Professional Elective – I | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 5 | PEME - 2 | Professional Elective – II | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 6 | OEME - 1 | Open Elective – 1 | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| **LaboratoryCourse** | | | | | | | | | | |
| 7 | PC691ME | Metrology and Machine Tools Lab | - | - | 2 | 2 | 25 | 50 | 3 | 1 |
| 8 | PC692ME | Computer Aided Engineering Lab | - | - | 2 | 2 | 25 | 50 | 3 | 1 |
| 9 | | Summer Internship* | | | | | | | | 2 |
| | | Total | 18 | 00 | 04 | 22 | | | | 22 |

Open Elective - 1 (OE611ME) : Industrial Robotics (Not for Mechanical / Prod. / Automobile)

| **PROFESSIONAL ELECTIVE - I** | |
|---|---|
| **PE611ME** | CAD/CAM |
| **PE612ME** | Automobile Engineering |
| **PE613ME** | Modern Machining and Forming Methods |

| **Professional Elective-II** | | |
|---|---|---|
| **S. No.** | **Course Code** | **Course Title** |
| 1. | PE621ME | Thermal Turbo Machines |
| 2. | PE622ME | Production and Operations management |
| 3. | PE623ME | Design For Manufacture |

PC: Professional Core PE: Professional Elective OE: Open Elective
L: Lecture T: Tutorial P: Practical D: Drawing
CIE: Continuous Internal Evaluation SEE: Semester End Evaluation (Univ. Exam)

* *At the end of VI semester students should undergo summer Internship - Credits for Summer Internship will be awarded in VII semester*

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **PC501ME** | **Fluid mechanics & Hydraulic machines** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **Mathematics& mechanics-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

**It is intended to make the students to**

1. Know various fluid properties, concepts and methods of fluid measurement.
2. Understand the basic concepts and principle of fluid flow.
3. Study different equations of fluid motion and fluid dynamics.
4. Analyze different flow characteristics of laminar flows.
5. Understand the working principle of hydraulic turbines and pumps and their performance**.**

**Course Outcomes**

After completing this course, , the student is able to

1. Distinguish the properties of the fluids and different types of pressure and measure them.
2. Explain different types of flows and analyze them.
3. Analyze the flow between parallel plates and in pipes and also calculate drag and lift coefficients.
4. Demonstrate the working principles of various hydraulic turbines and estimate their performance.
5. Demonstrate the working principles of various hydraulic pumps and estimate their performance.

**UNIT – I**

**Basic Concepts and Properties of Fluid**

Definition, distinction between solid and fluid, , Properties of fluids, density, specific weight, specific volume, specific gravity, temperature, viscosity, compressibility, vapour pressure, capillary and surface tension, units and dimensions.

Fluid statics

Concept of fluid static pressure, absolute and gauge pressures, pressure measurements by manometers and pressure gauges.

**UNIT-II**

**Fluid Kinematics**

Flow visualization, lines of flow, types of flow, velocity field and acceleration, Continuity equation (one and three-dimensional differential forms), Equation of streamline, stream function, velocity potential function, circulation, flow net**.**

**Fluid Dynamics**

Equations of motion, Euler's equation along a streamline, Bernoulli's equation, applications. Venturi meter, Orifice meter, Pitot tube.

**UNIT-III**

**Incompressible Fluid Flow**

Viscous flow, Shear stress-pressure gradient relationship, laminar flow between parallel plates, Laminar flow through circular tubes (Hagen poiseulle's), Hydraulic and energy gradient lines**.**

**Flow through pipes**

Darcy- Weisback's equation, pipe roughness, friction factor, minor losses, flow through pipes in series and in parallel, power transmission, Boundary layer flows, boundary layer thickness, boundary layer separation, drag and lift coefficients.

**UNIT IV**

**Hydraulic Turbines**

Definition and classifications, Pelton turbine, Francis turbine, propeller turbine, Kaplan turbine, working principles, velocity triangles, work done, specific speed. Efficiencies, performance curve for turbines.

**UNIT V**

**Hydraulic Pumps**

**Pumps:** definition and classifications, Centrifugal pump: classifications, working principles, velocity triangles, specific speed, efficiency and performance curves. Reciprocating pump: classification, working principles, indicator diagram, performance curves, cavitation in pumps, Rotary pumps: working principles of gear and vane pumps.

**Suggested Reading**

1. **Streeter, V.L., and Wylie, E.B., "Fluid Mechanics", McGraw-Hill, 1983.**
2. **Modi & Seth "Hydraulic and Fluid Mechanics" – standard book house, 2002.**
3. **Bansal, R.K., "Fluid Mechanics and Hydraulics Machines", (5$^{th}$ edition), Laxmi publications (P) Ltd. Delhi, 1995.**
4. **Kumar D. S., "Fluid Mechanics and Fluid Power Engineering", S. K. Kataria & Sons.**
5. **White, F.M., "Fluid Mechanics", Tata McGraw-Hill, 5$^{th}$ Edition, New Delhi, 2003.**
6. **Som, S.K., and Biswas, G., "Introduction to fluid mechanics and fluid machines", Tata McGraw-Hill, 2$^{nd}$ edition, 2004.**

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| PC502ME | DESIGN OF MACHINE ELEMENTS | | | | | | Core |
| Prerequisite | Contact Hours per week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| | 3 | -- | -- | -- | 30 | 70 | 3 |

**Course Objectives:**

- Importance of codes, materials, manufacturing processin design of mechanical components
- Importance of theories of failure and effects of fatigue and stress concentration on the life of the component
- Learn the concepts required to design machine components like keys, shafts, couplings
- Will learn to determine size of rivets, welds and cotter joints for specific applications
- Will Understand the concepts used for designing machine components like cotters, bolts, nuts

**Course Outcomes:**

- Identify & Use codes and standards, selection proper material & perform static design.
- Analyze cyclic loading conditions and provide fatigue design of components
- Analyze machine elements like keys, shafts and couplings,
- Evaluate various joining techniques like welding, riveting and cotter joints.
- Synthesize an d design screw threads for fasteners and power screw applications.

UNIT-I

Steps involved in Design, Design considerations of Machine Elements, Materials used and their specifications. Codes and standards used in design. Practice of using Design data book. Concept of Aesthetics & Ergonomics in design, Preferred numbers. Manufacturing considerations in design. Concept of Value analysis, Principles of concurrent design,

Types of loads and simple stresses. Principal stresses, Stresses due to Biaxial and Triaxial loads. Stress concentration effects, Factor of safety. Theories of failures. Design of components subjected to impact loading.

UNIT-II

Design for Fatigue: Fluctuating stresses, fatigue strength and endurance limit Stress concentration factor and Notch sensitivity. Factors affecting fatigue strength. S-N diagram, Soderberg and Modified Goodman's diagrams for fatigue design, Cumulative fatigue - Miner's rule.

UNIT-III

Design of shafts: solid, hollow and splined shafts under torsion and bending loads. Design of keys. Design of couplings – Industrial Flange coupling, Flexible rubber bush couplings.

UNIT-IV

Design of Joints: Cotter and Knuckle joints. Design of rivetted and welded joints under direct and eccentric loads.

UNIT-V

Design of Screw threads: Design of bolts and nuts, Locking devices for nuts, Bolts of uniform strength. Design of gasket joints, Bolted joints under eccentric loads, Differential and Compound Screws, Design of power Screws and screw jack.

Suggested Reading:

1. V. B. Bhandari, "Design of Machine Elements", Tata McGraw-Hill Publ, 3rd Edn. 2010.
2. J.E. Shigley & Charles R. Mischke "Mechanical Engineering Design", Tata McGraw-Hill.,6th ed.2010.
3. P. Kannaiah, Machine Design, Sci-Tech Publ., 2009.
4. P.C. Sharma & D.K. Aggarwal, "Machine Design", S.K. Kataria & Sons, 10th edn, 2003
5. V. B. Bhandari, "Design Data Book " 2nd edition, ", Tata McGraw-Hill Publ, 2019

**Note** : Solution of Numerical problems using Design data book should be practiced.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| PC503ME | DYNAMICS OF MACHINES | | | | | | Core |
| Prerequisite | Contact Hours per week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| Kinematics of Machines | 3 | -- | -- | -- | 30 | 70 | 3 |

**Course Objectives:**

- To know effect of inertia of links, and external forces on the input torque, and forces developed at joints in typical mechanisms in motion; understand the gyroscopic couple and its effect on vehicles in motion.
- To know the working principles and characteristics of typical governors, as also the function of flywheels.
- To know the concept of unbalancing rotating and reciprocating masses in single and multi-cylinder in line and radial engines.
- To understand the phenomena of free of free and forced, including the effect of damping for single dof systems, and concepts of isolating vibration.
- To determine natural frequencies of undammed, damped and forced vibrating systems of one, two and multi degree freedom systems.

**Course Outcomes:**

- Analyse static and dynamic forces in slider crank and other mechanisms; determine the magnitude of gyroscopic couple and its effect on vehicles in motion.
- Evaluate the performance of various types of governors and design flywheels considering speed and energy fluctuation
- Analyse problems of balancing in rotating and reciprocating machinery.
- Evaluate the natural frequencies of single and two degree of freedom systems in free and forced vibration mode, also considering the effect of damping.
- Determine the natural frequencies and mode shapes of multi degree of freedom systems, including by Dunkerley, Raleigh and Holzer methods.

## *UNIT-I*

Static and Dynamic Force Analysis: *Static equilibrium:* Constraint and Applied forces, Static Force analysis of Single slider crank mechanism without Friction, Principle of Superposition.

*Dynamic Equilibrium:* d'Alambert's Principle, Equivalent offset inertia force, Dynamic force Analysis of Slider Crank Mechanism,

Engine Force Analysis: Piston effort, Force along connecting rod, thrust on sides of cylinder, crank effort. Thrust on bearing. Dynamically Equivalent System for Connecting Rod.

*Gyroscope:* Gyroscopic Couple, gyroscopic effects on aeroplanes, naval ships.

Stability of two wheel vehicle only.

### *UNIT-II*

Governors: Working principle of governor, Classification & types of governors, analysis of Watt, Porter, and Hartnell governors. Characteristics of governors:

Controlling Force, Stability, Isochronism, Sensitivity, Power and Effort of governors.

Flywheels: Functions, Differences between flywheel and governor, turning moment diagrams, flywheel analysis for I-C Engines and presses.

***UNIT - III***

Balancing: Static balancing, Dynamic balancing, balancing of several masses rotating in several planes, consideration of bearing forces, balancing of reciprocating masses, primary balancing shaking forces in single cylinder engine, partial balancing and its effects, secondary balancing.

***UNIT - IV***

Vibrations: Vibrations of Single degree freedom system (axial, transverse and torsional), Equivalent system of combination of springs, Stepped shaft, Whirling speed of shafts.

Damped Vibrations: Types of damping, Vibrations with viscous damping

Forced Damped Vibrations: Magnification factor, Resonance, Vibration isolation and Transmissibility.

***UNIT –V***

Vibration Analysis of Multi Degree Freedom Systems: Torsional Vibrations of Two rotor, three rotor and Geared systems. Natural frequencies of two degree freedom systems Modes of vibration approximate methods for determining natural frequencies: Dunkerley's method, Rayleigh's method. Holzer's method (only Theory).

## Suggested Reading:

1. S.S. Rattan, Theory of Machines, Tata McGraw Hill, 2010
2. Thomas Bevan, the Theory of Machines, CBS Publishers & Distributors, 2004.
3. John J.Uicker, Jr. Gordon, R.Pennock, Joseph E.Shigley, Theory of Machines and Mechanisms, Oxford University Press, 2003.
4. J.S. Rao and Gupta, Theory and Practice of Mechanical Vibrations, Prentice Hall, 1984.
5. R.L.Nortan, "Kinematics and Dynamics of Machinery", Tata McGraw Education Pvt. Ltd , New Delhi, 2009.
6. Ghosh and Mallik, Theory of Mechanisms and Machines, Affiliated East-West Press, 1988.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **PC504ME** | **METAL CUTTING & MACHINE TOOLS** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| - | 3 | - | - | - | 30 | 70 | 3 |

**Course Objectives:**

- To learn the tool material, geometry and mechanics of metal cutting for turning, drilling and milling.
- To know the heat distribution, tool wear, tool life, and machinability
- To learn the principle and working of various machine tools like lathe, shaper, planer, milling, drilling and grinding machines etc.
- To learn various types of fixtures, conventional and unconventional machining processes.

**Course Outcomes:**

- Understand the cutting tool geometry, mechanism of chip formation and mechanics of orthogonal cutting.
- Understand the thermal aspects of metal cutting, influence of tool wear on tool life and machinability.
- Identify basic parts and operations of machine tools including lathe, shaper, planer, milling, drilling, and boring machines.
- Design locating and clamping devices to produce a component.
- Understand the principles of various finishing processes and gear manufacturing processes
- Understand the principle and working of various unconventional machining processes.

**UNIT-I**

**Cutting Tool Materials:** High carbon steel, HSS, Stellites, Carbides, Coated carbides, Diamonds, Tool material properties; **Tool Geometry:** Nomenclature of single point cutting tool by ASA & ORS systems. Geometry of drills, milling cutters; **Chip Formation:** Types of chips, BUE, Chip breakers; **Machining:** Orthogonal and oblique cutting, Mechanics of metal cutting, Merchant's analysis, Shear angle, Solutions of Merchant and Lee & Shafer.

**UNIT-II**

**Thermal Aspects of Metal Cutting:** Sources of heat and heat distribution, various methods of measurement of temperature, Cutting fluids and applications; **Tool Wear, Tool Life and Machinability:** Types of wear, mechanism of tool wear, Tool life & Machinability, Machinability index. Taylor's tool life equation; **Economics of Machining:** Tool life for maximum production, minimum cost.

**UNIT-III**

**Machine Tools:** Constructional features and specifications of machine tools, various operations on Lathe, Types of Lathes - capstan and turret Lathes; Drilling, Milling and Boring machines. Indexing methods, differences between shaper, planer and slotter, Tool holding and work holding devices Quick return mechanisms.

**UNIT-IV**

**Grinding Machines:** Types of grinding, Abrasives and bonds used for grinding wheels. Specification and selection of grinding wheels; Broaching, Lapping, Honing, Polishing, Buffing, Super Finishing and Burnishing.

**Screws and Gear Manufacturing:** Tapping, Chasers, Thread rolling, Thread milling, Thread grinding. Gear shaping, Gear hobbing, Gear shaving and grinding.

**UNIT-V**

**Jigs and Fixtures:** Design principles for location and clamping. Quick clamping devices Types of Jigs and fixtures. Applications of Jigs and Fixtures.

**Unconventional Machining:** Principle of working, merits, demerits and applications of USM, AJM, EDM, ECM, LBM and EBM

**Suggested Reading:**

1. B.L. JuneJa and Shekon, "Fundamentals of Metal Cutting & Machines Tools", Wiley Eastern Ltd. 1987.
2. P.N. Rao, "Manufacturing Technology – Metal Culling & Machine Tools", Vol. 2, Tata McGraw Hill Education Pvt. Ltd, 2010.
3. Amitab Ghosh and Mallick, "Manufacturing Science", Affiliated East West Press 1985.
4. P.K Misha, "Non Traditional Machining Processes", Narosa Publications, 2006.
5. V.K.Jain “Advanced Machining Processes“ Allied Publishers, Hyderabad, 2011.
6. A. Bhattacharyya, “Metal Cutting Theory and Practice” New Central Book Agency (P) Ltd. Calcutta, 1996.
7. Stephan Radavich, “Gear Manufacturing”, CRC Press, ,1 Edn,2011

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **PC505ME** | **HEAT TRANSFER** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **FLUID MECHANICS** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

The objectives of this course is to impart knowledge of

- The basic concepts of heat transfer Obtaining centroids and moments of inertia for various regular and irregular areas.
- The concepts of conduction, convection, radiation and heat exchangers applicable for commercial and industrial use
- The applications of various experimental heat transfer correlations in engineering applications.
- Thermal analysis and sizing of heat exchanger.
- solving problems on different modes of heat transfer which are related to thermal power plants, refrigeration and air conditioning

**Course Outcomes**

After completing this course, the student will be able to:

1. To understand the basic concepts of heat transfer.
2. To understand the concepts of heat transfer through extended surfaces.
3. To Familiarize with time dependent heat transfer and compute convective heat transfer coefficients in forced, natural convection.
4. To understand radiation heat transfer
5. To understand , heat exchangers and mechanism involved in boiling and condensation.

**UNIT – I**

**Conduction:**Modes of Heat Transfer, Laws of Heat Transfer - Fourier, Newton, Stefan-Boltzmann General conduction equation in cartesian, cylindrical and spherical coordinates, One dimensional steady state conduction through slabs, hollow cylinders and spheres with and without heat generation, Effects of variable thermal conductivity in heat transfer of one dimensional steady state conduction of plate, cylinders and spheres, Steady state heat transfer through composite slabs, cylinders and spheres, Critical radius of insulation.

**UNIT – II**

**Fins:** Heat transfer analysis of tips with heat dissipation environment - rectangular straight and pin fins, Application of fin to temperature measurement, unsteady state conduction, Lumped parameter, analysis of a body with negligible internal temperature gradients, Transient heat transfer analysis of finite slab with specified temperature and convective boundary conditions, Use of Grober and Heisler charts for solving problems of infinite slabs, cylinders and spheres.

**UNIT-III**

**Free and forced convection**: Dimensional analysis and its use in free and forced convection, Buckingham theorem, Physical significance of different dimensionless numbers, Application of Von-Karman integral equation for the analysis of thermal boundary layer in forced convection of flat plate, Reynold's analogy for flow over plane surfaces, calculation of heat transfer for flow over plates, cylinders and for flow through tubes in free and forced convection using empirical formulae.

**UNIT –IV**

**Radiation:** Definition of absorptivity, reflectivity and transmissivity, Concept of black-body and emissivity. Kirchoffs law, Planck's black body spectral distribution, Wien's and Steffan Boltzmann law, Monochromatic and total emissive power, radiant heat exchange between two gray surfaces, Shape factor, Thermal circuit for radiant heat exchange between infinite parallel plates and between concentric, cylinders, Enclosures with black and gray surfaces, Radiation shields and re-radiation surfaces.

**UNIT – V**

**Heat Exchangers:** Classification and applications of heat exchangers in industry, Analysis and design of counter flow and parallel flow heat exchanger, Fouling factors, solving problems for multi pass heat exchanger using non dimensional parameter plots.

**Change of Phase:** Boiling-pool boiling regimes nucleate pool boiling, effect of surface wettability on bubble contact angle, Critical heat flux, boiling in forced convection, Condensation: Film condensation, Drop wise condensation, Condensation film thickness, Heat transfer coefficient in film condensation.

***Suggested Readings:***

1. Holman, J.P., "Heat Transfer", McGraw Hill Publication, New Delhi, 2010 2.
2. Rajput, R.K., "Heat and Mass Transfer", S. Chand & Company Ltd, New Delhi, 2004.
3. Yadav, R., Sanjay. and Rajay., "Heat and Mass Transfer ', Central Publishing House, Allahabad, 2004
4. Sachdeva,R.C., "Fundamentals of Engineering Heat and Mass Transfer ", New Age International (P) Ltd Publishers, New Delhi,
5. Arora, S.C. and Domkandwar., "A course in Heat and Mass Transfer ", DhanpatRai& Sons, New Delhi, 2004.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **PC591ME** | **THERMAL ENGINEERING Lab - II** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **-** | **-** | **-** | **2** | **25** | **50** | **1** |

**Course Objectives**

- Determining thermal conductivity of an insulating powder in composite slab or cylinder. The concepts of conduction, convection, radiation and heat exchangers applicable for commercial and industrial use
- Evaluating the heat transfer coefficients under natural convection and forced convection phenomena Thermal analysis and sizing of heat exchanger.
- determining the necessary constants pertaining to radiation
- understanding the working principles of axial flow fan and its overall efficiency
- estimating overall efficiency of a centrifugal compressors and pressure distribution over cylinder and an aerofoil section on turbo machines.

**Course Outcomes**

Aftercompletingthis course, thestudentwillbe ableto:

1. Interpret the link between refrigeration effects, work done and COP of the system, describe different methods adopted to evaluate COP, list the different psychrometric processes and describe how those processes can be maintained
2. Calculate the overall efficiency of centrifugal blower and axial flow fan at different volume flow rates, show the variation of overall efficiency with load and speed graphically To understand radiation heat transfer, heat exchangers and mechanism involved in boiling and condensation.
3. . Identify the various components of low speed wind tunnel, plot a graph showing variation of pressure over the entire length of aerofoil blade and also evaluate the lift and drag coefficient values for a given aerofoil blade at different angle of assign
4. Describe the modes of heat transfer, calculate thermal conductivity, heat transfer coefficient subjected to natural and forced convection environment and Stefan Boltzmann constant value of thermal radiation.
5. Express the working principle of heat exchangers and its application in real life, calculate the LMTD and effectiveness of a given heat exchanger for both parallel and counter flows.

**List of Experiments:**

1. Determination of thermal conductivity of metal bar
2. Determination of thermal conductivity of composite wall.
3. Determination of the efficiency of pin-fin subjected to natural and forced convection
4. Determination of effectiveness of parallel flow and counter flow heat exchanger

5. Determination of emissivity of given test plate
6. Determination of Stefan Boltzmann constant.
7. Determination of COP of the Air conditioning system
8. Determination of percentage relative humidity and study of humidification and dehumidification process in Air Conditioning systems
9. .Determination of COP of refrigeration systems using capillary tube/ thermostatic expansion valve
10. Determination of overall efficiency of centrifugal blower
11. Determination of overall efficiency of axial flow fan
12. Pressure distribution on symmetrical and non-symmetrical specimen in wind tunnel
13. Measurement of lift and drag force of the models in wind tunnel test section

**Note:** At least ten experiments should be conducted.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **PC592ME** | **DYNAMICS OF MACHINES LAB** | | | | | | **Core** |
| **Prerequisite** | **Contact Hours per week** | | | | **CIE** | **SEE** | **Credits** |
| | **L** | **T** | **D** | **P** | | | |
| **Theory of Machines** | **--** | **--** | **--** | **2** | **25** | **50** | **1** |

**Course Objectives:**

- To understand the effects and importance of kinematic and dynamic analysis of mechanisms
- To understand effects and analysis of Single degree freedom vibration systems
- To study the gyroscope, governors and cams
- To carry out the static and dynamic analysis of four bar mechanisms and drives

**Course Outcomes:**

- To experimentally quantify the effect of inertia forces in systems like flywheel, gyroscope and governors.
- To evaluate vibrational characteristics of various systems experimentally.
- To Synthesize balancing method of multi plane rotating masses.

## List of Experiments

1. Centrifugal Governors: Experiment on Performance Characteristic Curves.
2. Estimation of Gyroscopic Couple & Understanding of Gyroscopic Effects on a rotating disc.
3. Static and Dynamic Balancing of Rotating Masses.
4. Determination of Moment of Inertia of Connecting Rod by compound pendulum method.
5. Damped and Undamped Torsional Vibrations of Single and Double Rotor System.
6. Single DOF (Degrees of Freedom) of Spring Mass Damper System. (Damped and Undamped Systems).
7. Free and Forced Vibration of Simply Supported Cantilever Beam.
8. Dunkerley Method to Find Fundamental Frequencies.
9. Critical Speed of Shaft.
10. Modal Analysis of Beam.
11. Cam Analysis of Cams.
12. Any Experiment explaining dynamic aspects of mechanical systems.

## Additional Experiments Suggested

1. Determination of Moment of Inertia of Flywheel.
2. Experiment with Bifilar System.

**Demonstration Experiments** (Can't be allocated in final exams)

1. Velocity Ratios of Simple, Compound, Epicyclic and Differential Gear Trains.
2. Virtual Lab Experiment I – Governors.
3. Virtual Lab Experiment II – Natural Frequency of Cantilever beam.

**Note**: Minimum ten experiments should be conducted in the semester.

**Suggested Reading:**

1. S.S. Rattan, Theory of Machines, Tata McGraw Hill, 2010
2. John J.Uicker, J r. G o r d o n, R.Pennock, Joseph E.Shigley, Theory of Machines and Mechanisms, Oxford University Press, 2003.
3. Lab manual supplied by department.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **PC593ME** | **Fluid mechanics & Hydraulic machines laboratory** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| - | - | - | - | **2** | **25** | **50** | **1** |

**Course Objectives**

**Students able to understand**

1. **the working of pumps of different kinds and their behaviour.**
2. **the working of turbines of different kinds and their behaviour.**
3. **the theory of working of various flow measuring devices and their utility in industry.**

**Course Outcomes**

Aftercompleting this course, thestudentwillbe ableto:

1. Practice and experiment on different types of turbines and analyse their performance at rated and off design conditions.
2. Investigate through experimentation different types of pump models and estimate their performance.
3. Apply the priniciple of different flow measuring instruments and their adoptability to the industry.
4. Develop the hydraulic circuits to cater the needs of the industry.

**List of Experiments:**

1. **Performance and characteristic curves of Self Priming pump**
2. **Performance and characteristic curves of Centrifugal/ Submergible pump**
3. **Performance and characteristic curves of Reciprocating pump**
4. **Performance and characteristic curves of Gear pump**
5. **Impact of Jets on Vanes**
6. **Performance and characteristic curves of Pelton Wheel**
7. **Performance and characteristic curves of Francis Turbine**
8. **Performance and characteristic curves of Kaplan Turbine**
9. **To determine coefficient of discharge of venturi meter**
10. **To determine coefficient of discharge of orifice meter**
11. **Study of Hydraulic Circuits**
12. **Study of pneumatic Circuits**

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| PC601ME | MACHINE DESIGN | | | | | | Core |
| Prerequisite | Contact Hours per week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| DMM | 3 | -- | -- | -- | 30 | 70 | 3 |

**Course Objectives:**

- Importance of helical coil springs and leaf springs in mechanical systems
- Understand the design of gears such as spur, Helical and bevelgears
- How to apply design concepts in bearing design
- Importance of design procedure in designing IC engine components
- Utilization of curved beams on mechanical components

**Course Outcomes:**

- Analyze helical coil springs and leaf springs for mechanical systems
- Evaluate kinematic transmission systems using gears
- Select bearing system for specific applications
- Design various IC engine components
- Determine load carrying capacity of curved beams

**Note**: Standard Design data book is allowed in University exam.

UNIT-I

Mechanical Springs: function of springs, Types of springs and materials used. Design of helical coil springs based on strength deflection and energy considerations. End preparation of coil springs, Design for fluctuating loads. Principles of limit design, Concentric springs

Leaf Springs: Stresses and Deflection.Nipping of Leaf springs

UNIT-II

Gears: Types of gears and materials used. Standards for gear specifications. design of spur gears, Helical and Bevel Gears basedstrength criterion -Lewis equation, Wear considerations, dynamic tooth load, Types of gear tooth failure and preventive measures.

UNIT-III

Bearings: Materials used for Bearings. Classification of Bearings. Viscosity of Lubricants Theory of Hydrostatic and Hydrodynamic lubrication. Design of sliding contact bearings - for axial and thrust loads

*Rolling Contact Bearings*: Different types of rolling element bearings and their constructional details.Static and Dynamic load carrying capacity, Load-life relationship, Design of deep groove ball bearing and roller bearing only, Design for cyclic loads,

UNIT-IV

I.C. Engine Parts: Design of piston, connecting rod and crank shafts. Design of Flywheels for I.C. Engines and Presses

UNIT-V

Curved beams: Theory of bending of members with initial curvature - rectangular, circular and Trapezoidal sections. Design of crane Hooks, Machine frames and C-clamps.

Design of chain drives: types of chain drives, polygonal effect, power rating of roller chains, design of roller and bush type chain, silent chain.

Suggested Reading:

1. V. B. Bhandari, "Design of Machine Elements", Tata McGraw-Hill Publ, 3rd Edn. 2010.
2. J.E. Shigley & Charles R. Mischke "Mechanical Engineering Design", Tata McGraw-Hill.,6th ed.2010.
3. P. Kannaiah, Machine Design, Sci-Tech Publ., 2009.
4. P.C. Sharma & D.K. Aggarwal, "Machine Design", S.K. Kataria & Sons, 10th edn, 2003
5. V. B. Bhandari, "Design Data Book " 2nd edition, ", Tata McGraw-Hill Publ, 2019

**Note** : Solution of Numerical problems using Design data book should be practiced.

| Course Code | Course Title | Core/Elective |
|---|---|---|

| PC602ME | METROLOGY & INSTRUMENTATION | | | | | | Core |
|---|---|---|---|---|---|---|---|
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| - | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

The objectives of this course is to impart knowledge of

- To familiarize with Limits & fits, I.S.O. system and the instruments used to measure these limits.
- To have knowledge of various precision linear and angular measuring instruments.
- To learn the importance of form and how to measure form errors.
- To understand the working principles of various instruments used for the measurement of strain, forces, pressure, temperature and vibrations.

**Course Outcomes**

After completing this course, the student will be able to:

6. To understand limits, fits and tolerances and their applications. Linear and angular measurements and measuring instruments.
7. To understand the design of limit gauges, evaluate roughness and its measurement.
8. To understand basic measuring system, static and dynamic characteristics of instruments
9. To understand various principles to measure pressure, temperature, displacement, force, torque and vibrations.

**UNIT – I**

Introduction to Limits, Fits,Tolerances as per ISO, types of interchangeability and limit gauges.Taylor's Principle of guage design, Uses of Plug, Ring and Snap gauges. Introduction to Linear and Angular measurements – Slip gauges and End bars – Gauge materials, Different types of Micrometers, Height gauges Tomlinson gauges. Precision polygon, Sine bar, Auto collimator**.**

**UNIT – II**

Comparators: Dial indicators, Mechanism of Dial indicators, Mechanical comparators, Pneumatic comparators, Optical comparators, Electrical comparators, Tool maker's Microscope and its applications. Measurement of Straightness and Flatness Roundness measurement with bench centers and talyround.

**UNIT-III**

Introduction to Surface Roughness Measurements, Profilometer, Taylor Hobson Talysurf. Application of Thread metrology - 2 wire and 3 wire methods, Gear measurement - Gear tooth thickness, Parkinson gear tester, General geometric tests for testing machine tools – Lathe, drill and Mill.

**UNIT –IV**

Introduction to Elements of instrumentation - Static and Dynamic characteristics, Types of errors, Transducers, LVDT, Strain measurement -Wire and foil type resistance strain gauges. Rosette Gauges,Bonding procedure Lead resistance compensation. Proving ring, Strain gauge load cells, measurement of axial load and torsion by strain gauges, Piezo-electric load cell.

**UNIT – V**

Introduction to Seismic Transducers -displacement and acceleration measurement, Pressure measurement -Bourdon pressure gauge, pirani gauge. Temperature measurement by thermo couples and its law.Types of materials used in thermocouples Protection tubes. Extension wire- Series and parallel circuit's compensation.

***Suggested Readings:***

1. I.C. Gupta – "Engineering metrology", Dhanpat Rai Publications, New Delhi.
2. Rega Rajendra, "Principles of Engineering Metrology", Jaico Publishing House, Mumbai.
3. RK Jain, "Engineering Metrology", Khanna Publications, 1996.
4. Doeblin,"Measurement Systems Application and Design", Tata Mc¬Graw Hill,5th ed., 2004.
5. Beckwith, Buck, Lienhard, Mechanical Measurements, Paerson education india.
6. P. Donald Echman, "Industrial Instrumentation", John Wiley and Sons, 1996.
7. Hume, "Engineering Metrology", Kalyani Publications, 1985.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| PC603ME | FINITE ELEMENT ANALYSIS | | | | | | Core |
| Prerequisite | Contact Hours Per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| EM, MOM, HT | 3 | - | - | - | 30 | 70 | 3 |

**Course Objectives:**

1. Equip the students with the Finite Element Analysis fundamentals and formulations
2. Enable the students to formulate the axial, truss, beam and 2d problems
3. Enable the students to formulate the heat conduction and dynamics problems
4. Able to understand use of numerical integration and Gaussian quadrature
5. Enable the students to perform engineering simulations using FE software (ANSYS)

**Course Outcomes:**

1. Summarize basic equations of elasticity and formulate finite element modeling of one dimensional element using Potential energy approach.
2. Formulate finite element modeling of truss and frame elements along with the concepts of transformation from local to global matrices.
3. Interpolate Hermitian shape function of beam element in natural coordinate system.
4. Develop stiffness matrix for a plane stress & plane strain conditions on a CST, Axisymmetric elements by interpolating shape functions in natural coordinate system.
5. Formulate finite element model to steady state heat transfer analysis using one & two dimensional elements.
6. Formulate mass and stiffness matrices of 1D & beam elements to establish Eigen values &Eigen vectors using Lagarangian and Hamilton principles.

**UNIT-I**

Introduction to Finite Element Method for solving field problems, Stress and Equilibrium, Boundary conditions, Strain, Displacement, Stress-Strain relations.

**One dimensional problems:** Finite element modeling coordinates and shapes functions, Potential Energy approach: Assembly of Global stiffness matrix and load vector, Finite element equations, Treatment of boundary conditions, Galerkin's approach, Quadratic shape functions.

**UNIT-II**

Analysis of trusses and frames: Element stiffness matrix for a truss member, Analysis of plane truss with two at each node. Analysis of frames with two translations and a rotational degree of freedom at each node, Analysis of Beams: Element stiffness matrix for two nodes (two degrees of freedom per node).

**UNIT-III**

Finite element modeling of two dimensional stress analysis with constant strain triangles and treatment of boundary conditions. Finite element modeling of axi-symmetric solids subjected to axi-symmetric loading with triangular elements.

**UNIT-IV**

Two dimensional four noded iso-parametric elements and numerical integration. Steady state heat transfer analysis: One dimensional analysis of a fin and two dimensional analysis of thin plate, Analysis of circular shaft subjected to torsion.

**UNIT-V**

Dynamic Analysis: Formulation of finite element model, element matrices, Evaluation of Eigen values and Eigen vectors for a stepped bar and a beam, Time dependent field problems: Application to one dimensional heat flow in a rod **Convergence requirements.** Introduction to Finite Element Analysis Software.

**Suggested Reading:**

1. G.Ramamurthy, Applied Finite Element Analysis, I.K. International Publishing House Pvt.Ltd., New Delhi, 2009.
2. Tirupathi R, Chandraputla and Ashok D Belagundu, Introduction to Finite Elements in Engineering, Prcatice Hall of India,1997.
3. Rao S S, The Finite Element Method in Engineering, Pergamon Press, 1989.

4. Segerlind L J, Applied Finite Element Analysis, Wiley Eastern, 1984.
5. Reddy JN, An Introduction to Finite Element Method, McGraw-Hill, 1984.

| Course Code | Course Title | Core/Elective |
|---|---|---|

| **PE611ME** | **CAD/CAM** | | | | | | **Core** |
|---|---|---|---|---|---|---|---|
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

***Course Objectives:***

- ❖ To introduce the concepts of CAD and advanced modeling techniques
- ❖ To help the students in understanding the functioning of computer numerical control machine tools and also in writing programs for operating this machines.
- ❖ To help the student in understanding advanced manufacturing concepts like Group technology, flexible manufacturing systems, Computer aided Process Planning, Computer aided quality control, Artificial Intelligence etc.

***Course Outcomes:***

The Students will be able to

- ➢ Understand the fundamental applications of computer in design, manufacturing and geometric transformation techniques in CAD
- ➢ Develop mathematical Model for curves, surfaces, solid models and understand the fundamental concepts of Finite Element Analysis
- ➢ Write CNC Part program for manufacturing components
- ➢ Understand the concepts of Machining Centres, adaptive control and as well as fundamentals knowledge of robotics
- ➢ Understand the working of various components of an modern manufacturing systems

**Unit-I**

CAD Fundamentals, Product life cycle in conventional and computer based manufacturing system, Hardware integration and networking. CAD Software: Definitions of system software and application software. Graphic Standards and Exchange Formats. CAD database and structure. Automatic 2-D facilities such as Fillets, Chamfers, Hatching, Dimensioning, Editing, Windowing & Zooming. 2-D & 3-D Geometric Transformations.

**Unit-II**

Geometric modeling: 3-D wire frame modeling: wire frame entities and their definitions, Interpolation and approximation of curves, synthetic curves and curve fitting. Definitions of cubic, Bezier, and B-spline curves.

Surface modeling: Definitions of basic surfaces, surface of revolution, blends, intersection, and Cubic, Bezier, B-spline surfaces.

Solid Modeling: Solid entities, Boolean operations, B-rep and C-rep approaches. Feature based modeling: Concepts and applications, Assembly modeling.

Finite element modeling: Introduction, modeling, Meshing, Characteristics of different elements, different solvers and post processing.

**Unit-III**

Numerical Control of machine Tools: Features and elements of NC. Positional, paraxial and contouring types. Definitions of axes, punched type, formats of tape preparation. Definitions of interpolation, post-processor, preparatory and miscellaneous functions, canned cycles, tool length and cutter radius compensation. Manual and computer aided part programming (APT) for simple components. Programming with MACROS.

**Unit-IV**

Computer Control in NC and Robots: Machining centers, CMC, DNC and adaptive control systems. Their types, typical configurations and relative features. Industrial Robots: Classification based on manipulator configurations, relative characteristics, Online and offline programming methods, controls and drives, applications.

**Unit-V**

Group Technology: Organization, G.T. layout, part classification and coding, CAPP: Variant and Generative approaches and their relative features. Computer Aided Quality Control: Computer in quality control, Contact and non contact inspection, optical and non optical computer aided testing. Basic concepts of FMS, Experts systems. Artificial intelligence, CAD/CAM integration, Introduction to 3D Printing: Process chain, Classification , description about SLA, SLS and FDM processes.

***Suggested Reading:***

1. Ibrahim Zeid, "CAD/CAM, theory and practice", McGraw Hill Inc, N.Y.1991.
2. Grover, MP and Zimmers E.W., "CAD/CAM", Prenctice Hall of India 1989.
3. Rao P.N., Tiwari N.K., Kundra T.K., "Computer Aided Manufacturing", Tata McGraw Hill, New Delhi, 1993.
4. Radhakrishnan. P, Subramanyan. S, Raju. V, "CAD/CAM/CIM", New Age international (P) Ltd., 2nd Edn., 2004.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **PE612ME** | **AUTOMOBILE ENGINEERING** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

The objectives of this course is to impart knowledge of

- Understand the Working of Fuel, Ignition, and cooling Systems.
- Understand the Working of Lubrication and Electrical Systems
- Understand the Working of Suspension, Steering and Braking Systems.
- Understand the Working of Power Transmission.
- Understand the Necessity of Pollution Control and Maintenance.

**Course Outcomes**

After completing this course, the student will be able to:

1. Generalize the different types of automobiles, list the engine components, describe the functioning of IC engines and classify the fuel supply system for S.I and C.I engines
2. Differentiate the types of lubrication system; identify different lubrication and cooling systems used in vehicles. Classify ignition system and describe the functioning of battery and automobile air conditioning system.
3. List the salient features of different steering mechanisms, describe the importance of wheel alignment and wheel balancing, describe the importance of different suspension systems and shock absorbers used in an automobile
4. Identify different components in power transmission system design a system, components, or process to meet desired needs with in realistic constrains such as economic, environmental, health and safety, describe about braking system
5. Adapt techniques, skills and modern engineering tools necessary to control the pollution, record the automobile parts maintenance, design and build components and system to reduce pollution of automobile vehicles

**UNIT – I**

Types of automobiles: Normal, Hybrid and Hydrogen fuel vehicles. Engine location and its components, chassis layout, crank shaft proportion, firing order, piston and piston rings, cylinder liners, valves and operation mechanism, inlet and exhaust manifolds, carburetion and fuel injection system, mechanical fuel injection system & electronic fuel injection system.

**UNIT – II**

Lubricating systems: Wet sump, dry sump and petrol systems, and Cooling systems: Water pumps, radiators, thermostat control anti freezing compounds. Types of Ignition systems, modern ignition systems, types of batteries and charging systems, starting motors, lighting and electrical accessories, automobile air-conditioning.

**UNIT-III**

Steering systems: Linkage arrangements and its components modified Ackerman linkage, wheel alignment, caster and camber. Rack and pinion assembly – recent trends Wheel and tyres: Tyre construction, specification. Tyre wear and causes, wheel balancing, types of suspension system, independent suspension coil and leaf springs, torsion bar, shock absorbers.

**UNIT –IV**

Power Train: Clutches, gear and gearbox manual, semi-automatic and automatic gearboxes. Torque converter, propeller shaft, universal coupling differential, four-wheel drive system.Brake systems: Description and operation of hydraulic brake, leading and trailing shoe layout, disc brakes, master cylinder, hand brake linkage, recent trends.

**UNIT – V**

Maintenance: Pollution control, trouble shooting and servicing procedure overhauling, engine tune up, tools and equipment for repair and overhaul, testing equipment, pollution control technologies used for petrol and diesel engines, types and study of catalytic converters, Euro norms 2 & 3 and Bharat Norms – recent trends.

***Suggested Readings:***

1. Crouse & Anglin, 'Automotive Mechanics' Tata McGraw Hill, Publishing Co., Ltd., New Delhi, Tenth edition - 2004..
2. Kirpal Singh, "Automobile Engineering", Vol I & II Standard Publishers, Delhi.
3. Joseph Heitner, 'Automotive Mechanics', Affiliated East West Pvt., Ltd.,
4. C.P. Nakra, "Basic Automobile Engineering", Dhanpat Rai Publishing Co.(P) Ltd., New Delhi, 2003

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **PE613ME** | **MODERN MACHINING AND FORMING METHODS** | | | | | | **Elective** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| - | 3 | - | - | - | 30 | 70 | 3 |

**Course Objectives:**

To know the importance of unconventional machining and forming processes.

To learn the working principle of various modern machining and forming processes.

To understand the advantages, limitations and applications of various modern machining and forming processes.

To know the relationship between process parameters and performance of various processes.

To know the suitability of processes for various engineering materials and applications.

**Course Outcomes:**

Students will be able to:

- Understand the evolution, classification and need of nontraditional machining technology in modern manufacturing
- Understand the principle, description, the parametric effect on process performance and material removal mechanics of USM, AJM, WJM and AWJM processes.
- Understand the principle, description, the parametric effect on process performance and material removal mechanics of EDM, EDG, ECM and CHM processes.
- Understand the principle, description, the parametric effect on process performance and material removal mechanics of LBM, EBM, PAM and Ion machining processes.
- Compare conventional & high energy rate forming methods
- Understand the principle, working and applications of various types of high energy rate forming methods.

**UNIT-I**

Introduction: Need for nontraditional machining processes, selection, classification & comparative study of different processes; **Ultrasonic Machining (USM):** Introduction, process description, abrasive slurry, Abrasive materials and their characteristics. Functions of liquid medium in slurry, Types of Transducers, effect of process parameters, applications and limitations; **Abrasive Jet Machining (AJM):** Principle of operation, process details, process variables and their effect on MRR and accuracy. Equation for MRR Advantages, disadvantages and applications; **Water Jet Machining (WJM):** Schematic diagram, equipment used, advantages and applications; **Abrasive Water Jet Machining (AWJM):** Schematic diagram, equipment used, advantages and applications.

**UNIT-II**

**Electro Discharge Machining (EDM):** Process description with schematic diagram, process parameters, functions and characteristics of dielectric medium, dielectric fluids, over cut and side taper' Flushing, Mechanism of metal removal, crater volume, types of power supply circuits, mathematical analysis of metal removal rate (MRR), characteristics of spark eroded surfaces, advantages, disadvantages and applications.

**Wire EDM:** Process description and applications; **Electro Discharge Grinding:** Process description and applications; **Electro-Chemical Machining (ECM):** Schematic of the process parameters, function and characteristics of electrolyte, chemistry of the process, Equation for specific MRR and electrode feed rate, advantages, limitations and applications; **Electro Chemical Grinding:** Process description and applications.

**UNIT-III**

**LASER Beam Machining (LBM):** Principle of LASER Beam production, materials used, thermal analysis of the process, process parameters, equations for power density and machining rate, advantages, limitations and applications; **Plasma Arc Machining (PAM):** Introduction equipment used, process description and parameters, types of plasma arc - Transferred arc and non transferred arc; advantages, disadvantages and applications; **Electron Beam Machining (EBM):** Schematic of the process, process parameters, principle of production of Electron beam, equipment used, Advantages, disadvantages and applications; **Ion Etching:** Process description and applications.

**UNIT-IV**

**High Energy Rate Forming (HERF):** Introduction, comparison of conventional & high energy rate forming methods. Types of high energy rate forming methods; **Explosive Forming:** principle, Explosive materials, types of explosive forming - standoff operation and contact operation, advantages, disadvantages and applications; **Electro-Hydraulic forming (EHF):** Schematic of the process description and its applications; **Electro-Magnetic Forming (EMF):** Schematic of the process description and its applications; **Rubber Pad Forming:** Principle, process details and its types; Guerin, wheel on, Marfoming and Hydro forming processes and applications.

**UNIT-V**

**Stretch Forming:** Introduction, types of stretch forming - stretch draw forming, rotary stretch forming or stretch wrapping, compression forming and radial draw forming, Stretch forming equipment and accessories, accuracy and surface finish, process variables, limitations and applications; **Tube spinning:** Introduction, methods of tube spinning - backward spinning, Forward spinning; machines and tools used, machine variables - speeds and feeds; effect of tube spinning on work metal properties and applications; **Hydrostatic Forming:** Process principle, description and applications; **Water Hammer Forming (WHF):** Schematic diagram of the process, principle of operation, process variables, work materials, process limitations and applications.

**Suggested Reading:**

1. P.K.Mishra "Non Traditional Machining processes" Narosa Publications, New Delhi, 2001.
2. V.K Jain "Advanced Machining Processes" Allied Publishers, Hyderabad.
3. Davies and Austin, Developments in High Speed Metal Forming, The Machinery Publishing Co. Ltd., 1985.
4. HMT Production Technology, Tata McGraw Hill Publications, 1995.

**THERMAL TURBO MACHINES**

# PE621ME

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*

*CIE: 30 marks* *SEE: 70 marks*

*Credits : 3*

**Objectives:**

| | |
|---|---|
| 1. | Understand isentropic flow for variable areas and relations |
| 2. | Understand and apply fanno flow, Rayleigh flow and shock flow. |
| 3. | Understand centrifugal and axial flow compressor with velocity triangles |
| 4. | Understand and analyze impulse and reaction steam turbines with velocity triangles |
| 5. | Understand and analyze gas turbines and rocket propulsion. |

**Outcomes:**

| | |
|---|---|
| 1. | Analyze situations of Thermal gradients in Turbo machines and apply the situation of fluid flow analysis with energy conversion principles for work transfer. |
| 2. | Develop knowledge about working principles of work absorption and work producing situations |
| 3. | Understand applications of Thermodynamics with fluid flow behavior and compressibility effects |
| 4. | Attain knowledge of Power production using External combustion engines, with methods of improving efficiencies |
| 5. | Demonstrate the learnt fundamentals in applying for real time situations such as undertaking final dissertation projects on Thermal turbo Machines and power plants with knowledge of International standards and testing. |
| 6. | Establish and compute one dimensional thermodynamic analysis of Compressors, Turbines (both for air & Vapour working fluids) and analyzing using velocity triangles for single and multi stages. |

**Unit-I**

**Introduction to compressible flows:** Speed of propagation of pressure waves, Mach number, Acoustic velocity and Mach cone, limits of compressibility, pressure field due to a moving source of disturbance, one dimensional compressible flow.

Isentropic flow with variable area, Mach number variation, Area ratio as function of Mach number, flow through nozzles and diffusers.

Flow in constant area ducts with friction-Fanno flow, variation of flow properties, variation of Mach number with duct length, isothermal flow with friction.

**Unit**-II:

**Flow in constant area duct with Heat Transfer**, -The Rayleigh liner, Rayleigh flow relations, variation of flow properties, Maximum heat transfer.

Flow with Shock Waves-Development of Normal Shock waves, governing equations, Prandtl -Meyer relation, Rankine-Hugoniot equations, Stagnation pressure ratio across shock.

**Unit-III**

**Blade nomenclature of an aerofoil, Rotodynamic compressors:** Introduction and general

classification, Comparison of Reciprocating and Rotary compressors, Positive displacement Rotary compressors, Flow through rotary compressors. Static and total head quantities, Thermodynamic cycles and work done,calculation of various efficiencies. Velocity diagrams and prewhirl. Euler equation for energy transfer between fluid and rotor, Analysis of Centrifugal compressors and analysis of axial flow compressors, Chocking, Surging and Stalling.

**Unit-IV**

**Steam Turbines:** Classification, flow over blades, pressure velocity variations, Compounding of steam turbines- pressure compounding, velocity compounding and pressure-velocity compounding, Impulse turbine with several blade rings, Nozzle efficiency, Blade efficiency and Gross stageefficiency of Impulse turbine, Velocity diagrams for Impulse turbine-De Laval Turbine, blade efficiency of Impulse turbine, Optimum blade speed ratio, Maximum work done and blade efficiency of Impulse turbine, Degree of reaction of Reaction turbine, Parson Reaction turbine, Velocity diagram for Parson Reaction turbine, blade efficiency of Parson Reaction turbine, Maximum work done and blade efficiency of Parson Reaction turbine, Height of blades of Reaction turbine, Balancing of End thrust.

**Unit-V**

**Gas Turbines:** Applications and Classification of Gas Turbines- constant pressure and constant volume gas turbines, Joule cycle-configuration diagram and temp-entropy diagram, Thermal efficiency of Joules cycle, Maximum pressure ratio in terms of temperature ratio, optimum pressure ratio for maximum work output with and without considering machine efficiencies, Improvement of gas turbine plant performance- Inter-cooling, Reheating and Regeneration. Simple Problems on Joule cycle.

**Air Craft Propulsion:** Air craft engine types, air craft propulsion theory, Turbo jet engines, Ramjet engines, Pulse jet engines, Rocket Propulsion: Types of Propellants, Types of Rocket engines, Rocket propulsion theory-Rocket applications.

**Suggested Reading:**


1. Yahya S M, *Fundamentals of Compressible Flow*, New Age International Publishers, Third Edition, 2007.
2. Mathur ML, & Mehta F S, *Thermal Engineering*, Jain Brothers, New Delhi, 2003.
3. Dennis G Shepherd, *Aerospace Propulsion*, Elsevier Publishing Company, New York, 1995.
4. CohenH Rogers G F C, SaravanaMutto H I H, *Gas Turbine Theory*, Longman 5th Edition, New York, 2004.
5. Ganeshan V, *Gas Turbines*, Tata Me Graw Hills, New Delhi, 2003
6. Yadav, R *Steam and Gas Turbines*, Central Publishing House Ltd, Alllahabad, 2003.

**PRODUCTION AND OPERATIONS MANAGEMENT**

# PE622ME

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*

*CIE: 30 marks* *SEE: 70 marks*

*Credits : 3*

**Objectives:**

| |
|---|
| 1. To understand the concept of Production & Operations Management. |
| 2. To understand role of work study and work measurement in Industry. |
| 3. To learn use of forecasting and various methods of it. |
| 4. To understand importance Aggregate planning, Materials Requirement Planning for Industry. |
| 5. To understand Project Management approaches in completion of Project. |

**Outcomes:**

| |
|---|
| 1. Explain various types of Production Systems, develop suitable layout for a given plant |
| 2. Develop various methods for work study and apply suitable Recording techniques. Develop standard procedures and time for the operations. |
| 3. Explain necessity of Forecasting and various methods of it. Develop suitable quantitative forecasting technique for the given past data. Compare accuracy of models in connection with forecast errors. |
| 4. Explain Aggregate planning & Mater scheduling, Materials Requirement Planning Processes. Develop quantitative models for Material requirement and resources based on time span. |
| 5. Elaborate the usages of PERT/CPM techniques for a give project and develop suitable quantitative model for the project in successful competition by identifying the time constraints for start and endof process activities. |

| **Unit-I** |
|---|
| **Production & Operations Managemen**t: Introduction, Types of production Systems. Job shop, Batch, Flow shop.<br><br>**Plant location and layout**: Factors affecting plant location, Break even analysis, plant layout objectives, Types of layouts, merits and demerits. |
| **Unit**-II: |
| **Work Study:** Introduction to method study, Steps in method study, Recording techniques- Flow process chart, String diagram, Therbligs, Principles of motion economy.<br><br>**Work measurement**: Stop watch time study, Standard time calculation. Work sampling-procedure, applications, advantages and disadvantages, Wages and incentives, types of incentive plans. |

| **Unit-III** |
|---|
| **Forecasting:** Introduction, Forecasting objectives and uses, demand patterns, Qualitative models Market survey, Delphi Tech, Quantitative models, Moving average, Weighted moving average, Simple exponential smoothing, trend adjusted exponential smoothing, Least square method, Simple regression, multiple regression.<br><br>**Forecast errors:** Mean absolute Deviation (MAD), Mean Square Error (MSE), Mean Forecast Error(MFE), Mean absolute percentage error (MAPE). |
| **Unit-IV** |
| **Aggregate Planning and Master Scheduling:** Introduction, objectives of aggregate planning, Cost in aggregate planning, Strategies in aggregate planning, Master production scheduling.<br><br>**Materials Requirement Planning MRP 1**: Importance of MRP, MRP system inputs and outputs, MRP calculations<br><br>**Manufacturing Resource Planning MRP 2 & Enterprise Resource Planning (ERP):** Features of ERP packages like SAP, BANN, People soft etc., |
| **Unit-V** |
| **Project Management:** Project management: Network fundamentals, difference between PERT/CPM Scheduling the activities. Fulkerson's rule. Earliest and latest times. Determination of ES and EF in the forward path. LS and LF in backward path. Determination of critical path. Free float, independent float, Total float, Program evaluation and review technique, crashing of network. |

**Suggested Reading:**


1. Joseph Monk, *Operations Management*, TMH Publishers, New Delhi, 2004.
2. Buffa Elwood S, *Modern Production / Operations Management*, John Wiley Publishers, Singapore, 2002.
3. Everett E Adam, Jr and Ronald J. Ebert, *Production and Operations Management – Concepts, Models and Behaviour*, 5th Ed. 1998, (EEE), Prentice Hall of India(P) Ltd., New Delhi.
4. Panneer Selvam R, "*Operations Research*", Second Edition, PHI Learning Pvt. Ltd. New Delhi, 2006.
5. S.D. Sharma, "*Operations Research*", Kedarnnath, Ramnath & Co., Meerut, 2009.

**DESIGN FOR MANUFACTURE**

# PE623ME

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*

*CIE: 30 marks* *SEE: 70 marks*

*Credits : 3*

**Objectives:**

| |
|---|
| 1. To understand and applications of the basics and working principles of manufacturing. |
| 2. To grasp the knowledge of basic mechanical components and design the simple components. |
| 3. To learn the knowledge of design of different types of machine components to meet varied functional and operational requirements. |

**Outcomes:**

| |
|---|
| 1. To recognize the strength and mechanical factors of metals and non metals. |
| 2. To understand the design of metallic components and its processes. |
| 3. To understand the advanced design of metallic and non metallic components. |
| 4. To recognize the design of non metallic assembled mechanical components. |
| 5. To understand the varies assemblies and part design with automation. |

| |
|---|
| **Unit-I** |
| Introduction: General design principles for manufacturability, strength and mechanical factors, mechanisms selection, evaluation method, geometrical tolerances, tolerances control and utilization. Economic Use of Raw Materials: Ferrous steel, hot rolled steel, cold finished steel, stainless steel,non ferrous materials aluminium, copper, brass, non metallic materials, plastics, rubber and composites. |
| **Unit**-II: |
| Metallic components design: metal extrusion. Metal stamping , , spring and wire forms, spun metal parts, cold headed parts, tube and section bends, rolled formed parts, power metal parts, forging electro forming parts, special forming methods. |
| **Unit-III** |
| Metallic components design: Turned parts, machined round holes, drilled parts and milled parts. Planned shaped and slotted parts, screw threaded contoured and internal ground parts, center less ground, Electrical discharged, electro chemical and advanced machine parts. |
| **Unit-IV** |
| Non metallic components design: Sand cast , die cast, investment cast and other cast products, injection moulded and rotational moulded parts, blow moulded, welded plastic articles, ceramics. |
| **Unit-V** |
| Assembled parts design: bolted connections, welded parts, arc, resistance , brazed and soldered parts, gear box assembly, bearing assembly, flanged connections, press fitted connections, surface finishing, plated parts, Heat treated parts, NC machining , Group technology, low cost automation, |

| |
|---|
| computer aided manufacture, product design requirements. |

**Suggested Reading:**

| | |
|---|---|
| *1* | *Hand book of product design for manufacturing by James G.Bralla, MC Graw Hill Co., 1986.* |
| *2* | *Knowledge based design for manufacture by K.G. Swift, Kogan page limited, 1987.* |
| *3* | *Design for manufacturability by David M. Anderson, Productivity Press, 2014.* |
| *4* | *1. Design for Manufacturability Handbook, McGraw-Hill Handbooks,1998.* |
| *5* | *2. Product Design for Manufacture and Assembly by Geoffrey Boothroyd, CNC Press, 2010* |

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **OE611ME** | **INDUSTRIAL ROBOTICS** | | | | | | **Elective** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| - | **3** | **0** | **0** | **0** | **30** | **70** | **3** |

**Course Objectives**

- To familiarize the student with the anatomy of robot and their applications.
- To provide knowledge about various kinds of end effectorsusage.
- To equip the students with information about various sensors used in industrial robots.
- To make the student understand the importance of spatial transformation of robots using forward and inverse kinematics.
- To specify and provide the knowledge of techniques involved in robot vision in industry.
- To equip students with latest robot languages implemented in industrial manipulators.

**Course Outcomes**

- Able to demonstrate knowledge of the relationship between mechanical structures of industrial robots and their operational workspace characteristics and have an understanding of the functionality and limitations of robot actuators and sensors.
- Able to demonstrate an ability to apply spatial transformation to obtain forward/Inverse kinematics equation of robot manipulators using analytical/numerical/simulation tools.
- Able to apply knowledge and choose the best & economically suitable sensors/end effectors required for specific applications.
- Able to understand the importance of robot vision and apply the learnt techniques to get the required information from input images.
- Able to design and develop a industrial robot for a given purpose economically.
- Appreciate the current state and potential for robotics in new application areas.

***UNIT – I***

**Introduction to Robotics:** Basic structure of Robots. Degree of freedom of Robots, Work envelope, Classification of Robots based on Drive Technology, Work-Envelope and motion control methods. Application of Robots in Industry, Repeatability, Precision and Accuracy as applied to Robots, Specifications of robots used for various applications. End effectors, Grippers: Mechanical grippers, pneumatic and hydraulic grippers, magnetic grippers, vacuum grippers, RCC grippers, Two fingered and three fingered grippers, internal grippers and external grippers, Selection and design considerations.

***UNIT – II***

**Requirements of a Sensor:** Principles and Applications of the following types of sensors- Position of sensors (Piezo electric sensor, LVDT, Resolvers, Optical encoders, Pneumatic position sensors), Range sensors (Triangulation principle, Structured, Lighting approach, Time of flight range finders, Laser range meters), Proximity sensors (Inductive, Hall effect, Capacitive, Ultrasonic and Optical proximity sensors), Touch sensors (Binary sensors, Analog sensors), Wrist Sensors, Compliance Sensors, Slip Sensors.

***UNIT – III***

**Kinematic Analysis of Robots:** Rotation matrix. Homogeneous transformation matrix, Denavit&Hartenberg representation, Euler and RPY angles representation. Representation of absolute position and orientation in terms of joint parameters, Direct Kinematics of manipulators, Inverse kinematics of Robot arm for position and orientation. Redundancy in Robots, Static force analysis

UNIT-IV

**Introduction to Techniques used in Robot Vision:** Image acquisition, illumination techniques, imaging geometry, basic relationship pixels, preprocessing, segmentation & description of 3-dimensional structures, their recognition and interpretation. Types of Camera, frame grabbing, sensing and digitizing image data, Signal conversion, Image Storage, Lighting techniques, Image processing and analysis, Data reduction, Segmentation, Feature extraction, Object recognition, and various algorithms, Applications, Inspection, identification, visual serving and navigation.

***UNIT – V***

**Robot Programming Languages:** Characteristics of robot level languages, task level languages. Teach pendant programming, Lead through programming, Robot programming languages, VAL programming, Motion commands, Sensor commands. End effecter commands, Simple programs. RGV, AGV, Implementation of robots in industries, various steps, Safety considerations for robot operations. Economic analysis of robots, Pay back method, EUAC method and Rate of return method

**Suggested Readings:**

1. Groover M P, "**Industrial Robotics"**, McGraw Hill Publications,1999.
2. Fu. K.S., GonZalez R.C., Lee C.S.G. "**Robotics, Control-sensing vision and Intelligence**", McGraw Hill, Int. Ed.,1987.
3. Spong and Vidyasagar, "**Robot Dynamics & Control**", John Wiley and Sons,Ed.,1990.
4. Mittal and Nagrath, "**Industrial Robotics**", Tata McGraw Hill Publications,2004.
5. Saha&Subirkumarsaha, '**Robotics'**, TMH,India.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **PC691ME** | **METROLOGY & MACHINE TOOLS LAB** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **-** | **-** | **-** | **2** | **25** | **50** | **1** |

**Course Objectives**

- To have knowledge of various precision measuring instruments.
- To familiarise machining and metal cutting operations.

**Course Outcomes**

After completing this course, the student will be able to:

1. Select and apply the knowledge of measuring tools for external, internal and angular measurements for promoting the qualitative production management.
2. Adapt the principles of optical measurements in measurement of screw and gear profiles.
3. Choose and practice the appropriate methods of force measuring devices principles for required situation.
4. Demonstrate the need of machine alignment test for qualitative production.
5. Practice calibration principles for maintaining the required precision of instruments / tools.
6. Select and practice the methods of temperature measurement.
7. Select cutting tool materials and tool geometries along with appropriate cutting conditions for different work materials and grind the cutting tools to the required geometry.
8. Recognize and summarize the features and applications of various machine tools like Lathe, Milling, Drilling, Grinding, Shaping, Slotting etc.

**List of Experiments:**

**A) Metrology & Instrumentation:**

1. Measurement with inside, outside and depth micrometers, Vernier calipers and Height gauges.
2. Measurement of roundness errors with Bench Centres, V-block and dial guage.
3. Measurement of Linear and Angular dimensions with Tool Maker's Microscope: Flat specimens.Plain cylindrical specimens with centers and threaded components.
4. Measurement of angles with Sinebar, Bevel protractor and Precision level.
5. Measurement with Dial Indicator / Electrical Comparator / Mechanical Comparator / Dial Bore Gauge / Snap Gauge/Plug gauges.
6. Calibration and Force measurement with Strain gauge type load cell/Proving Ring/spring type sensor

**B) Machining Operations:**

7. Thread cutting exercise on lathe machine as single start and multi start threads.
8. Typical exercises on lathe machine(Turning,Step turning,Facin,Parting off &Taper turning).
9. Typical exercises on shaper, cylindrical grinding machine.
10. Exercise of simple gear manufacturing on milling machine.
11. Production of threads with taps and threading dies and milling cutters.

**C) Metal Cutting:**

12. Estimation of shear angle by measuring thickness and length of chips.
13. Measurement of Cutting forces with Lathe tool dynamometer and determination of friction angle and stresses on shear plane and rake plane.
14. Study of geometrical tests on lathe machine.

**Note:** At least ten experiments should be conducted.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| PC692ME | Computer Aided Engineering LAB | | | | | | Core |
| **Prerequisite** | **Contact Hours per Week** | | | | **CIE** | **SEE** | **Credits** |
| | **L** | **T** | **D** | **P** | | | |
| - | - | - | - | 2 | 25 | 50 | 1 |

**Course Objectives:**

- To introduce fundamentals of the analysis software, its features and applications.
- To learn the basic element types in Finite Element analysis.
- To know the concept of discretization of continuum. Loading conditions and analyze the structure using pre-processor and postprocessor conditions.

**Course Outcomes:**

- Classify the types of Trusses (Plane Truss & Spatial Truss) and Beams (2D & 3D) with various cross sections to determine Stress, Strains and deflections under static, thermal and combined loading
- Generalized Plane stress, plane strain conditions & axi-symmetric loading on inplane members to predicting the failure behavior and finding the SCF
- Analyse connecting rod with tetrahedron and brick elements, performing static analysis on flat & curved shells to determine stresses, strains with different boundary conditions.
- Predict the natural frequencies and modes shapes using Modal, Harmonic analysis. Also finding the critical load using Buckling analysis
- Simulate steady state heat transfer analysis of chimney, Transient heat transfer of castings, Non linear, Buckling analysis of shells CFD analysis
- Evaluate the stiffness matrix, B matrix and loading matrices of beam in plane/solid elements using MATLAB / Python software

1. Analysis of Plane Truss & Spatial Truss with various cross sections and materials to determine member forces, member strains & stresses, joint deflections under static, thermal and combined loading.
2. 2D & 3D beam analysis with different sections, different materials for different loads (forces and moments with different end supports.
3. 1D, 2D and 3D meshing with different element sizes for different CAD geometry (Proposed Experiment)
4. Static analysis of plates with a hole to determine the deformations, the Stresses to study the failure behavior and SCF.
5. Plane stress, plane strain and axi-symmetric loading on the in plane members with in plane landing to study the stresses and strains.
6. Static analysis of connecting rod with tetrahedron and brick elements
7. Static Analysis of flat and curved shell due to internal pressure and moments to estimate the strains, stresses and reactions forces and moments with different boundary conditions .
8. Buckling analysis of plates, shells and beams to estimate BF and modes.
9. Modal analysis of beams, plates and shells for natural frequencies and mode shapes.

10. Harmonic analysis of a Shaft subjected to periodic force and transient analysis of plate subjected to stepped and ramped loading with varying time .
11. Steady state heat transfer Analysis Cross section of chimney and transient heat transfer analysis of solidification of castings.
12. Non linear analysis of cantilever beam with non-linear materials at tip moment and post Buckling analysis of shells for critical loads
13. Coupled field analysis.
14. Flow analysis of pipe with different fluids/gasses/air for velocity and pressure gradients.
15. Implicit and Explicit Analysis of car with 300m/s (Proposed Experiment)
16. CFD analysis of aerofoil design.
17. CFD analysis of ducts/impeller/fan.
18. CFD analysis of racing car (Proposed Experiment)
19. Use of MATLAB / Python for finding B matrix, stiffness matrix and loading matrices of beam/in plane/solid elements and interfacing with CAE software's .

**Note : Any 12 experiments to be conducted**

**SCHEME OF INSTRUCTION & EXAMINATION**
**B.E. (Mechanical Engineering) VII – SEMESTER**
**(wef: 2021-2022)**

| S. No. | Course Code | Course Title | Scheme of Instructions | | | | Scheme of Examination | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P/D | Contact Hours/W | CIE | SEE | Duration in Hours | |
| **Theory Course:** | | | | | | | | | | |
| 1 | PC701ME | Operations Research | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 2 | PC702ME | Refrigeration & Air Conditioning | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 3 | PE-III | Professional Elective-III | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 4 | PE-IV | Professional Elective-IV | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 5 | OE-II | Open Elective-II | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| **Practical / Laboratory Course:** | | | | | | | | | | |
| 6 | PW702ME | Project -I | - | - | 6 | 6 | 50 | | | 3 |
| **Total** | | | | | | | | | | **18** |

| *Professional Elective-III* | | |
|---|---|---|
| *S. No.* | *Course Code* | *Course Title* |
| 1 | PE711ME | Industrial Engineering |
| 2 | PE712ME | ControlSystems Theory |
| 3 | PE713ME | Electric and Hybrid vehicles Technology |

| *Professional Elective-IV* | | |
|---|---|---|
| *S. No.* | *Course Code* | *Course Title* |
| 1 | PE721ME | Additive Manufacturing Technology |
| 2 | PE722ME | Robotics Engineering |

| **Open Elective – II** | | |
|---|---|---|
| 1 | **OE701 CE** | Green Building Technologies (Not for Civil Engg students) |
| 2 | **OE701 CS** | Data science and Data Analytics (Not for CS students) |
| 3 | **OE701 EE** | Non Conventional Energy Sources (Not for EEE & EIE Students) |
| 4 | **OE701 EC** | Fundamentals of IoT (Not for ECE Students) |
| 5 | **OE701 IT** | Cyber security (Not for IT students) |
| 6 | **OE701 ME** | Start-up Entrepreneurship (Not for Mech/Prod Engg students) |
| 7 | **OE701AE** | Automotive Maintenance (Not for Automobile Engineering) |

**MC**: Mandatory Course
**CIE:** Continuous Internal Evaluation
**SEE:**SemesterEndExamination(Univ.Exam)
**BS**: Basic Science
**L**: Lecture
**P**: Practical
**ES:** Engineering Science
**T**: Tutorial
**D**: Drawing

**Note:**

1. Eachcontacthourisaclockhour

2. Thedurationofthepracticalclassistwohours,howeveritcanbeextendedwherevernecessary, toenablethestudenttocompletetheexperiment.

**Code:PC701ME**

**OPERATIONS RESEARCH**
**(Professional Core Course)**
*Credits:3*

*Instruction: 3 periodsperweek* *Duration of SEE: 3hours*
*CIE:30marks* *SEE: 70marks*

**Course Objectives:**

1. To use variables for formulating complex mathematical models in managementscience, industrial engineering and transportation models.
2. Tousethebasicmethodologyforthesolutionoflinearprogrammingproblems.
3. To understand the mathematical tools that are needed to solve optimizationproblems like Transportation models and Assignment models.
4. Tounderstandthereplacementmodelswithchangeinmoneyvalueconsidering withtimeandwithouttime.
5. To Model measuresasystemasaqueuingmodelandcomputeimportantperformance .

**Course Outcomes:**

After completing this course, the student will be able to:

1. Topreparethestudentstohavetheknowledgeof LinearProgrammingProbleminoperationsResearchattheendstudentswouldbeabletounderstandtheconcept anddevelopthemodelsfordifferentapplications.
2. Tomakestudentsunderstandtheconcept Replacementmodelsattheendstudentswouldabletoexplain variousfeaturesandapplicationsofreplacementmodelsin real timescenario.
3. Topreparethestudentstounderstandtheory of Gameinoperationsresearchatthe endstudentswouldabletoexplainapplicationofGametheoryindecisionmakingfor a conflict.
4. Topreparethestudentstohavetheknowledgeof Sequencingmodelattheend studentwouldabletodevelopoptimummodelforjobscheduling.
5. To prepare students to understand Queuing theory concepts and various optimizationtechniquesattheendstudentswouldabletodevelopmodelsforwaiting line cases.

**Unit-I**

***Introduction:*** Definition and Scope of Operations Research.

***LinearProgramming:*** Introduction,Formulationoflinearprogrammingproblems,graphical methodofsolvingLPproblem,simplexmethod,maximizationandminimization,Degeneracy inLPP,Unboundedand,Infeasiblesolutions.

**Unit-II:**

***Duality:*** Definition, Relationship between primal and dual solutions,Economic Interpretation,Postoptimalofsensitivityanalysis,DualSimplexMethod.

**Unit-III**

***TransportationModels:*** Findinganinitialfeasiblesolution-NorthWestcornermethod, leastcostmethod,Vogel'sApproximationmethod,Findingtheoptimalsolution,optimal solutionbysteppingstoneandMODImethods,SpecialcasesinTransportationproblems- Unbalanced Transportation problem.

***Assignment Problems:*** Hungarian method of Assignment problem, Maximization in Assignmentproblem,unbalancedproblem,problemswithrestrictions,travellingsalesman problems.

**Unit-IV**

***ReplacementModels:*** Introduction,replacementofitemsthatdeteriorateignoringchange inmoneyvalue,replacementofitemsthatdeterioratecons ideringchangeinmoneyvalue withtime,replacementofitemsthatfailsuddenly-Individualreplacementpolicy,Group

replacementpolicy.
***GameTheory:***Introduction,2personzerosumgames,Maximin-Minimaxprinciple, PrincipleofDominance,Solutionformixedstrategyproblems,Graphicalmethodfor2xn andmx2games.

**Unit-V**

***Sequencing Models:*** Introduction, General assumptions, processing n jobs through 2 machines, processing 'n' jobs through m machines, Processing 2 jobs through m machines
***QueuingTheory:***Introduction,singlechannel-Poissonarrivals-exponentialservicetimes withinfinitepopulation&finitepopulation,Multichannel-poisonarrivals-Exponential servicetimeswithinfinitepopulation.
***Introduction to Optimization Techniques:*** Single objective & Multi objective optimization Techniques like G.A, NSGA, P.Q.O& MPSO Techniques.

**Suggested Reading:**


1. Hamdy, A. Taha, "*Operations Research-An Introduction*", Sixth Edition, Prentice Hall ofIndia Pvt. Ltd., 1997.
2. S.D. Sharma, "*Operations Research*", Kedarnath, Ramnath & Co., Meerut, 2009.
3. HrveyM.Wagner,"*PrinciplesofOperationsResearch*",SecondEdition,PrenticeHallofIndia Ltd., 1980.
4. V.K. Kapoor, "*Operations Research*", S. Chand Publishers, New Delhi, 2004.
5. R.PaneerSelvam,"*Operations Research*",SecondEdition,PHILearningPvt.Ltd.,New Delhi, 2008.
6. Data Reconciliation by Prof. Shanker Narasimha.

**Code: PC702ME**

**REFRIGERATION & AIR CONDITIONING**
**(Professional Core Course)**
*Credits :3*

*Instruction: 3 periodsperweek* *Duration of SEE: 3hours*
*CIE:30marks* *SEE: 70marks*

**Course Objectives:**

1. To understand the basic concepts of refrigeration and air conditioning systems.
2. Tostudythemethodsofrefrigerationforcommercialandindustrialapplications.
3. Tostudythelowertemperatureapplications:cryogenicsbyusingcascadesystems.
4. Solving the problems related to cooling and heating system (HVAC).

**Course Outcomes:**

1. Identifyvariousnaturalandartificialmethodsofrefrigeration.Statetheimportanceof refrigerantselectionandtheenvironmentalissuesrelatedtotheuseofCFCs
2. Formulate equations for different types of refrigerants used in vapour compression refrigeration system. Justify the selection of single or multi stage system based onoperating temperature range
3. Explain the working principles of vapour absorption, thermoelectric and steam-jet refrigeration systems. Select a suitable refrigerant absorbent mixture for Vapourabsorption refrigeration system
4. Define Psychrometry and its properties. Analyze various problems on psychrometricprocesses, know the construction and application of Psychrometric chart
5. Abletodesignanaircondoningsystembasedongiveninsideandoutsideconditions. Evaluatecoolingandheatingloadsinanair-conditioningsystem
6. List typical conditions required for various food product processes and List applications of refrigeration and air conditioning

**Unit-I**

Introduction to Refrigeration: Definition of Refrigeration and Air-conditioning, Necessity of Refrigeration, Methods of Refrigeration, Unit of Refrigeration and C.O.P. Reversed Carnot cycle.

Properties of Refrigerants: Survey, Designation, Desirable properties of refrigerants, Thermodynamic,ChemicalandPhysicalproperties,ClassificationofRefrigerants,Ozone depletion&Globalwarming,GreenHouseEffectandFutureofRefrigerants.

Air Refrigeration Systems: Analysis of Bell-Coleman Cycle, Open and Dense airsystem, Application to aircraft refrigeration, Simple cooling system and Bootstraprefrigeration system,RegenerativecoolingsystemandReducedambientcoolingsystem.

**Unit-II:**

Vapourcompressionsystem:Workingprincipleandessentialcomponentsof Simplevapor compressionRefrigerationcycle,Compressor,condenser,evaporator,andexpansiondevices, Analysisofcycle,C.O.P,RepresentationofthecycleonT-S,P-HandH-Scharts.Performance improvementofsimplevapourcompressionrefrigerationcyclebymeansofflashchamber andaccumulatorDryandwetcompression,Effectofoperatingconditionslikeevaporating pressure, condenser pressure, Liquid sub-cooling and Vapor super heating, Performance of thesystem.Lowtemperaturerefrigerationsystem(withsingleloadsystem),Compound compressionwithwaterintercoolerandFlashintercooler,Cascaderefrigerationsystem-Analysis and advantages

**Unit-III**

Vapour Absorption Refrigeration System: Simple absorption systems, COP, Practical ammonia absorption refrigeration system, Lithium bromide absorption system, Electrolux refrigerator, Common refrigerants and absorbents properties, Comparison with vapor compression refrigeration system
SteamJetRefrigeration:Principleofworking,Analysisofthesystem,Advantages,limitations andapplications.
Non-Conventional Refrigeration Systems: Principle and operation of Thermoelectric Refrigeration Systems, Seebeck effect - Peltier effect - Thomson effect, Analysis, Pulse tube refrigeration system.

**Unit-IV**

Psychrometry:Psychrometricproperties,Psychrometricchart,construction,Representation ofPsychrometricprocessesonthechart.
Introduction to Air Conditioning: Requirements of comfort air conditioning, Thermodynamics of human body, Body temperature, Metabolism, Body defense and Human tolerance, Effect of heat on performance, ASHRE comfort chart and Effective temperature.

**Unit-V**

CoolingLoadCalculationsinAirConditioning:Conceptofbypassfactor,Sensibleheatfactor, ApparatusDewPoint,RoomSensibleHeatFactor(RSHF),GrossSensibleHeatFactor(GSHF), Differentheatingandcoolingloads,Problems.
Designofairconditioningsystems:Allfreshair,Re-circulatedairwithbypassedair,Designof Summer,winterandYearroundairconditioningsystems,Energyconservationinair conditionedbuilding,Casestudyofonebuildingwithallloadcalculations.
AirConditioningSystems:Types,Componentsofairconditionerequipments,Humidifier, Dehumidifier,Filter,Grills,FansandBlowers,Ductmaterial,FunctionofDampers,Diffusers.
ApplicationsofRefrigerationandAirconditioningFoodPreservation,Transportair conditioning,andIndustrialapplications.

***Suggested Reading***:


1. AroraC.P.,"RefrigerationandAirconditioning",TataMcGrawHill,NewDelhi,2009.
2. Arora,S.C.andDomkundwar,S.,"ACourseinRefrigeration and Air conditioning",DhanpatRai&Sons,NewDelhi,2010.
3. Jain,V.K.,"RefrigerationandAirConditioning",SChand&Company,NewDelhi,2010.
4. Stocker,W.S.,"RefrigerationandAirconditioning",McGrawHill,NewDelhi,2009.
5. RKRajput.,"Refrigeration&Airconditioning",SKKataria&SonsNewDelhi,Third Edition2015.

**Code: PE711ME**

**INDUSTRIAL ENGINEERING**
**(Professional Elective-III)**
*Credits:3*

*Instruction: 3 periodsperweek* *Duration of SEE: 3hours*
*CIE:30marks* *SEE: 70marks*

**Course Objectives:**

1. TolearntheconceptofManagement.
2. TounderstandroleofProductionPlanningandControlinIndustry.
3. Tolearnvariousmaterialprocurementpolicies.
4. Tounderstandimportanceofqualitycontrolandvariousmethods.
5. TointerprettheroleofDecisiontheoryinIndustry.

**Course Outcomes:**

After completing this course, the student will be able to

1. Explainvariousapproachesforindustrialmanagement.Abletoinferconceptof managementinhumanresourcedomain
2. ApplyPhilosophyofProductionPlanningandControlinIndustryandcontrolthe activities in delivering the products in time
3. Determinetheoptimumrequirementofinventorybydevelopingthevarious quantitativemodels.
4. Developvariousmodelsormethodsforensuringtherequiredqualityoftheproducts orprocesses.
5. ElaboratetheroleofDecisiontheoryandapplyvariousapproachesunder UncertaintyandRiskconditions

**Unit-I**

**Management:** Introduction to Management, Scientific Management, Systems approach to Management, MBO, and Decision Making Process.
**Personnel Management:** Functions of personnel management, types of training, Job evaluation and Merit rating, Collective bargaining and labour participation in management.

**Unit**-II:
**ProductionPlanning&Control:**Definition,Objectives,ImportanceandFunctionsof ProductionPlanning&Control.
**ProductionControl:**Routing,Scheduling,Dispatching,Follow-upandprogressReport.

**Unit-III**

**Inventory Control:** Importance of inventory control, types of inventory models Inventorycostsdeterministicinventorymodels BasicEOQmodels,productionmodel without shortages, Purchase model with instantaneous replenishment and with shortages production model with shortages Inventory model with pricebreaks,Fixedorderqualitysystem,periodicreviewsystemInventorymodelwithproba bilisticdemand.

**Unit-IV**

**QualityControl**:Conceptofquality,evolutionofqualitycontrol,assignableandchance causesofvariation,VariableControlcharts(XandRcharts)
**Attributes control charts:** P chart and C chart
**AcceptanceSampling**–SingleSampling,DoubleSamplingandMultisamplingplans – OC curves of single

**Unit-V**

**DecisionTheory**:Introduction,Decision,DecisionMaking&DecisionTheory,Types ofDecisions,decisionmakingprocess,TypesofDecisionmakingEnvironment:

**Decision making under Uncertainty**- Criterion of Optimism or Maximax, Criterion of Pessimism or Maximin, Minimax decision criteria
**Decision making under Risk:** Expected Monetary Value(EMV), Expected Opportunity Loss (EOL) Criterion & Expected Value of Perfect Information(EVPI) Criterion, Decision Trees.

**Suggested Reading:**


1. M.Mahajan,"IndustrialEngineeringandProductionManagement",Dhanpatrai& sons, New Delhi
2. S.K.SharmaandSavitasarma,"IndustrialEngineeringandOrganization Management",SKKataria&Sons,NewDelhi.
3. S.D. Sharma, "Operations Research", Kedarnnath, Ramnath& Co., Meerut, 2009
4. S Kalavathi, "Operations Research", Vikas Publishing House Pvt. Ltd, 2009
5. V. K. Kapoor, "Operations Research", S. Chand, New Delhi.
6. SKSharma&SavitaSharma,"AcourseinIndustrialEngineering&Operations Management",SKKataria&Sons,2008

**Code:**
**PE712ME**

## CONTROL SYSTEMS THEORY
## (Professional Elective-III)

*Credits :3*

*Instruction: 3 periodsperweek* *Duration of SEE: 3hours*
*CIE:30marks* *SEE: 70marks*

### Course Objectives:

1. Toknowthedevelopmentofinput-outputrelationsusingblockdiagrams,signalflow graphsofmechanical,electromechanicalsystemsetcandmethodsofobtainingtime and frequency response.
2. Tounderstandthestabilityandmarginsforstabilityfromcharacteristicsequation,root-locus method or frequency methods.
3. Toknowthedevelopmentofthealternativestatespacemodelsofdynamicsystems, andtheirimportanceinpredictingtimeresponseofmultiplevariablesofthesystem.

### Course Outcomes

1. Derivethetransferfunctionofmechanical,electrical,hydraulicandthermalsystems.
2. Evaluate the time response of I and II order systems for various input signals.
3. SketchtheBode,PolarandRootlocusplotstocheckthestabilityofthesystem.
4. Sketch the Nyquist plot and design the Lead & Lag compensators to meet therequirements.
5. DeveloptheStatespacemodelofasystem,checkforitsControllability&Observability.

### Unit-I

ControlSystemsClassification:OpenLoop&ClosedLoopSystems.Mathematicalmodelsand Transferfunctionsfromgoverningequationsofmechanical,electrical,hydraulic,pneumatic, thermalsystemsAC,DCservomotors&Electromechanicalservosystems

### Unit-II:

BlockDiagrams-Blockdiagramreduction.Signalflowgraphs,Mason'sgainformula.Transient responseTimedomainspecificationsof1stand2ndordersystemsSteadystateerror,Error coefficients,andsensitivityPerformanceindicesRouthcriteria

### Unit-III

Routhcriteria-RootLocusmethodFrequencyResponse:Bode,Polarplots.Correlation betweentransientandfrequencyresponse,Bandwidth,Experimentaldeterminationof transferfunctions

### Unit-IV

Nyquistcriteria-Gainandphasemargins,Lead.LagandLead-lagcompensatordesign,PID controller,linearizationofNonlinearsystems.

### Unit-V

State-SpaceRepresentationofLinearControlSystems:Statetransitionmatrix.Solutionof stateequations:ZeroinputresponseandZerostateresponse.Conceptofcontrollabilityand observability

### Suggested Reading:


1. Dorf, R.C., *Modern Control Systems, Addison*-Wesley1989.
2. M. Gopal, *Con tori Systems,* Tata McGraw Hill,2004.
3. Ogata, K., *Modern Control Engineering,* Prentice Hall,2004.
4. NormanS.Nise,*ControlSystemsEngineering*,JohnWiley&Sons,Inc.,2001.

**Code: PE713ME**

**ELECTRIC AND HYBRID VEHICLE TECHNOLOGY**
**(Professional Elective-III)**

*Credits :3*

*Instruction: 3 periodsperweek* *Duration of SEE: 3hours*
*CIE:30marks* *SEE: 70marks*

**Course objectives:**

- To Understand Electric vehicle technology
- To Understand electric vehicle Energy Storage systems
- To know Electric propulsion systems
- To know the classification drives in hybrid vehicles their principles and merits
- To understand Drive Structures forelectric vehicle technology

**Course Outcomes:**

The student is able to

1. Understand Electric vehicle technology.
2. Know-how of power plants used in Electric vehicles and their significance
3. Understand Electric propulsion systems
4. To provide exposure to Electric vehicle battery technology and control systems.
5. Able to classify drives in hybrid vehicles their principles and merits

**UNIT - I**

**INTRODUCTION:** Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy suppliesElectric vehicles; configuration of EVs, performance, traction motor characteristics, tractive effort and transmission requirements.

**UNIT- II**

**Energy Storage**: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices.

**UNIT - III**

**Electric Propulsion unit**: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives

**UNIT - IV**

**Hybrid Drives:** Introduction, features, functional classification, start/stop system, mild hybrid, full hybrid, plug-in-hybrid, batteries for hybrid vehicles, and optimization of hybrid configurations. Changing modes for conductive charging.

**UNIT - V**

**Hybrid Electric Vehicles (HEVS) And Drive Structures**: Concept of electric drive train, architecture of hybrid electric drive train, series hybrid drive, parallel hybrid electrical drive train.

**Electric and Hybrid Vehicles - Case Studies:** Honda Insight, Chevrolet Volt, GM EV1, Toyota RAV 4 EV and Ford; Think City

**Suggested Reading**


1. Iqbal Husain, "Electic and Hybrid vehicles Design Fundamentals" , CRC Press, second Edition 2013
2. James Larminie, John Lowry, "Electric vehicle techonology Explained" 2nd Ed.,Wiley 2012
3. Vehicular Electrical Power Systems – Emadi, Ehasni, Mercel (Marcel Dekker)
4. Electric and Hybrid vehicles – Pistoia (Elsevier)
5. Fuel cells principles and applications - B.Vishwanath, M. Aulice Scibion (University Press)
6. Electrical vehicle machine and drives – K.T.Chau (Wiley).

**Code:PE721ME**

**ADDITIVE MANUFACTURING TECHNOLOGY**
**(Professional Elective-IV)**
*Credits:3*

*Instruction: 3 periodsperweek* *Duration of SEE: 3hours*
*CIE:30marks* *SEE: 70marks*

**CourseObjectives:**

1. Tounderstandthefundamentalconceptsofadditivemanufacturing,itsadvantagesand limitations.
2. Toknowtheworkingprinciple,advantages,disadvantagesandapplicationsofliquid,solid and Powder based Technologies.
3. ToknowthevarioustypesofSTLfileerrorsandotherdataformatsusedinadditive manufacturingTechnology.
4. To know the features of various softwares used in additive manufacturing.
5. To know diversified applications of additive manufacturing Technologies.

**Course Outcomes:**

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

1. Interpret the features of additive manufacturing and compare it with conventional methods.
2. Illustratetheworking principleofliquid, solidandpowder based additive manufacturing Technologies. Additive manufacturing
3. IdentifyvarioustypesoferrorsinSTLfileandotherdataformatsused additive manufacturingTechnology.
4. Select suitable software used in additive manufacturing Technology.
5. Apply the knowledge of various additivemanufacturingtechnologies for developing innovative applications.

**Unit-I**

***Introduction:*** Prototyping fundamentals: Need for time compression in product development, Historical development, Fundamentals of Rapid Prototyping, rapid prototypingprocesschain,AdvantagesandLimitationsofrapidprototyping,rapid prototyping wheel, Commonly used Terms, Classification of processes.

**Unit**-II:

***Liquid-basedSystems:***StereoLithographyApparatus(SLA):Modelsandspecifications, Process,workingprinciple,photopolymers,photopolymerization,Layeringtechnology, laserandlaserscanning,Applications,AdvantagesandDisadvantages,Casestudies.Polyjet: Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Casestudies

***Solid-based System:*** Laminated Object Manufacturing (LOM): Models and specifications, Process,workingprinciple,Applications,AdvantagesandDisadvantages,Casestudies. Fused Deposition Modeling (FDM): Models and specifications, Process, workingprinciple, Applications, Advantages and Disadvantages, Case studies.

**Unit-III**

***Powder Based Systems:*** Working principle, Specifications, Materials used, Process, Applications,AdvantagesandDisadvantages,CasestudiesofthefollowingTechnologieslike Selective laser sintering (SLS), Selective Laser Melting (SLM) and Direct MetalLaser

Sintering(DMLS),LaserEngineeredNetShaping(LENS),ElectronBeamMelting(EBM).

**Unit-IV**

***DataFormats&Software:***STLFormat,STLFileProblems,ConsequenceofBuildingValid andInvalidTessellatedModels,STLfileRepairs,NewlyProposedFormats. Software'sFeatures:Magics,Mimics,SolidView,ViewExpert,3DRhino,3Ddoctor,Flash Print,ObjectStudio,Cura,ITKSnap,3-matic,Simplant,3-matic,Simplant,MeshLab,Ansys for Additive Manufacturing

**Unit-V**

***ApplicationsofAdditiveManufacturing:***ApplicationinDesign,ApplicationinEngineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Electronic Industry, JewelleryIndustry,CoinIndustry,GISapplication,ArtsandArchitecture.RPMedicaland BioengineeringApplications:Planningandsimulationofcomplexsurgery,Customized Implants&Prosthesis,DesignandProductionofMedicalDevices,ForensicScienceand Anthropology,VisualizationofBiomolecules.Biopolymers,Packaging,Disaster Management, Entertainment and Sports industry.

**Suggested Reading:**


1.CheeKaiChuaandKahFaiLeong,"*3D Printingand AdditiveManufacturingPrinciples and Applications*"FifthEdition,Worldscientific

2.IanGibson,DavidWRosen,BrentStucker,"*AdditiveManufacturingTechnologies:3D Printing, Rapid Prototyping, and Direct Digital Manufacturing*" Springer,SecondEdition,2010.

3. "*Rapid Prototyping & Engineering Applications*"- Frank W.Liou, CRC Press, Taylor &Francis Group,2011.

4.RafiqNoorani,"*RapidPrototyping:PrinciplesandApplicationsinManufacturing*",John Wiley &Sons,2006.

5. NPTEL Course on Rapid Manufacturing.https://nptel.ac.in/courses/112/104/112104265/

**Code: PE722ME**

**ROBOTIC ENGINEERING**
**(Professional Elective-IV)**
*Credits:3*

*Instruction: 3 periodsperweek* *Duration of SEE: 3hours*
*CIE:30marks* *SEE: 70marks*

**CourseObjectives:** Students will understand

1.Theconfiguration,workenvelopandmotioncontrolsandapplications
2. Familiarities with the kinematics ofrobots.
3. Robot end effectors and theirdesign.
4. Familiarities with the dynamics ofrobots.
5.Robot Programming methods & Languages ofrobot.
6. Various Sensors and drives and their applications inrobots

**CourseOutcomes:**

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

1. Identify and classify various robot configurations with their workspaces, recognize and find suitable robot for a particular Industrial application considering theirDegrees of freedom, type of end effector and other Specifications.
2. Able to use rotation matrices and perform forward kinematic operations. Find Jacobean in velocity domain.
3. Able to perform inverse kinematics and convert a world space problem to joint space problem. Develop dynamical equations for control of robots.
4. Perform trajectory planning and implement independent joint control. Identifysuitability of various control methods.
5. Interface various hardware and software components to develop robotic systems forindustry&Evaluatetheirperformance.

**Unit-I**

BriefHistory,Typesofrobots,Overviewofrobotsubsystems,RobotJointsanditsLinks, Degreesoffreedomofrobots,WorkspaceofRobots,accuracy,precision,resolutionand repeatability,Robotclassification:Basedonkinematicconfigurations,controlmethods, workspace.DifferenttypesofWristsusedinindustrialrobots.DifferenttypesofRobot Drives.EndeffectorsandGrippers,Mechanical,Electrical,vacuumandothermethodsof gripping.
Robots used in various Industrial operations like Material handling,Assembly, Inspection,WeldingandPainting.DescriptionandSpecificationsineachcase.

**Unit**-II:

Rotationmatrices,Representationoflocationandorientation.EulerangleandRPY representation, Homogeneous transformation matrices Denavit-Hartenbergnotation,
representation of Translation and rotation in terms of joint parameters, Forward kinematics. Velocity Kinematics and Jacobian in Velocity domain.

**Unit-III**

Inverse Kinematis, inverse location, inverse orientation,inverse velocity, Singular Configurationofrobots,StaticforceanalysisofRPtypeandRRtypeplanarrobots, DynamicanalysisusingLagrangianandNewton-EulerformulationsofRRandRPtype planar robots.

**Unit-IV**

Trajectory Planning: Joint interpolation, task space interpolation, executing user specified tasks, Independent joint control, PD and PID feedback, actuator models, nonlinearityofmanipulatormodels,Computedtorquecontrol,forcecontrol,hybrid control,neuralnetworkbasedcontrolofmanipulator,fuzzycontrolofmanipulator,CNN based control of manipulator.

**Unit-V**

Sensors:typesofsensors,tactile&nontactilesensors,sensorstomeasurePosition, velocity &acceleration , Optical encoders. Range and Proximity sensing, acoustic, pneumatic,Halleffectsensor,Eddycurrentsensors,ForceandTorquesensors.

Vision: Image acquisition, types & components of vision system, Image representation, digitisation, binary, gray scale, RGB representation, Image processing, Image segementation, image smoothening, object descriptors, object recognition.

**Suggested Reading:**


1.SpongandVidyasagar,"RobotDynamics&Control",JohnWileyandSons,Ed.,1990

2.MittalandNagrath,"IndustrialRobotics",TataMcGrawHillPublications,2004.

3. Saha&Subirkumarsaha, 'Robotics', TMH, India.

4. Asada and Sllotine , 'Robot analysis and intelligence' BS Publications , India.

5.Fu.K.S.,GonZalezR.C.,LeeC.S.G."Robotics,Control-sensingvisionandIntelligence", McGrawHill,Int.Ed.,1987.

6. GrooverM.P.,"Industrial Robotics", McGraw Hill Publications, 1999.

7. Robotics toolbox in MATLAB.

**Code: PE723ME**

## COMPUTATIONAL FLUID DYNAMICS
## (Professional Elective-IV)

*Credits:3*

*Instruction: 3 periodsperweek* *Duration of SEE: 3hours*
*CIE:30marks* *SEE: 70marks*

### Course Objectives

1. Toconverttheconservationequationsoffluidflowindifferentialforminto algebraicequationsandapplynumericalmethodstoobtainsolutions
2. To learn the finite difference method.
3. Tolearnfinitevolumemethodandsolutionmethodologyforfluidflowproblems

### Course Outcomes

1. Understand the concepts of turbulence and fluid dynamics
2. Determineanddevelopthepartialdifferentialequationsforvariousconditions
3. Design the grid for different applications
4. Determine the finite difference solutions
5. Analyse the systems using finite volume method

### UNIT-I

Review of basic equations of fluid dynamics: Continuity, Momentum and Energy equations,NavierStokesequations,ReynoldsandFavreaveragedN–Sequations. Differentialequationsforsteadyandunsteadystateheatconduction.Differential equations for diffusion. Introduction to turbulence, Turbulence models-mixinglength model, K- turbulence Model.

### UNIT-II

Classification of PDEs – Elliptic, parabolic and hyperbolic equations. Initial and boundaryvalueproblems.ConceptsofFinitedifferencemethods–forward,backward andcentraldifference.Errors,Consistency,StabilityanalysisbyvonNeumann. Convergence criteria.

### UNIT-III

Grid Generation- Types of grid O,H,C. Coordinate transformation, algebraic methods. Unstructured grid generation.

### UNIT-IV

FinitedifferenceSolutions-ParabolicPDEs–Euler,CrankNicholson,Implicitmethods, Elliptic PDEs – Jacobi, Gauss Seidel, ADI, methods. FD- solution for Viscous incompressibleflowusingStreamfunction–Vorticitymethod&MACmethod.

### UNIT-V

IntroductiontoFinitevolumemethod.Finitevolumeformulationsfordiffusion equation, convection diffusion equation. Solution algorithm for pressure velocity coupling in steady flows. Use of Staggered grids SIMPLE Algorithm.

***Suggested Reading:***


1. PradipNiyogi,ChakrabarttySK,LahaM.K.,„IntroductiontoComputationalFluid Dynamics",PearsonEducation,2005.
2. MuralidharK,SundararajanT,„ComputationalFluidflowandHeattransfer",Narosa Publishing House,2003.
3. Chung,TJ,„ComputationalFluidDynamics",CambridgeUniversityPress,2002.
4. JohnDAnderson,„ComputationalFluidDynamics",McGrawHill,Inc.,1995.
5. Patankar,S.V,„NumericalHeattransferandFluidflow",HemispherePublishing Company,NewYork,1980.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| OE701CE | GREEN BUILDING TECHNOLOGIES | | | | | | OE-II |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| - | 3 | - | - | - | 30 | 70 | 3 |

**Course Objectives:**

- Learn the principles of green building technologies and rating systems
- Understand the principles of effective energy and resources management in buildings
- Understand the methodologies to reduce, recycle and reuse towards sustainability.

**Course Outcomes:**

1. After completing this course, the student will be able to
2. Classify the various features, benefits, and rating systems for a green building
3. Outline the criteria used for site selection and water efficiency methods
4. Select the energy efficiency techniques in designing a green building
5. Select materials for sustainable built environment & adopt waste management methods
6. Identify an appropriate method for maintaining indoor environmental quality in a green building

**UNIT-I**

Introduction to Green Buildings: Definition of green buildings and sustainable development, typical features of green buildings, benefits of green buildings towards sustainable development. Green building rating systems – GRIHA, IGBC and LEED, overview of the criteria as per these rating systems.

**UNIT- II**

Site selection and planning: Criteria for site selection, preservation of landscape, soil erosion control, minimizing urban heat island effect.

Water conservation and efficiency: Rainwater harvesting methods for roof & non-roof, reducing landscape water demand by proper irrigation systems, water efficient plumbing systems, water metering, waste water treatment, recycle and reuse systems.

**UNIT-III**

Energy Efficiency: Environmental impact of building constructions, Concepts of embodied energy, operational energy and life cycle energy.

Methods to reduce operational energy: Energy efficient building envelopes, efficient lighting technologies, energy efficient appliances for heating and air-conditioning systems in buildings, zero ozone depleting potential (ODP) materials, wind and solar energy harvesting, energy metering and monitoring, concept of net zero buildings.

**UNIT-IV**

Building materials: Methods to reduce embodied energy in building materials: (a) Use of local building materials (b) Use of natural and renewable materials (c) use of materials with recycled content such as blended cements materials from agro and industrial waste. (d) reuse of waste and salvaged materials

Waste Management: Handling of construction waste materials, separation of household waste, on-site and off-site organic waste management

**UNIT-V**

Indoor Environmental Quality for Occupant Comfort and Well being: Day lighting, air ventilation, exhaust systems, low VOC paints, materials & adhesives, building acoustics.

Codes related to green buildings: NBC, ECBC, ASHRAE, UPC etc.

**Suggested Readings:**


1. IGBC Green Homes Rating System, Version 2.0., Abridged reference guide, 2013, Indian Green Building Council Publishers
2. GRIHA version 2015, GRIHA rating system, Green Rating for Integrated Habitat Assessment
3. 'Alternative building materials and technologies' by K.S. Jagadish, B.V. Venkatarama Reddy and K.S. Nanjunda Rao.
4. 'Non-Conventional Energy Resources' by G. D. Rai, Khanna Publishers.
5. Sustainable Building Design Manual, Vol.1 and 2, TERI, New Delhi 2004

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **OE 701 CS** | **Data Science and Data Analytics** | | | | | | **Open Elective-II** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- To learn basics of Data Science: Linear Algebra, Linear Equations, Matrices, Eigen Values and Eigen Vectors.
- To learn various statistical concepts like linear and logistic regression, cluster analysis, time series forecasting
- To learn Decision tree induction, association rule mining and text mining

**Course Outcomes:**

1. At the end of the course, the students will be able to
2. Use various Mathematical models, and Probability and Statics
3. Uselinear,non-linearregressionmodels,andclassificationtechniquesfordataanalysis
4. Use clustering methods including K-means and CURE algorithm

**UNIT – I**

Data Science: Introduction to data science, Linear Algebra for data science, Linear equations, Distance, Hyper planes, Half spaces, Eigen values, Eigenvectors.

**UNIT II**

Statistical Modelling, Random variables, Probability mass/density functions, sample statistics, hypothesis testing.

**UNIT III**

Predictive Modelling: Linear Regression, Simple Linear Regression model building, Multiple Linear Regression, Logistic regression

**UNIT IV**

Decision Tree: Introduction, What Is A Decision Tree? Appropriate Problems For Decision Tree Learning, Basic Decision Tree Learning Algorithm, Measuring Features, Hypothesis Space Search In Decision Tree Learning, Inductive Bias In Decision Tree Learning, Why Prefer Short Hypotheses, Issues In Decision Tree Learning.

Classification: K-Nearest neighbors (KNN), Performance Measures,

**UNIT V**

Clustering: K-Means Algorithm,

**Association Rules:** Introduction, Frequent Itemset, Data Structure Overview, Mining Algorithm Interfaces, Auxiliary Functions, Sampling from Transaction, Generating Synthetic Transaction Data, Additional Measures of Interestingness, Distance Based Clustering Transaction and Association.

***Suggested Readings:***


1. Nina Zumel, Practical Data Science with R, Manning Publications,2014.
2. Peter Bruce and Andrew Bruce, Practical Statistics for Data Scientists, O'Reilly,2017.
3. Hadley Wickham and Garrett Grolemund, R for Data Science, O'Reilly,2017.
4. Roger D Peng, R Programming for Data science, Lean Publishing,2016.
5. **Rafael A Irizarry,** Introduction to Data Science, LeanPublishing,2016.
6. Vishwa Vishwanathan and Shanthi Vishwanathan, R Data Analysis cookbook 2015

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| OE701EC | Fundamentals of IoT | | | | | | Open Elective-II |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| - | 3 | - | - | - | 30 | 70 | 3 |

**Course Objectives:**

- Discuss fundamentals of IoT and its applications and requisite infrastructure
- Describe Internet principles and communication technologies relevant to IoT
- Discuss hardware and software aspects of designing an IoT system
- Describe concepts of cloud computing and Data Analytics
- Discuss business models and manufacturing strategies of IoT products

**Course Outcomes:**

1. After completing this course, the student will be able to
2. Understand the various applications of IoT and other enabling technologies.
3. Comprehend various protocols and communication technologies used in IoT
4. Design simple IoT systems with requisite hardware and C programming software
5. Understand the relevance of cloud computing and data analytics to IoT
6. Comprehend the business model of IoT from developing a prototype to launching a product.

**UNIT – I**

Introduction to Internet of Things: Definition and Characteristics of IoT, Physical Design of IoT: Things in IoT, IoT protocols, Logical Design of IoT: IoT functional Blocks, Communication Models, APIs, IoT enabling Technologies: Wireless Sensor Networks, Cloud Computing, Big Data Analytics (Ref 1)

IoT Applications: Smart Home, Smart Cities, Smart Environment, Smart Energy, Smart Retail and Logistics, Smart Agriculture and Industry, Smart Industry and smart Health (Ref1)

**UNIT – II**

Internet Principles and communication technology: Internet Communications: An Overview – IP, TCP, IP protocol Suite, UDP. IP addresses – DNS, Static and Dynamic IP addresses, MAC Addresses, TCP and UDP Ports, Application Layer Protocols – HTTP, HTTPS, Cost Vs Ease of Production, Prototypes and Production, Open Source Vs Closed Source. Prototyping Embedded Devices – Sensors, Actuators, Microcontrollers, SoC, Choosing a platform, Prototyping Hardware platforms – Arduino, Raspberry Pi. Prototyping the physical design – Laser Cutting, 3D printing, CNC Milling (Ref 2)

**UNIT – III**

API Development and Embedded programming: Getting started with API, writing a new API, Real time Reactions, Other Protocols, Techniques for writing embedded code: Memory management, Performance and Battery Life, Libraries, Debugging. (Ref 2)

Developing Internet of Things: IoT design Methodology, Case study on IoT System for weather monitoring (Ref 1)

**UNIT – IV**

IoT Systems - Logical Design using Python: Introduction to Python, Data Types and Structures, Control Flow, Functions, Modules, Packages, File Handling, Date/Time Operations., Classes, Python packages for IoT (Ref 1 and Ref 3)

IoT Physical Devices and Endpoints: Raspberry Pi, Interfaces of Pi, Programming pi with Python - Controlling LED and LDR using Pi with python programming.

**UNIT – V**

Cloud computing and Data analytics and IoT Product Manufacturing: Introduction to Cloud storage models and Communication APIs, Amazon web services for IoT, Skynet IoT Messaging Platform. Introduction to Data Analytics for IoT (Ref 1). Case studies illustrating IoT Design – Smart Lighting, Weather Monitoring, Smart Irrigation. (Ref 1) Business model for IoT product manufacturing, IoT Start-ups, Mass manufacturing, Ethical issues in IoT. (Ref 2)

Suggested Readings:

1. Internet of Things (A Hands-On-Approach), Vijay Madisetti, ArshdeepBahga, VPT Publisher, 1st Edition, 2014.
2. Designing the Internet of Things, Adrian McEwen (Author), Hakim Cassimally. Wiley India Publishers.
3. Fundamentals of Python, Kenneth A Lambert and B.L. Juneja, Cengage Learning
4. Internet of Things - Converging Technologies for smart environments and Integrated ecosystems, River Publishers.
5. Internet of things -A hands on Approach, Arshdeep Bahga, Universities press.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **OE701EE** | **Non-Conventional Energy Sources (Open Elective)** | | | | | | **Elective** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- To understand basics and types of Non-conventional energysources.
- To understand the working and operation of Solar and wind energysystems.
- To understand the working and operation of Ocean, Geo-thermal and biomass energysystems.

**Course Outcomes**

At the end of the course students will be able to

- Understand the applications of non-conventional energy sources and fuelcells.
- Acquire the knowledge of Solar energy storage systems, wind generation andcontrol.
- Acquire the knowledge of Geothermal, Biomass and ocean energy conversionsystems.

**UNIT-I**

Review of Conventional and Non-Conventional energy sources - Need for non-conventional energy sources Types of Non- conventional energy sources - Fuel Cells - Principle of operation with special referencetoH2°2Cell-ClassificationandBlockdiagramoffuelcellsystems-Ionexchangemembrane cell-Moltencarbonatecells-Solidoxideelectrolytecells-Regenerativesystem-RegenerativeFuelCell-Advantages and disadvantages of Fuel Cells- Polarization - Conversion efficiency and Applications of FuelCells.

**UNIT-II**

Solar energy - Solar radiation and its measurements - Solar Energy collectors -Solar Energy storage systems - Solar Pond - Application of Solar Pond - Applications of solar energy.

**UNIT-III**

Windenergy-Principlesofwindenergyconversionsystems-Natureofwind-PowerintheWind-Basic components of WECS -Classification of WECS - Site selection considerations - Advantages and disadvantages of WECS - Wind energy collectors -Wind electric generating and control systems - Applications of Wind energy -Environmentalaspects.

**UNIT-IV**

Energy from the Oceans - Ocean Thermal Electric Conversion (OTEC) methods - Principles of tidal power generation -Advantages and limitations of tidal power generation -Ocean waves - Wave energy

conversiondevices-Advantagesanddisadvantagesofwaveenergy-Geo-thermalEnergy-TypesofGeo- thermal Energy Systems - Applications of Geo-thermalEnergy.

**UNIT-V**

Energy from Biomass - Biomass conversion technologies / processes - Photosynthesis - Photosynthetic efficiency-Biogasgeneration-SelectionofsiteforBiogasplant-ClassificationofBiogasplants-Details of commonly used Biogas plants in India - Advantages and disadvantages of Biogas generation - Thermal gasification of biomass - Biomass gasifies

***Suggested Readings:***


1. Rai G.D, Non-Conventional Sources of Energy, Khandala Publishers, New Delhi,1999.
2. M.M.El-Wakil, Power Plant Technology. McGraw Hill,1984.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **OE 701 IT** | **CYBER SECURITY** | | | | | | Open Elective |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| | 3 | - | - | - | **30** | **70** | **3** |

**Course Objectives:**

Students should be able to understand

- The difference between threat and attacks, how threats materialize into attacks.
- Security in Operating Systems & Networks.
- Security Countermeasures
- Privacy in Cyberspace.
- Security Planning, Risk Analysis, Cyber Warfare, Cyberspace and Law

**Course Outcomes:**

Student will be able to

1. Acquire adequate knowledge about threat and attacks
2. Enhance their skills to implement security in design of Operating Systems
3. Use various techniques of Security Countermeasures
4. Acquire understanding in Privacy Principles and Policies in Cyberspace
5. Enhance their understanding in Security Planning, Risk Analysis, Cyber Warfare, Cyberspace and Law

**UNIT I**

**Introduction To Cyber Security**

Introduction -Computer Security - Threats -Harm - Vulnerabilities - Controls - Authentication - Access Control and Cryptography - Web—User Side - Browser Attacks - Web Attacks Targeting Users - Obtaining User or Website Data - Email Attacks

**UNIT II**

**Security In Operating System & Networks**

Security in Operating Systems - Security in the Design of Operating Systems -Rootkit - Network security attack- Threats to Network Communications - Wireless Network Security - Denial of Service - Distributed Denial-of-Service.

**UNIT III**

**Defences: Security Countermeasures**

Cryptography in Network Security - Firewalls - Intrusion Detection and Prevention Systems - Network Management - Databases - Security Requirements of Databases - Reliability and Integrity - Database Disclosure - Data Mining and Big Data.

**UNIT IV**

**Privacy In Cyberspace**

Privacy Concepts -Privacy Principles and Policies -Authentication and Privacy - Data Mining - Privacy on the Web - Email Security - Privacy Impacts of Emerging Technologies - Where the Field Is Headed.

**UNIT V**

**Management And Incidents**

Security Planning - Business Continuity Planning - Handling Incidents - Risk Analysis - Dealing with Disaster - Emerging Technologies - The Internet of Things - Economics - Electronic Voting - Cyber Warfare- Cyberspace and the Law - International Laws - Cyber crime - Cyber

Warfare and Home Land Security.

**Suggested for Readings**


1. Charles P. Pfleeger Shari Lawrence Pfleeger Jonathan Margulies, Security in Computing, 5th Edition , Pearson Education , 2015
2. George K.Kostopoulous, Cyber Space and Cyber Security, CRC Press, 2013.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **OE 701 ME** | **START- UP ENTREPRENEURSHIP** | | | | | | Open Elective |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| | 3 | - | - | - | **30** | **70** | **3** |

**Course Objectives:**

Students should be able to understand

- To motivate students to take up entrepreneurship infuture.
- To learn nuances of starting an enterprise & project management.
- To understand the design principles of solar energy systems, their utilization and performance evaluation.
- To understand the behavioural aspects of entrepreneurs and time management

**Course Outcomes:**

Student will be able to

- Understand Indian Industrial Environment, Entrepreneurship and Economic growth, Small and Large Scale Industries, Types and forms of enterprises.
- Identify the characteristics of entrepreneurs, Emergence of first generation entrepreneurs, Conception and evaluation of ideas and their sources.
- Practice the principles of project formulation, Analysis of market demand, Financial and profitability analysis and Technical analysis.
- Understand the concept of Intellectual Property Rights and Patents
- Comprehend the aspects of Start-Ups.

**Unit-I**

Indian Industrial Environment-competence, Opportunities and Challenges. Entrepreneurship and Economic growth. Small Scale Industry in India, Objectives, Linkage among small, medium and heavy industries. Types of enterprises.

**Unit-II:**

Identification and characteristics of entrepreneurs. Emergence of First generation entrepreneurs, environmental influence and women entrepreneurs. Conception and evaluation of ideas and their sources. Choice of Technology - Collaborative interaction for Technology development.

**Unit-III**

Project formulation, Analysis of market demand, Financial and profitability analysis and Technical analysis, project financing in India.

**Unit-IV**

**Intellectual Property Rights:** Meaning, Nature, Classification and protection of Intellectual Property, themain forms of Intellectual Property, Concept of Patent, Patent document, Invention protection, Granting ofpatent,Rightsof apatent, Licensing, Transfer oftechnology.

**Unit-V**

**Aspects of Start-Up:** What is Start-Up, Start-up Policy, start-up strategy, Progress of startups in India, Principles of future organizations, start-up sectors, action plan for start-ups by Govt. of India.

**Suggested Reading:**

1. Vasant Desai, *"Dynamics of Entrepreneurial Development and Management",* Himalaya Publishing House,1997.

2. Prasanna Chandra, *"Project-Planning, Analysis, Selection, Implementation and Review",* Tata McGraw-Hill Publishing Company Ltd. 1995.
3. Stephen R. Covey and A. Roger Merrill, *"First Things First",* Simon and Schuster Publication, 1994.
4. G.S. Sudha, *"Organizational Behaviour",*1996.
5. Robert D. Hisrich, Michael P. Peters, *"Entrepreneurship",* Tata Me Graw Hill Publishing Company Ltd., 5lh Ed.,2005.
6. G.B.Reddy,IntellectualPropertyRightsandtheLaw5thEd.2005GogiaLawAgency
7. AjitParulekarandSaritaD'Souza,IndianPatentsLaw– Legal&BusinessImplications,MacmillanIndiaLtd,2006.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **OE 701 AE** | **AUTOMOTIVEMAINTENANCE** | | | | | | Open Elective |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| | 3 | - | - | - | **30** | **70** | **3** |

**Course Objectives:**

Students should be able to understand

- To studybasic types of vehiclemaintenancealong with its importance
- Tounderstandthe troublediagnosis procedurefor electrical andelectronicsystemsin
- automobiles
- ToacquaintwithvariousTroubleshooting,faulttracingpracticesavailable in
- automobileindustry
- Tounderstand themaintenanceprocedurefor air-conditioningin automobiles.

**Course Outcomes:**

Student will be able to

1. DemonstratethemaintenanceprocedureforautomotiveEngine.
2. Illustratethetroublediagnosisprocedureforelectricalsystemslike Battery,Starting
3. Systems
4. Identifythe troublediagnosis procedureforsteeringand suspensionsystem
5. Illustratetroublediagnosis procedure forlubrication andfuel deliverysystem etc.
6. Explaintroublediagnosisprocedureforheatingsystem ofautomobile.

**UNIT – I**

***Maintenance,WorkshopPractices,SafetyandTools:*** Maintenance– Need,importance,primary and secondary functions, policies - classification of maintenance work - vehicleinsurance-basic problem diagnosis.

vehicles, fire safety - First aid. Basic tools –Scheduled maintenance services – service intervals -Towingand recovering.

**UNIT – II**

***Engine and Engine Subsystem Maintenance:*** introduction engine IC Engine General Engineservice-

coolingandlubricatingsystem,fuelsystem,IntakeandExhaustsystem,electricalsystem-Electronicfuelinjectionandenginemanagement.**S**ervice-faultdiagnosis-servicingemissioncontrols.

**UNIT – III**

***Transmission and Driveline Maintenance:*** Clutch- general checks, adjustment and service-roadtesting,Rearaxleservicepoints-removingaxleshaftandbearings-servicingdifferential assemblies-faultdiagnosis.

**UNIT– IV**

***Steering, Brake, Suspension and Wheel Maintenance:*** *Inspection*, Maintenance and Service ofHydraulicbrake,Drumbrake,Discbrake,Parkingbrake.Bleedingofbrakes.Inspection,MaintenanceandServiceofMcpersonstrut,coilspring,leafspring,shockabsorbers.Wheelalignment and balance, removing and fitting of tyres, tyre wear and tyre rotation. Inspection,Maintenance and Serviceof steeringlinkage.

**UNIT – V**

***AutoElectricalandAirConditioningMaintenance*:**Maintenanceofbatteries,startingsystem,chargingsystemandbodyelectrical-

FaultdiagnosisusingScantools.Maintenanceofairconditioningpartslike compressor,condenser,expansionvalve,evaporator-Vehiclebodyrepairlikepanel beating, tinkering, soldering, polishing,painting.

**SuggestedReadings:**


1. EdMay,"*AutomotiveMechanicsVolume*,McGrawHillPublications,2003.
2.EdMay,"*AutomotiveMechanicsVolumeTwo*||,McGrawHillPublications,2003
3.*VehicleServiceManualsof reputedmanufacturers*
4.*BoschAutomotiveHandbook*, Sixth Edition,2004

**Code: PW702ME**

**PROJECT-I**
**(Project Work-I)**
***Credits:3***

*Instruction: 6 periodsperweek* *Duration of SEE:--*
*CIE: 50marks* *SEE: 70marks*

**Objectives:**

1. To enhance practical and professional skills.
2. To familiarize tools and techniques of systematic literature survey and documentation
3. To expose the students to industry practices and team work.
4. Toencouragestudentstoworkwithinnovativeandentrepreneurialideas

**Outcomes:**

1. Demonstratetheabilitytosynthesizeandapplytheknowledgeandskillsacquiredin the academic program to the real-world problems.
2. Evaluate different solutions based on economic and technical feasibility
3. Effectivelyplanaprojectandconfidentlyperformallaspectsofprojectmanagement
4. Demonstrate effective written and oral communication skills

Thedepartmentcaninitiatetheprojectallotmentprocedureattheendof VIsemesterand finalizeitinthefirsttwoweeksofVIIsemester.

The department will appoint a project coordinator who will coordinate the following:

- Collection of project topics/ descriptions from faculty members (Problems can also beinvitedfromtheindustries)
- Groupingofstudents(max3inagroup)
- Allotmentofprojectguides

Theaimofprojectworkistodevelopsolutionstorealisticproblemsapplyingthe knowledgeandskillsobtainedindifferentcourses,newtechnologiesandcurrentindustry practices.Thisrequiresstudentstounderstandcurrentproblemsintheirdomainand methodologiestosolvetheseproblems.Togetawarenessoncurrentproblemsand solutiontechniques,thefirst4weeksofVIIsemesterwillbespentonspeciallectures by facultymembers,researchscholars,postgraduatestudentsofthedepartmentandinvited lecturesbyengineersfromindustriesandR&Dinstitutions.Aftercompletionofthese seminarseachgrouphastoformalizetheprojectproposalbasedontheirownideasoras suggestedbytheprojectguide.

Seminarschedulewillbepreparedbythecoordinatorforallthestudentsfromthe5th weektothelastweekofthesemesterwhichshouldbestrictlyadheredto.

**1. Each group will be requiredto:**

1. Submitaone-pagesynopsisbeforetheseminarfordisplayonnoticeboard.
2. Givea30minutes'presentationfollowedby10minutes'discussion.
3. Submitatechnicalwrite-uponthetalk.

AtleasttwoteacherswillbeassociatedwiththeProjectSeminartoevaluatestudentsfor theawardofsessionalmarkswhichwillbeonthebasisofperformanceinallthe3items statedabove.

The seminar presentation should include the following components of the project:

- Problemdefinitionandspecification
- Literaturesurvey
- Broadknowledgeofavailabletechniquestosolveaparticularproblem.
- Planningofthework,preparationofbar(activity)charts
- Presentation-oralandwritten.

**SCHEME OF INSTRUCTION & EXAMINATION**
**B.E. (Mechanical Engineering) VIII – SEMESTER**
**(Proposed for the Academic year 2021-2022)**

| S. No | Course Code | Course Title | Scheme of Instructions | | | | Scheme of Examination | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P/D | Contact Hours/Week | CIE | SEE | Duration in | |
| **Theory Course** | | | | | | | | | | |
| 1 | PE-V | Professional Elective-V | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 2 | PE-VI | Professional Elective-VI | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 3 | OE-III | Open Elective-III | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| **Practical / Laboratory Course** | | | | | | | | | | |
| 4 | PW703ME | Project-II | - | - | 16 | 16 | 50 | 150 | | 8 |
| **Total** | | | | | | | | | | **17** |

| *Professional Elective-V* | | |
|---|---|---|
| *S. No.* | *Course Code* | *Course Title* |
| 1 | PE811ME | Mechanical Vibrations |
| 2 | PE812ME | Composite Materials |
| 3 | PE813ME | Power Plant Engineering |

| *Professional Elective-VI* | | |
|---|---|---|
| *S. No.* | *Course Code* | *Course Title* |
| 1 | PE821ME | Energy Conservation & Management |
| 2 | PE822ME | Non-Destructive Testing |
| 3 | PE823ME | Entrepreneurship Development |

| **Open Elective – III** | | |
|---|---|---|
| 1 | OE801 CE | Road Safety Engineering (Not for Civil Engg. Students) |
| 2 | OE801CS | Fundamentals of AI & ML ( Not for CSE & IT students) |
| 3 | OE801 EE | Smart Building Systems (Not for EEE & EIE Students) |
| 4 | OE802 EE | Programmable Logic Controllers (Not for EEE & EIE Students) |
| 5 | OE801EC | Principles of Electronic Communications ( Not for ECE students) |
| 6 | OE801IT | Software Engineering (Not for IT Students) |
| 7 | OE801ME | 3D Printing Technologies ( Not for Mechanical and Production students) |
| 8 | OE801AE | Elements of Electrical and Hybrid Vehicle Technology |

**MC**: Mandatory Course
**CIE:** Continuous Internal Evaluation
**SEE:**SemesterEndExamination(Univ.Exam)
**BS**:BasicScience
**L**: Lecture
**P**: Practical
**ES:**Engineering Science
**T**: Tutorial
**D**: Drawing

**Note:**

1. Eachcontacthourisaclockhour
2. Thedurationofthepracticalclassistwohours,howeveritcanbeextendedwherever

necessary,toenablethestudenttocompletetheexperiment.

**Code: PE811ME**

**MECHANICAL VIBRATIONS**
**(Professional Elective-V)**
*Credits :3*

*Instruction: 3 periodsperweek* *Duration of SEE: 3hours*
*CIE:30marks* *SEE: 70marks*

**Objectives:**

Student has to understand the

1.Explaintheconceptofvibrations,withsingledegreeoffreedomsystems
2.Discuss the numerical methods involved in vibrations
3.Demonstrate the concept of Transient vibrations

**Outcomes:**

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

1. FindtheNaturalfrequenciesofSDoFSystems.
2. Drawthemodeshapes.
3. SolvetheMDoFSystems
4. DotheModelanalysis.
5. Applythenumericalmethodstovibration Problems.

**Unit-I**

**FreeVibrationofSingleDegreeofFreedomSystems:**Introduction,causesandeffects ofvibration.FreeVibrationofanUndampedTranslationalSystem,EquationofMotion usingNewton'ssecondlawofmotion,Equationofmotionusingothermethods, Equationofmotionofaspring,masssysteminverticalposition,solution,Harmonic MotionFreeVibrationofanUndampedTorsionalSystem-Equationofmotion.Free Vibration with Viscous Damping- Equation of motion.

**Unit**-II:

**Forced Vibration of Single Degree of Freedom Systems:** Introduction, Beating Phenomenon.ResponseofaDampedsystemundertheHarmonicMotionofthebase, Force Transmitted, Relative Motion.

**Unit-III**

**Two Degree of Freedom Systems:** Introduction, Equations of Motion for forced Vibration, Free Vibration Analysis of and undamped system, Torsionalsystem, CoordinateCouplingandPrincipalCoordinates,forcedVibrationAnalysis,Semidefinite Systems.

**Unit-IV**

**Multi-degreeofFreedomSystems:**IntroductionModelingofContinuoussystemsas Multi-degreeofFreedomsystems.Equationsofmotion,InfluenceCoefficients.Potential andkineticenergyexpressionsinmatrixform,Generalizedcoordinatesandgeneralized forces,UsingLagrange'sequationstoderiveequationsofmotion,Equationsofmotionof undampedsystemsinmatrixform,Eigenvalueproblem,solutionoftheEigenvalue problems – solution of the characteristic equation, orthogonality of normal modes.

**Unit-V**

**Determination of Natural Frequencies and Mode Shapes**: Introduction,Dunkerley's formula, Rayleigh's Method- Properties of Rayleigh's Quotient, Computation ofthe FundamentalNaturalFrequency,FundamentalFrequencyofBeamsandShafts.Holzer's

Method-Torsional systems, Spring Mass Systems. Jacobi method, Standard Eigen value Problems.

**Suggested Reading:**


1. W T Thomson., "Theory of Vibrations with Applications", CBS Publishers
2. S S Rao, "Mechanical Vibrations", Addison-Wesley Publishing Co.
3. LeonardMeirovitch,"FundamentalsofVibration",McGrawHillInternationalEdison.
4. J P Den Hartog, "Mechanical Vibrations", McGraw Hill.
5. Srinivasan, "Mechanical Vibration Analysis", McGraw Hill.
6. NunoManuelMendesMaiaetal,"TheoreticalandExperimentalModalAnalysis",Wiley John &sons,1999

**Code: PE812ME**

**COMPOSITE MATERIALS**
**(Professional Elective-V)**
*Credits :3*

*Instruction: 3 periodsperweek* *Duration of SEE: 3hours*
*CIE:30marks* *SEE: 70marks*

### *Objectives*

Student has to understand the

1. Understandthebasicstructureofcomposites
2. Manufacturingprocessesinvolvedincomposites
3. Higro-thermal stresses incomposites
4. Behavior and design of composites

### *Outcomes*

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

1. Demonstratetheknowledgeofcompositesandtheirstructures
2. Demonstrate the manufacturing processes involved in composites
3. Analyseandpredictthestressandstrainrelationshipincomposites.
4. Summarizeandapplythedesignproceduresandfailurecriteriaof composites
5. Apply the testing procedures of composites

**UNIT-I**

**Introduction:** Fibres, Matrixmaterials, interfaces, polymermatrixcomposites, metalmatrix composites, ceramic matrix composite, carbon fibre composites, Applications of composites.

**UNIT-II**

Fabricationprocesses, openmouldprocesses, handlay-upcomposites, sprayupcomposites, prepeggingprocesses, autoclavemoulding, sheetmouldingcompound(SMS), Resigntransfer moulding, thermo plastic moulding, Filament winding process, pultrusion process.

**UNIT-III**

**Micromechanics of Composite**s: Mechanical Properties: Prediction of Elastic constant, micromechanical approach, Halpin-Tsai equations, Transverse stresses. Thermal properties: Hygrothermal stresses, mechanics of load transfer from matrix to fibre.

**UNIT-IV**

**Macromechanics of Composites:** Elastic constants of a lamina relations between engineeringconstantsandreducedstiffnessandcompliances, variationoflaminaproperties withorientation, analysisoflaminatedcomposites, stressesandstrainswithorientation, inter-laminarstressesandedgeeffects, Simplifiedcompositebeamsolutions. Bendingof laminatedbeams.

**UNIT-V**

Designofcomposites-Maximumstresstheory, maximumstraincriteria, Tsai-hill, Tsai-wu criteria, fracturemodesincomposites.

Testingofcomposites-Measurementofconstituentmaterialproperties-fibretestandresign matrixtest.Measurementofbasiccompositeproperties–Tensiletest,compressivetest,in-planesheartest,interlaminarsheartest,flexuraltest

**Suggested Readings:**


1. Jones,R.M.,'MechanicsofCompositeMaterials',Mc-GrawHillCo.,1967.
2. Calcote,L.R.,'TheAnalysisofLaminatedCompositeStructures',VanNostrand,1969.
3. Whitney.I.M., Daniel, R.B.Pipes, 'Experimental Mechanics of fibre Reinforced CompositeMaterials',PrenticeHall,1984.
4. Hyer.M.W.,'StressAnalysisofFibre-ReinforcedCompositeMaterials',McGrawHillCo., 1998.
5. Carl.T.Herakovich,'MechanicsofFibrousComposites',JohnWileySonsInc.,1998.

**Code: PE813ME**

**POWER PLANT ENGINEERING**
**(Professional Elective-V)**
*Credits :3*

*Instruction: 3 periodsperweek* *Duration of SEE: 3hours*
*CIE:30marks* *SEE: 70marks*

**Objectives:**

Student has to understand the

1.Operation of steam turbine and gas turbine power plants
2.About hydraulic power plant, hydrology, dams and spillways
3. Various types of nuclear power plants including Pressurized water reactor, Boiling water reactor, Liquid metal fast breeder reactor and Gas cooled reactor
4. The power plant economics
5.The environmental and safety aspects of power plant operation.

**Outcomes:**

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

1. Selectcoalandashhandlingmethodsforacoalfiredpowerplant.
2. Comprehendbasicworkingprincipleofsteamandgasturbinepowerplant
3. ClassifyDamsandSpillways.
4. Demonstrate the basic principles of thermal-fission and fast-breeder nuclear powerplants,suchaspressurized-water,boiling-water,andheavy-waterreactors.
5. Analyzeloadfactor,capacityfactor,averageloadandpeakloadonapowerplant.
6. Illustratethecontrolmethodsofmajorpollutantsemittedfromfossil-fuelpower plants.

**Unit-I**

Introduction to Sources of Energy-Resources and Development of Power in India. Steam***PowerPlant:***Plantlayout,workingofdifferentCircuits,Fuelandhandling equipment,typesofcoal,coalhandling,choiceofhandlingequipment,coalstorage,ash handlingsystems.

**Unit**-II:

***CombustionProcess:***Propertiesofcoal-overfeedandunderfeedfuelbeds,traveling gratestokers,spreaderstokers,retortstokers,pulverizedfuelburningsystemandits components, combustion needs and draught system, cyclone furnace, design and construction,Dustcollectors,coolingtowers,andheatrejection,corrosionandfeed watertreatment.
***Gas Turbine Power Plant:*** Introduction -Classification-Layout with Auxiliaries-Principles of working of closed and open cycle gas turbines

**Unit-III**

***HydroElectricPowerPlant:***WaterPower-Hydrologicalcycle,flowmeasurement-drainageareaCharacteristics-Hydrographs-storageandpondage-classificationof damsandspillways

**Unit-IV**

***NuclearPowerStation:***Nuclearfuel-breedingandfertilematerials-Nuclearreactor- reactor Operation- Pressurized water reactor, boiling water reactor, sodium-graphite reactor,fastbreederreactor,homogeneousreactor,gas-cooledreactor.
Radiation hazards and shielding -radioactive waste disposal.

**Unit-V**

***Power Plant Economics and Environmental Considerations:*** Capital cost,investment offixedcharges,operatingcosts,generalarrangementofpowerdistribution,Load curves,averageloadandloadfactor,deliveryfactor-relatedexercisesEffluentsfrom powerplantsandimpactonenvironment-PollutantsandPollutionStandards-Methods of pollution control

**Suggested Reading:**


1.Rajput,RK,*ATextBookof'PowerPlantEngineering*,3rdEdition.LaxmiPublications,New Delhi.

2.AroraSC,DomukundwarS,*ACourseinPowerPlantEngineering,*DhanpatRai&Sons,New Delhi.

3. Yadav R, *Steam & Gas Turbines and Power Plant Engineering,* 7th Edition, Central Publishing House, Allahabad,2007.

4.NagPK,*PowerPlantEngineering,*2ndEdition,TataMcGrawHillsCo.Ltd,New Delhi,2002.

5. WakilMM,*Power Plant Technology*,MeGrawHillPublications,Newyork,2005.

**Code: PE821ME**

## ENERGY CONSERVATION AND MANAGEMENT
## (Professional Elective-VI)

*Credits :3*

*Instruction: 3 periodsperweek* *Duration of SEE: 3hours*
*CIE:30marks* *SEE: 70marks*

**Objectives:**

1. Tolearnaboutenergyconservation.
2. Tounderstandsourcesoflossofpowerinenergyconversion.
3. TounderstandProcedureforComprehensiveEnergyConservationPlanning.
4. TounderstandIndustrialenergyconservationmethods.

**Outcomes:**

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

1. Understanddifferentformsofenergy.
2. Calculatetheamountofheatenergyavailable.
3. Understandtheindustryenergyconservationmodeling.
4. Understandmethodologyforforecastingindustrialenergysupplyanddemand.

**Unit-I**

Definition, Principles of Energy Conservation - Maximum Thermodynamic efficiency. MaximumCost-effectivenessinenergyuse.Variousformsofenergy-HeatMechanical. ElectricalenergyandChemicalenergy.Identificationofpotentialsourcesofenergylosses-Transportation, operation and conversion from one from to another.

**Unit-II:**

Heatenergyandstorage-Mediaoftransportofheatenergy-steam,oilandfluegases. Calculationofsteamquality.Calculationofamountofheatenergyavailable.Recuperators. Constructionaldetails,Selectionofmaterialstostoreheatenergy.Conceptofpower. Modesofmechanicalenergytransport-Gears,pulleys,belts,shaftsetc.,Calculationof power.Sourcesoflossofpowerinenergyconversionintoelectricity,potentialenergy(i.e., pumps).

**Unit-III**

Chemicalenergy-combustionoffuels-petrol,dieselandcoal.Lossduetoqualityoffuel, conversionintootherformofenergy-boilers,I.C.engines.Calculationrelatedtolosses. Electricalenergy-Workingprincipleofmotorsandgenerators.Calculationofefficiencyof generators. Losses during transmission and energy conversion - into mechanical energy, thermalenergy.Calculationofeffectingparameters.

**Unit-IV**

Procedure for Comprehensive Energy Conservation Planning (CECP) -Specifying targets, identifying energy in-efficient facilities. Synthesize evaluation and optimization of alternative conservation measures in view of organization costs. Flow chart of organization's functions. Collection of accountable data. Application of CECP method. An example.

**Unit-V**

Industrialenergyconservationmodeling-Methodology-Definitionofproductionsystem-Aprimarycopperproductionsystem,Modelconstruction-MathematicalProgramming.

Market penetration, Structure of energy conservation model. Data preparation - coefficientsneededinamodel,Unitproductioncostandunitenergyrequirements.Model exercise,verificationandvalidation.MethodologyforforecastingIndustrialEnergySupply andDemand.

**Suggested Reading:**


1. GottschalkC.M.,"*Industrial Energy Conservation*",JohnWiley&Sons,1996.
2. ChaturvediP.,andJoshiS.,"*StrategyforEnergyConservationinIndia*",Concept PublishingCo., NewDelhi,1997.
3. Sharna and VenkataSebhaiah, "Energy *management and conservation*".
4. Dr. Sanjeevsingh, UmeshRathore, "*Energy management*", Edition 2019.
5. Mrs.PNagaveni,Dr.AAmudha,Dr.M.SivaramkumarandMr.N.Prasanna,"*Energy management and Energyconservation*".

**Code: PE822ME**

**NON-DESTRUCTIVE TESTING**
**(Professional Elective-VI)**

*Credits :3*

*Instruction: 3 periodsperweek* *Duration of SEE: 3hours*
*CIE:30marks* *SEE: 70marks*

**Objectives:**

Student has to understand the

1. Need, basic concepts and technologies of Non-Destructive Testing(NDT)
2. Security precautions from Radiography, protection from radiation and measurement of radiation received by personnel.
3. Technologyofacousticemission(AE),theassociatedinstrumentationandapplications
4. Technologies like neutron radiography; laser induced ultrasonics, surface analysis and thermography
5. Merits and demerits of the different NDT Technologies
6. Latest research and developments in NDT

**Outcomes:**

1. The knowledge of different NDT techniques.
2. Clear understanding of liquid penetrate inspection and magnetic particle inspection.
3. The basics of Eddy Current Testing.
4. View and interpret radiographs, utilize the various principles of radiography for different components of different shapes
5. TheknowledgeofacousticemissionforNDTandtheinstrumentationusedforNDT
6. The knowledge of latest research, developments and trends in NDT

**Unit-I**

***Liquid Penetrate inspection:*** Principle of penetrate inspection, characteristics of a penetrate, water washable system, post emulsification system, solvent removable system, surface preparation and cleaning, penetrate application, development, advantages, limitations, andapplications.

***Magnetic Particle Inspection:*** Principle, magnetization methods, continuous and residual methods, sensitivities, demagnetization, Advantages, Limitations, and Applications.

**Unit**-II:

***EddyCurrentTesting:***Principle,lift-offfactor,andedgeeffect,skineffect,inspection frequency,coilarrangements,inspectionprobes,typesofcircuits,referencepieces,phase analysis,displaymethodsandapplications

**Unit-III**

***UltrasonicTesting:***Generationofultrasound,Characteristicsofanultrasonicbeam, sound waves at interfaces, sound attenuation, display systems, probe construction,type of display, inspection techniques, identification of defects, immersion testing, sensitivity and calibration. Reference standards, surface conditions, applications

**Unit-IV**

***Radiography:***Principleandusesofradiography,limitationprinciple,radiationsources, production of X-rays, X-ray spectra, attenuation of radiation, shadow formation enlargement and distortion, radiographic film and paper, inspection of simple and complexshapes,radiationhazard,protectionagainstradiation.

**Unit-V**

***Acoustic Emission:*** physical principles, sources of emission, instrumentation and applications.

***OtherNDTTechniques:***Neuronradiography,laserinducedultrasonics,surfaceanalysis, andthermography.

**Suggested Reading:**


1. Barry Hull & Vernon John, '*Non-Destructive Testing*' , 1988.
2. Non-Destructive examination and quality control, ASM International, Vol.17, 9th edition 1989
3. J. Prasad and C.G.K. Nair, Non-Destructive Test and evaluation of materials, Tata McGraw-Hill Education, 2nd edition 2011
4. B.Raj,T.JayakumarandM.Thavasimuth,PracticalNon-DestructiveTesting,Alpha Science International Limited, 3rd edition 2002
5. T.Rangachari,J.PrasadandB.N.S.Murthy,TreatiseonNon-DestructiveTestingand Evaluation,Navbharathenterprises,Vol.3,1983.

**Code: PE823ME**

**ENTREPRENEURSHIP DEVELOPMENT**
**(Professional Elective-VI)**

*Credits :3*

*Instruction: 3 periodsperweek* *Duration of SEE: 3hours*
*CIE:30marks* *SEE: 70marks*

**Objectives:**

1. Tomotivatestudentstotakeupentrepreneurshipinfuture.
2. Tolearnnuancesofstartinganenterprise&projectmanagement.
3. Tounderstandthedesignprinciplesofsolarenergysystems,theirutilizationand performanceevaluation.
4. Tounderstandthebehavioralaspectsofentrepreneursandtimemanagement.

**Outcomes:**

1. UnderstandIndianIndustrialEnvironment,EntrepreneurshipandEconomic growth,SmallandLargeScaleIndustries,Typesandformsofenterprises.
2. Identifythecharacteristicsofentrepreneurs,Emergenceoffirstgeneration entrepreneurs,Conceptionandevaluationofideasandtheirsources.
3. Practicetheprinciplesofprojectformulation,Analysisofmarketdemand,Financialandpr ofitabilityanalysisandTechnicalanalysis.
4. ApplytheconceptsofProjectManagementduringconstructionphase,projectorganizatio n,projectplanningandcontrolusingCPM,PERTtechniques.
5. Understandthebehaviouralaspectsofentrepreneurs,TimeManagement,Various approachesoftimemanagement,theirstrengthsandweakness.Theurgency addictionandtimemanagementmatrix.

**Unit-I**

Indian Industrial Environment-competence, Opportunities and Challenges. EntrepreneurshipandEconomicgrowth.SmallScaleIndustryinIndia,Objectives,Linkage amongsmall,mediumandheavyindustries.Typesofenterprises.

**Unit-II:**

Identification and characteristics of entrepreneurs. Emergence of First generation entrepreneurs, environmental influence and women entrepreneurs. Conception and evaluationofideasandtheirsources.ChoiceofTechnology-Collaborativeinteractionfor Technologydevelopment.

**Unit-III**

Projectformulation,Analysisofmarketdemand,Financialandprofitabilityanalysisand Technicalanalysis,projectfinancinginIndia.

**Unit-IV**

ProjectManagementduringconstructionphase,projectorganization,projectplanningand controlusingCPM,PERTtechniques.Humanaspectsofprojectmanagement.Assessment of taxburden.

**Unit-V**

Behavioural aspects of entrepreneurs: Personality - determinants, attributes and models. Leadership concepts and models. Values and attitudes. Motivation aspects. Change behaviour. Time Management: Various approaches of time management, their strengths

and weaknesses. The urgency addiction and time management matrix.

**Suggested Reading:**


1. VasantDesai,"*DynamicsofEntrepreneurialDevelopmentandManagement*",Himalaya Publishing House,1997.
2. Prasanna Chandra, "*Project-Planning, Analysis, Selection, Implementation and Review*", Tata McGraw-Hill Publishing Company Ltd. 1995.
3. StephenR.CoveyandA.RogerMerrill,"*FirstThingsFirst*",SimonandSchuster Publication,1994.
4. G.S. Sudha, "*Organizational Behaviour*", 1996.
5. Robert D. Hisrich, Michael P. Peters, "*Entrepreneurship*", Tata Me Graw Hill Publishing Company Ltd., 5lh Ed., 2005.

| CourseCode | CourseTitle | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **OE801 CE** | *ROADSAFETYENGINEERING* | | | | | | **Open Elective-III** |
| Prerequisite | ContactHoursper Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**CourseObjectives:**

- Introductiontovariousfactorsconsideredforroadsafetyandmanagement
- Explainthe roadsafetyappurtenancesanddesignelements
- Discussthevarious trafficmanagementtechniques

**CourseOutcomes:**

Aftercompletingthis course,the studentwillbe ableto

1. Understandthe fundamentalsoftraffic safetyanalysis
2. AnalyzeAccidentdata
3. Rememberthe conceptsofroad safetyin urban transport
4. Applycrashreduction techniques
5. DesignofurbanInfrastructureconsideringsafetyaspects.

**UNIT – I**

***Introduction:***

RoadSafetyscenarioinIndiaandWorld,RoadAccidentCharacteristics.

***Traffic Safety Analysis:*** Fundamentals of Traffic Engineering **-** Basic Characteristics of Motor-Vehicle Traffic,Highway Capacity, Applications of Traffic ControlDevices, Design of Parking Facilities, Traffic EngineeringStudies;StatisticalMethodsinTrafficSafetyAnalysis– RegressionMethods,PoissonDistribution,Chi-Squared Distribution,StatisticalComparisons.

**UNIT – II**

***Accident Analysis:*** Accident Investigations and Risk Management, Collection and Analysis of Accident Data,Condition and Collision Diagram, Causes and Remedies, Traffic Management Measures and Their Influence onAccident Prevention, Assessment of Road Safety, Methods to Identify and Prioritize Hazardous Locations andElements,DeterminePossibleCausesofCrashes,CrashReduction CapabilitiesandCountermeasures,Effectiveness ofSafetyDesignFeatures,AccidentReconstruction. Applicationofcomputeranalysisofaccidentdata.

**UNIT – III**

***RoadSafetyinplanningandGeometricDesign:***VehicleAndHumanCharacteristics,RoadDesignandRoadEquipment‘s,RedesigningJunctions,CrossSection Improvements,ReconstructionandRehabilitationofRoads, RoadMaintenance,TrafficControl,VehicleDesignandProtectiveDevices,PostAccidentCare.

**UNIT – IV**

***TrafficSignals&Roadsigns*:**TrafficSignals,Factorsaffectingsignaldesign,stre etlighting,ProvisionsforNMTVehiclesinIndia, SafetyProvisionsfor Pedestrians&Cyclists, Road SignsandPavementMarkings.

**SafetyatConstructionSite:**Safetyprovisionsfor workersatconstructionsite,ConstructionZone markings,signs.

**UNIT – V**

***TrafficManagementsafetyaudit:***TrafficManagementSystemsforSafety,Roa dSafetyAuditsandToolsforSafetyManagementSystems, RoadSafety Audit Process,ApproachtoSafety,RoadSafetyImprovementStrategies,ITSandSafety.

*SuggestedReadings:*

1. Kadiyali L.R,. *TrafficEngineeringandTransportplanning*,9thEdition,KhannaTech Publishers,2013.
2. C.E.G.Justo, A. VeeraragavanandS. K.Khanna,*HighwayEngineering*,10th Edition, NemChandPublishers,2017.
3. DonaldDrew,*TrafficFlow TheoryChapter 14 inDifferential EquationModels*, Springer, 1983
4. C. Jotinkhisty and B. Kent Lall, *Transportation Engineering – An Introduction, 3rd Edition,Pearsonpublications, 2017*
5. RuneElvik, AlenaHoye,TrulsVaa,Michael Sorenson,*Handbookof RoadSafety measures,secondEdition,EmeraldPublishing,2009.*
6. HighwayResearch Programme(NCHRP) Synthesis336.*A synthesisofHighwayResearch Board, WashingtonD.C,2016*.

| CourseCode | CourseTitle | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **OE801CS** | *FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING* | | | | | | **Open Elective-III** |
| Prerequisite | ContactHoursper Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**CourseObjectives:**

- Cover various paradigms that come under the broad umbrella of AI.
- To understand various key paradigms for machine learning approaches
- To familiarize with the mathematical and statistical techniques used in machine learning.
- To understand and differentiate among various machine learning techniques

**CourseOutcomes:**

Aftercompletingthis course,the studentwillbe ableto

1. Develop an understanding of modern concepts in AI and where they can be used
2. Design, implement and apply novel AI techniques based on emerging real-world requirements
3. To formulate a machine learning problem
4. Select an appropriate pattern analysis tool for analyzing data in a given feature space.
5. Apply pattern recognition and machine learning techniques such as classification and feature selection to practical applications and detect patterns in the data.
6. Design and program efficient algorithms related to recent machine learning techniques, train models, conduct experiments, and develop real-world ML-based applications and products

**UNIT**-I:

INTRODUCTION: Definitions of Artificial Intelligence, Artificial Intelligence Problems, Topics of Artificial Intelligence, Timelines of Artificial Intelligence, Production Systems, State Space Representation, Branches of Artificial Intelligence, Applications of Artificial Intelligence,

**UNIT-II:**

HEURISTIC SEARCH TECHNIQUES: Generate-and-Test , Hill Climbing, Search Techniques, Problem Reduction, Constraints Satisfaction, Means-ends Analysis

KNOWLEDGE REPRESENTATION: Knowledge Management, Types of Knowledge, Knowledge Representation, Approaches to Knowledge Representation, Issues in Knowledge Representation, Knowledge Base

**UNIT-III:**

LEARNING: Types of Learning, Machine Learning, Intelligent Agents

CLUSTERING: k-Means Clustering, Fuzzy Clustering, Hierarchical Clustering, Cluster Similarity, Case Studies,

**UNIT-IV:**

STATISTICAL LEARNING: Hidden Markov Models, Linear Classifiers, Quadratic Classifiers, Decision Trees, Bayesian Networks, Case Studies,

ARTIFICIAL NEURAL NETS: ANN Basics, ANN—Learning Process, Types of Networks, Perceptron, RBF Networks, ANN Summary, Case Studies

**UNIT-V:**

SUPERVISED LEARNING: Support Vector Machines, Inductive Logic Programming, Case-based Reasoning, Ensemble Classifiers, Nearest Neighbourhood, Fuzzy Network, Case Studies,

UNSUPERVISED LEARNING: Expectation Maximization, Self organizing maps, Adaptive resonance theory, Case studies

**Suggested Readings:**

1. Vinod Chandra S.S and AnandHareendran S , “Artificila Intelligence and Machine Learning ”, PHI , 2014
2. PrashantKikani, “Demystifying Artificial intelligence: Simplified AI and Machine Learning concepts for Everyone”, January 2021, BPB publication
3. Dr. Nilakshi Jain , “Artificial Intelligence, As per AICTE: Making a System Intelligent” January 2019, WILEY India
4. LavikaGoel , “Artificial Intelligence: Concepts and Applications” January 2021, WILEY India

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **OE801EE** | **SMART BUILDING SYSTEMS** | | | | | | **OE -III** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| | **3** | **-** | | **-** | **30** | **70** | **3** |

**Course Objectives:**

- To understand the basic blocks of Building Management System.
- To design various sub systems (or modular system) of building automation
- To integrate all the sub systems

**Course Outcomes:**

Student will be able to

- Describe the basic blocks and systems for building automation
- Use different subsystems for building automation and integrate them
- Understand basic blocks and systems for building automation
- Design different systems for building automation and integrate those systems

UNIT – I

**Introduction:** Concept and application of Building Management System (BMS) and Automation, requirements and design considerations and its effect on functional efficiency of building automation system, architecture and components of BMS.

UNIT – II

**Fire Alarm (FA) System**: concept of fire, Fire modes, History, Components, and Principles of Operation. Different fire sensors, smoke detectors and their types, Fire control panels, design considerations for the FA system. Field Components, Panel Components, Applications. Types of FAS Architectures, Examples. Classification of FAS loops, Examples. FAS Design procedure in brief, NFPA 72A, BS 5839, IS, Concept of IP enabled fire & alarm system, design aspects and components of PA system.

UNIT – III

**Access Control System:** Access Components, Access control system Design.

**CCTV:** Camera Operation & types, Camera Selection Criteria, Camera Applications, DVR Based system, DVM, Network design, Storage design. Components of CCTV system like cameras, types of lenses, typical types of cables, controlling system. CCTV Applications.

UNIT – IV

**Security Systems Fundamentals:** Introduction to Security Systems, Concepts.

**Perimeter Intrusion:** Concept, Components, Technology, Advanced Applications. Security system design for verticals. concept of automation in access control system for safety, Physical security system with components, RFID enabled access control with components, Computer system access control –DAC, MAC, RBAC.

**EPBX System & BMS subsystem integration:** Design consideration of EPBX system and its components, integration of all the above systems to design BMS.

UNIT – V

**Energy Management:** Energy Savings concept & methods, Lighting control, Building Efficiency improvement, Green Building (LEED) Concept & Examples.

**Building Management System:** IBMS (HVAC, Fire &Securi-ty) project cycle, Project steps BMS, Advantages & Applications of BMS, IBMS Architecture, Normal & Emergency operation, Advantages of BMS.

Suggested Readings:

1. Jim Sinopoli, *Smart Buildings,* Butterworth-Heinemann imprint of Elsevier,2nd ed., 2010.
2. Reinhold A. Carlson, Robert A. Di Giandomenico, *Understanding Building Automation Systems (Direct Digital Control, Energy Management, Life Safety, Security, Access Control, Lighting, Building Management Programs),* R.S. Means Company Publishing, 1991.
3. Albert Ting-Pat So, WaiLok Chan, Kluwer, *Intelligent Building Systems,* Academic publisher,3rd ed., 2012.
4. Robert Gagnon, *Design of Special Hazards and Fire Alarm Systems*, Thomson Delmar Learning; 2nd edition, 2007.
5. Levenhagen, John I.Spethmann, Donald H, *HVAC Controls and Systems*, McGraw-Hill Pub.
6. Hordeski, Michael F, *HVAC Control in the New Millennium*, Fairmont press, 2001.
7. Bela G. Liptak, *Process Control-Instrument Engineers Handbook*, Chilton book co.

| Course Code | CourseTitle | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **OE 802EE** | **PROGRAMMABLELOGICCONTROLLERS** | | | | | | **Open Elective-III** |
| Prerequisite | ContactHoursperWeek | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**CourseObjectives**

- TobeabletounderstandbasicsofProgrammablelogiccontrollers,basicprogrammingofPLC.
- TomakethestudentstounderstandtheFunctionsandapplicationsofPLC

**CourseOutcomes**

At theendofthe coursestudentswill beableto

1. DevelopPLCprogramsforindustrial applications.
2. AcquiretheknowledgeofPLCcounterfunctionsandPLCArithmeticfunctionsanddatahandlingfunctions.

*UNIT-I*

**PLC Basics:** Definition and History of PLC - PLC advantages and disadvantages - Over all PLC Systems - CPUsand Programmer Monitors - PLC input and output models - Printing PLC Information- Programming Procedures -Programming Equipment - Programming Formats- Proper Construction of PLC Diagrams - Devices to which PLCinput and output modules are connected - Input on/off switching devices - Input analog devices - Output analogon/offdevicesand outputanalogdevices.

*UNIT-II*

**Basic PLC Programming:** Programming on/off inputs to produce on/off outputs - PLC input instructions -Outputs - Operational procedures - Contact and coil input/output programming examples - Relation of digital gatelogic contact / coil logic - PLC programming and conversion examples - Creating ladder diagrams from processcontroldescriptions- Sequencelistings-Large process ladderdiagramconstructions.

*UNIT-III*

**Basic PLC Functions:** General Characteristics of Registers - Module addressing - Holding registers - Inputregisters - output registers - PLC timer functions - examples of timer functions. Industrial applications - PLCcounterfunctions.

*UNIT-IV*

**Intermediate Functions:** PLC Arithmetic functions - PLC additions and subtractions - The PLC repetitive clock -PLC Multiplications, Division and Square Root - PLC trigonometric and log functions - Other PLC arithmeticfunctions - PLC number comparison functions. PLC basic

comparison functions and applications - Numberingsystems and number conversion functions - PLC conversion between decimal and BCD-Hexadecimals numberingsystems.

*UNIT-V*

**Data Handling Functions:** The PLC skip and master control relay functions - Jump functions - Jump with nonreturn - Jump with return. PLC data move Systems - The PLC functions and applications. PLC functions workingwithbits-PLCdigital bitfunctionsand applications-PLCsequencefunctions-PLCmatrix functions.

*SuggestedReading:*

1. John W. Weff, Ronald A. Reis, Programmable Logic Controllers, Prentice Hall of India Private Limited, Fifthedition,2003.
2. FrankD.Petruzella,*Programmable LogicControllers*,5th Edition,Mc-GrawHill,2019.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **OE 801 EC** | **PRINCIPLES OF ELECTRONIC COMMUNICATIONS** | | | | | | **Open Elective-III** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | **Credits** |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- Provide an introduction to fundamental concepts in the understanding of communicationssystems.
- Provide an introduction to network model and some of the network layers including physical layer, data link layer, network layer and transportlayer.
- Provide an introduction to the evolution of wireless systems and current wirelesstechnologies.

**Course Outcomes**

1. Understand the working of analog and digital communicationsystems
2. Understand the OSI network model and the working of datatransmission
3. Understand the evolution of communication technologies from traditional telephony systems to modern wireless communicationsystems.

**UNIT – I**

**Introduction to communication systems:** Electromagnetic Frequency Spectrum, Signal and its representation, Elements of Electronic Communications System, Types of Communication Channels.

**Signal Transmission Concepts:** Baseband transmission and Broadband transmission,

**Communication Parameters:** Transmitted power, Channel bandwidth and Noise, Need for modulation **Signal Radiation and Propagation:** Principle of electromagnetic radiation, Types of Antennas, Antenna Parameters and Mechanisms of Propagation.

**UNIT – II**

**Analog and Digital Communications:** Amplitude modulation and demodulation, FM modulation and demodulation, Digital converters, Digital modulation schemes – ASK, FSK, PSK, QPSK, Digital demodulation.

**UNIT – III**

**Data Communication and Networking:** Network Models, OSI Model, Data Link Layer – Media Access control, Ethernet, Network Layer – Internet Protocol (IPv4/IPv6), Transport Layer – TCP, UDP.

**UNIT – IV**

**Telecommunication Systems:** Telephones, Telephone system, Paging systems, Internet Telephony.

**Optical Communications:** Optical Principles, Optical Communication Systems, Fiber –Optic Cables, Optical Transmitters & Receivers, Wavelength Division Multiplexing.

**UNIT – V**

**Wireless Communications:** Evolution of Wireless Systems: AMPS, GSM, CDMA, WCDMA, OFDM. Current Wireless Technologies: Wireless LAN, Bluetooth, PAN and ZigBee, Infrared wireless, RFID communication, UWB, Wireless mesh networks, Vehicular adhoc networks.

**Suggested Readings:**

1. *Principles of Electronic Communication Systems*, Louis E. Frenzel, 3e, McGraw Hill,2008.
2. *Data Communications and Networking,* Behrouz A. Forouzan, 5e TMH,2012.
3. Kennady, Davis, *Electronic Communications systems*, 4e, McGraw Hill,1999.

| CourseCode | CourseTitle | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **OE 801 IT** | *SOFTWAREENGINEERING* | | | | | | **Open Elective-III** |
| Prerequisite | ContactHoursper Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**CourseObjectives:**

- Tointroducethebasicconceptsofsoftwaredevelopmentprocessesfromdefiningaproductto shippingandmaintaining.
- Toimpartknowledgeonvariousphases,methodologiesandpracticesofsoftwaredevelopment.
- Tounderstandtheimportanceoftestinginsoftwaredevelopment,studyvarioustestingstrategiesalongwithitsrelationshipwithsoftware qualityandmetrics.

**CourseOutcomes:**

Aftercompletingthis course,the studentwillbe ableto

1. Acquired working knowledge of alternative approaches and techniques for each phase ofsoftwaredevelopment
2. Judgeanappropriateprocessmodel(s)assessingsoftwareprojectattributesandanalyze necessaryrequirements forproject developmenteventuallycomposingSRS.
3. Creationofvisualmodelstodescribe(non-)algorithmicsolutionsforprojectsusing variousdesignprinciples.
4. Acquireskillsnecessaryasanindependentoraspart ofateamfor architectinga completesoftwareprojectbyidentifyingsolutionsforrecurringproblems exertingknowledgeon patterns.

**UNIT – I**

***IntroductiontoSoftwareEngineering:***

***A generic view of Process:*** Software Engineering, Process Framework, CMM Process Patterns,ProcessAssessment.

***ProcessModels:***PrescriptiveModels,WaterfallModel,IncrementalProcessModels,Evolutionary Process Models, Specialized Process Models, The Unified Models, Personal andTeamProcess Models, Process Technology, Product andProcess.

***AnAgileviewofProcess:***IntroductiontoAgilityandAgileProcess,AgileProcessModels

**UNIT – II**

***SoftwareEngineeringPrinciples:***SEPrinciples,CommunicationPrinciples,PlanningPrinciples,ModelingPrinciples, Construction Principles, Deployment.

***System Engineering:*** Computer-based Systems, The System Engineering Hierarchy, BusinessProcessEngineering, Product Engineering,

SystemModeling.

***Requirements Engineering:*** A Bridge to Design and Construction, Requirements EngineeringTasks, Initiating Requirements Engineering Process, Eliciting Requirements, Developing Use-Cases, BuildingtheAnalysisModel, NegotiatingRequirements,ValidatingRequirements.

**UNIT – III**

***Building the Analysis Model:*** Requirements Analysis Modeling Approaches, Data ModelingConcepts, Object-Oriented Analysis, Scenario-based Modeling, Flow-oriented Modeling, Class-basedModeling, CreatingaBehavioral Model.

***Design Engineering:*** Design within the context of SE, Design Process and Design Quality,DesignConcepts, TheDesign Model,Pattern-based Software Design.

**UNIT– IV**

***Creating an Architectural Design:*** Software Architecture, Data Design, Architectural Styles andPatterns,Architectural Design.***ModelingComponent-LevelDesign:***DefinitionofComponent,DesigningClass-basedComponents,ConductingComponent-levelDesign,ObjectConstraintLanguage,DesigningConventionalComponents. ***PerformingUserInterfaceDesign:***TheGoldenRules,UserInterfaceAnalysisand Design,InterfaceAnalysis, InterfaceDesignSteps,Design Evaluation.

**UNIT – V**

***Testing: Strategies:*** A Strategic Approach to Conventional Software Testing, Test Strategies forO-OSoftware.

***Tactics:*** Software Testing Fundamentals, Black-box and White-box Testing, Basis Path Testing,ControlStructureTesting, O-O TestingMethods.

***Debugging:***DebuggingTechniques,TheArtof Debugging.

***ProductMetrics:***AFrameworkforProductMetrics,Metricsforeachphaseofsoftwaredevelopment.

***SoftwareQuality:***Definition,***QualityAssurance:***BasicElements,FormalApproaches,Statistical Software Quality Assurance, Software Reliability, ISO9000 Quality Standards, SQAPlan.

*SuggestedReadings:*

1. RogerS.Pressman,*SoftwareEngineering:APractitioner'sApproach*,7th Edition,McGraw Hill, 2009
2. AliBehforoozandFrederickJ.Hudson,*SoftwareEngineeringFundamentals*,Oxford UniversityPress, 1996
3. PankajJalote,*AnIntegratedApproachtoSoftwareEngineering*,3rd Edition,NarosaPublishingHouse, 2008

| CourseCode | CourseTitle | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **OE 801 ME** | *3DPRINTING TECHNOLOGIES* | | | | | | **Open Elective-III** |
| Prerequisite | ContactHoursper Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**CourseObjectives:**

- Tounderstandthefundamentalconceptsof3DPrinting,itsadvantagesandlimitations.
- Toknowtheworkingprinciple,advantages,disadvantagesandapplicationsofliquid,solidandPowderbased3DPrintingTechnologies.
- Toknowdiversifiedapplicationsof3DPrintingTechnologies.

**CourseOutcomes:**

Aftercompletingthis course,the studentwillbe ableto

1. Interpretthefeaturesof3DPrintingandcompareitwithconventionalmethods.
2. Illustratetheworkingprincipleofliquid,solidandpowder-based3DPrintingTechnologies.
3. Applytheknowledgeofvarious3DPrintingtechnologiesfordevelopingInnovativeapplications.

*Unit-I*

Introduction:Prototypingfundamentals,Historicaldevelopment,Fundamentalsof3DPrinting, Advantages and Limitations of 3D Printing, commonly used Terms, 3D PrintingProcess Chain, 3D Modeling, Data conversion and Transmission, Checking and Preparing,Building,Post-processing,RPDataformats,Classificationof3Dprintingprocesses,Fundamental AutomatedProcesses,Distinctionbetween3DPrintingandConventionalMachiningProcesses.

*Unit-II*

Liquid-basedSystems:StereoLithographyApparatus(SLA):Modelsandspecifications,Process,workingprinciple,photopolymers,photopolymerization,Layeringtechnology,laser and laser scanning, Applications, Advantages and Disadvantages, Case studies. Polyjet:Modelsandspecifications,Process,workingprinciple,Applications,AdvantagesandDisadvantages, Case studies. Solid ground curing (SGC): Models and specifications, Process,workingprinciple, Applications, AdvantagesandDisadvantages, Casestudies.

*Unit-III*

Solid-based System: Laminated Object Manufacturing (LOM): Models and specifications,Process,workingprinciple,Applications,AdvantagesandDisadvantages,Casestudies.Fused Deposition Modeling (FDM): Models and specifications, Process, working principle,Applications,AdvantagesandDisadvantages,Casestudies.Multi-JetModelling(MJM):Modelsandspecifications,Process,Workingprinciple,Applications,AdvantagesandDisadvantages, Case studies.

*Unit-IV*

Powder Based Systems: Selective laser sintering (SLS): Models and specifications, Process,workingprinciple,Applications,AdvantagesandDisadvantages,Casestudies.Three-dimensionalPrinting(3DP):Modelsandspecifications,Process,workingprinciple, Applications, Advantages and Disadvantages, Case studies. Laser Engineered Net Shaping(LENS): Modelsand specifications,Process, working principle,Applications,AdvantagesandDisadvantages,Case studies.

*Unit-V*

Applications of 3D Printing : Application in Design, Application in Engineering, Analysis andPlanning, Aerospace Industry, Automotive Industry, Electronic Industry, Jewelry Industry,Coin Industry, GIS application, Arts and Architecture, Pattern for investment and vacuumcasting,MedicalModelsandBioengineeringApplications:Planningandsimulationofcomplexsurgery,CustomizedImplants&Prosthesis,DesignandProductionofMedicalDevices,ForensicScienceandAnthropology,andWebBasedRapidPrototypingSystems.

*SuggestedReading:*

1. Chee Kai Chua and Kah Fai Leong, “3D Printing and Additive Manufacturing PrinciplesandApplications”FifthEdition,Worldscientific
2. Ian Gibson, David W Rosen, Brent Stucker, “Additive Manufacturing Technologies: 3DPrinting, Rapid Prototyping, and Direct Digital Manufacturing” Springer, Second Edition,2010.
3. Frank W.Liou, “Rapid Prototyping & Engineering Applications”- CRC Press, Taylor &FrancisGroup,2011.
4. Rafiq Noorani, “Rapid Prototyping: Principles and Applications in Manufacturing”, JohnWiley& Sons,2006.

| CourseCode | CourseTitle | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **OE 801 AE** | *ELEMENTS OF ELECTRIC AND HYBRID VEHICLE TECHNOLOGY* | | | | | | **Open Elective-III** |
| Prerequisite | ContactHoursper Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**CourseObjectives:**

- To understand the hybrid vehicle technology
- To know the energy storage requirements and analyze the hybridization of different storage devices.
- To understand the configuration of various electric propulsion units.
- To know the different hybrid drives and the concept of electric drive trains.

**CourseOutcomes:**

Aftercompletingthis course,the studentwillbe ableto

1. Explain the basics of electric and hybrid electric vehicles, their architecture, technologies and fundamentals.
2. Discuss different energy storage technologies used for hybrid electric vehicles and their control.
3. Analyze various electric drives suitable for hybrid electric vehicles.
4. Explain plug – in hybrid electric vehicle architecture, design and component sizing and the power electronics devices used in hybrid electric vehicles.
5. Demonstrate different configurations of electric vehicles and its components, hybrid vehicle configuration by different techniques, sizing of components and design optimization and energy management.

**Unit - I**

**Introduction:** Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy suppliesElectric vehicles; configuration of EVs, performance, traction motor characteristics, tractive effort and transmission requirements.

**Unit- II**

**Energy Storage**: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices.

**Unit - III**

**Electric Propulsion unit**: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives

**Unit - IV**

**Hybrid Drives:** Introduction, features, functional classification, start/stop system, mild hybrid, full hybrid, plug-in-hybrid, batteries for hybrid vehicles, and optimization of hybrid configurations. Changing modes for conductive charging.

**Unit - V**

**Hybrid Electric Vehicles (HEVs) And Drive Structures**: Concept of electric drive train, architecture of hybrid electric drive train, series hybrid drive, parallel hybrid electrical drive train.

**Electric and Hybrid Vehicles - Case Studies:** Honda Insight, Chevrolet Volt, GM EV1, Toyota RAV 4 EV and Ford; Think City

**Suggested Reading**

1. Iqbal Husain, "Electic and Hybrid vehicles Design Fundamentals" , CRC Press, second edition 2013
2. James Larminie, John Lowry, "Electric vehicle techonology Explained" 2nd Ed.,Wiley 2012
3. Vehicular Electrical Power Systems – Emadi, Ehasni, Mercel (Marcel Dekker)
4. Electric and Hybrid vehicles – Pistoia (Elsevier)
5. Fuel cells principles and applications - B.Vishwanath, M. AuliceScibion (University Press)
6. Electrical vehicle machine and drives – K.T.Chau (Wiley).

**Code: PW703ME**

**PROJECT-II**
**(Project Work-II)**
*Credits: 3*

*Instruction: 6 periodsperweek* *Duration of SEE:--*
*CIE: 50marks* *SEE: 70marks*

**Objectives:**

1. To enhance practical and professional skills.
2. To familiarize tools and techniques of systematic literature survey and documentation
3. To expose the students to industry practices and team work.
4. Toencouragestudentstoworkwithinnovativeandentrepreneurialideas

**Outcomes:**

1. Demonstratetheabilitytosynthesizeandapplytheknowledgeandskillsacquired in the academic program to the real-world problems.
2. Evaluate different solutions based on economic and technical feasibility
3. Effectively plan a project and confidently perform all aspects of project management
4. Demonstrate effective written and oral communication skills

TheaimofProjectwork–IIistoimplementandevaluatetheproposalmadeaspartof ProjectWork-I.Studentscanalsobeencouragedtodofulltimeinternshipaspartof projectwork-IIbasedonthecommonguidelinesforallthedepartments.Thestudents placedininternshipsneedtowritethenewproposalinconsultationwithindustry coordinatorandprojectguidewithintwoweeksfromthecommencementofinstruction.

The department will appoint a project coordinator who will coordinate the following:

1. Re-groupingofstudents-deletionofinternshipcandidatesfromgroups madeaspartofprojectWork-I
2. Re-Allotmentofinternshipstudentstoprojectguides
3. Projectmonitoringatregularintervals

Allre-grouping/re-allotmenthastobecompletedbythe1st weekofVIIIsemestersothat studentsgetsufficienttimeforcompletionoftheproject.

Allprojects(internshipanddepartmental)willbemonitoredatleasttwiceinasemester throughstudentpresentationfortheawardofsessionalmarks.Sessionalmarksare awardedbyamonitoringcommitteecomprisingoffacultymembersaswellasbythe supervisor.Thefirstreviewofprojectsfor25markscanbeconductedaftercompletion offiveweeks.Thesecondreviewforanother25markscanbeconductedafter12weeks ofinstruction.

Commonnormswillbeestablishedforthefinaldocumentationoftheprojectreportby therespectivedepartments.Thestudentsarerequiredtosubmitdraftcopiesoftheir projectreportwithinoneweekaftercompletionofinstruction.

**Note:** Three periods of contact load will be assigned to each project guid