B.E. AUTOMOBILE ENGINEERING SYLLABI

2018-2019

(For the regular programme students admitted during 2018-2019 and onwards)

DEPARTMENT OF AUTOMOBILE ENGINEERING

FACULTY OF ENGINEERING

Enable | Enlighten | Enrich
KARPAGAM
ACADEMY OF HIGHER EDUCATION
(Deemed to be University)
(Established Under Section 3 of UGC Act, 1956)

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POLLACHI MAIN ROAD, EACHANARI POST, COIMBATORE – 641 021.

SYLLABI

18BEAE101	MATHEMATICS - I (Calculus and Linear Algebra for Mechanical and Automobile Engineering)	Semester I 4H-4C

Instruction Hours/Week: L:3 T:1 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To develop the use of matrix algebra techniques that is needed for practical applications.
- To understand the geometrical aspects of curvature and elegant application of differential calculus.
- To apply differentiation to solve maxima and minima problems.
- To understand the concept of functions of several variables and vector identities.
- To introduce the sequence and series that is essential to many engineering applications.
- Analyse the characteristics of a linear system with Eigenvalues and Eigenvectors.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Analyse the characteristics of a linear system with Eigenvalues and Eigenvectors.
- Evaluate the functions to get the surface area and volume using multiple integral.
- Use the tool of power series for learning advanced engineering mathematics.
- Calculate grad, div and curl in Cartesian and other simple coordinate systems.
- Analyse the differential equations using power series, Taylor's series
- Analyse the differential equations using Fourier series analysis.

Course Contents:

UNIT I MATRICES

Inverse and rank of a matrix, rank – nullity theorem; system of linear equations; symmetric, skew-symmetric and orthogonal matrices; determinants; Eigenvalues and Eigenvectors; diagonalization of matrices; Cayley-Hamilton theorem, and orthogonal transformation. Simple problems using Scilab.

UNIT II CALCULUS

Evolutes and involutes; evaluation of definite and improper integrals; beta and gamma functions and their properties; applications of definite integrals to evaluate surface areas and volumes of revolutions.

UNIT III CALCULUS

Taylor's and Maclaurin theorems with remainders; indeterminate forms and L'Hospital's rule; Maxima and minima.

UNIT IV MULTIVARIABLE CALCULUS (DIFFERENTIATION)

Limit, continuity and partial derivatives, directional derivatives, total derivative; maxima, minima and saddle points; method of Lagrange multipliers; gradient, curl and divergence.

UNIT V SEQUENCES AND SERIES

Convergence of sequence and series, tests for convergence; power series, Taylor's series, series for exponential,trigonometric and logarithm functions; Fourier series: half range sine and cosine series, Parseval's theorem.

Suggested Readings:

1. Hemamalini P.T., *Engineering Mathematics*, McGraw-Hill Education (India) Pvt. Ltd., New Delhi, 2014.
2. G. B. Thomas and R. L. Finney, *Calculus and Analytic Geometry*, Pearson, 2002.
3. Erwin Kreyszig, *Advanced Engineering Mathematics*, John Wiley & Sons, 2006.
4. Veerarajan T., *Engineering Mathematics for First Year*,Tata McGraw-Hill, New Delhi, 2008.
5. Ramana B. V., *Higher Engineering Mathematics*, Tata McGraw-Hill New Delhi, 2010.
6. D. Poole, *Linear Algebra: A Modern Introduction*, Brooks/Cole, 2005.
7. N. P. Bali and Manish Goyal, *A Text Book of Engineering Mathematics*, Laxmi Publications, 2008.
8. B. S. Grewal, *Higher Engineering Mathematics*, Khanna Publishers, 2010.

18BEAE102	ELECTROMAGNETISM (Theory and Laboratory)	Semester I 7H-5C

Instruction Hours/Week: L:3 T:1 P:3 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To study the basics of electrostatics in vacuum.
- To study the fundamentals of magnetostatics.
- To inculcate the basics of properties of matter and its applications.
- To introduce the concepts of quantum mechanics.
- To impart the basic knowledge of vacuum science.
- Express the concepts of steady state diffusion and thermal conduction.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Express the concepts of steady state diffusion and thermal conduction.
- Distinguish between diamagnets, paramagnets and ferromagnets.
- Describe the basics of properties of matter and its applications.
- Explain the physical significance of wave function.
- Describe the scanning electron microscope.
- Explain the various types of vacuum pumps.

(i) THEORY

Course Contents:

UNIT I ELECTROSTATICS IN VACUUM

Calculation of electric field and electrostatic potential for a charge distribution; divergence and curl of electrostatic field; Laplace's and Poisson's equations for electrostatic potential and uniqueness of their solution and connection with steady state diffusion and thermal conduction; practical examples like Farady's cage and coffee-ring effect.

Electrostatics in a linear dielectric medium:Polarization – field of a polarized object – bound charges due to electric polarization; electric displacement; boundary conditions on displacement.

UNIT II MAGNETOSTATICS

Bio-Savart law, divergence and curl of static magnetic field; vector potential and calculating it for a given magnetic field using Stokes' theorem.

Magnetostatics in a linear magnetic medium:Magnetization – diamagnets, paramagnets, ferromagnets –field of a magnetized object – bound currents; auxiliary magnetic field $\vec{H}$; boundary conditions on $\vec{B}$ and $\vec{H}$ – magnetic susceptibility and permeability – ferromagnetism.

UNIT III PROPERTIES OF MATTER

Elasticity – three types of modulus of elasticity – basic definitions, relation connecting the moduli (derivation) – factors affecting elastic modulus and tensile strength–Poisson's ratio – torsional pendulum – bending of beams – bending moment – uniform and non-uniform bending - I-shaped girders – stress due to bending in beams.

UNIT IV QUANTUM MECHANICS

Introduction to quantum theory – black body radiation – dual nature of matter andradiation – de Broglie wavelength, uncertainty principle –Schrödinger's wave equation – time dependent and time independent equations – particle in one dimensional box – physical significance of wave function, scanning electron microscope.

UNIT V VACUUM SCIENCE

Introduction –importance of vacuum in industries – pumping speed and throughput –types of pumps – rotary vane type vacuum pump(oil sealed), diffusion pump and turbo molecular pump – measurement of high vacuum – McLeod gauge – Pirani gauge – Penning gauge.

Suggested Readings:

1. David J. Griffiths, *Introduction to Electrodynamics*, Cambridge University Press, 2017.
2. GanesanS and Baskar T, *Engineering Physics I*, GEMS Publisher, Coimbatore, 2015.
3. Ganesan S and Iyandurai N, *Applied Physics*, KKS Publishers, 2007.
4. Gaur R.K. and Gupta S.L., *Engineering Physics*, DhanpatRai Publications, 2013.
5. Halliday and Resnick, *Physics*,Wiley, 2007.
6. Wayne Saslow, *Electricity, Magnetism, and Light*, Academic Press, 2002.

(ii) LABORATORY

List of Experiments:

1. Torsional pendulum - Determination of rigidity modulus of wire and moment of inertia of disc.
2. Non-uniform bending - Determination of Young's modulus.
3. Uniform bending - Determination of Young's modulus.
4. Lee's disc - Determination of thermal conductivity of a bad conductor.
5. Potentiometer - Determination of thermo emfof a thermocouple.
6. Laser - Determination of the wavelength of the laser using grating.
7. Air wedge - Determination of thickness of a thin sheet/wire.
8. Optical fibre - Determination of Numerical Aperture and acceptance angle.
9. Ultrasonic interferometer - Determination of the velocity of sound and compressibility of liquids.
10. Determination of the band gap of a semiconductor.
11. Spectrometer - Determination of wavelength using grating.
12. Viscosity of liquids - Determination of coefficient of the viscosity of a liquid by Poiseuille's flow.

18BEAE103	BASIC ELECTRICAL ENGINEERING (Theory and Laboratory)	Semester I 6H-5C

Instruction Hours/Week: L:3 T:1 P:2 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To impart the basic knowledge about the electric circuits.
- To understand the working of electrical machines and transformers.
- To understand the working of power converters and components of low-voltage electrical installations.
- Understand the AC circuits
- Explain the working principle of electrical machines and power converters.
- Describe the single-phase and three-phase voltage source inverters.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Analyse the basic electric and magnetic circuits.
- Understand the DC circuits
- Understand the AC circuits
- Explain the working principle of electrical machines and power converters.
- Describe the single-phase and three-phase voltage source inverters.
- List the components of low-voltage electrical installations.

(i) THEORY

Course Contents:

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. Time-domain analysis of first-order RL and RC circuits.

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, RL, RC, RLC combinations (series and parallel), resonance. Three-phase balanced circuits, voltage and current relations in star and delta connections.

UNIT III ELECTRICAL MACHINES

Generation of rotating magnetic fields, construction and working of a three-phase induction motor, significance of torque-slip characteristic. Loss components and efficiency, starting and speed control of induction motor. Single-phase induction motor. Construction, working, torque-speed characteristic and speed control of separately excited DC motor. Construction and working of synchronous generators.

UNIT IV TRANSFORMERS AND POWER CONVERTERS

Magnetic materials, B-H characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto-transformer and three-phase transformer connections. Overviews of DC-DC buck and boost converters, duty ratio control. Introduction to single-phase and three-phase voltage source inverters.

UNIT V ELECTRICAL INSTALLATIONS

Components of LT switchgear: Switch Fuse Unit (SFU), MCB, ELCB, RCCB, 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 Readings:

1. V. D. Toro, *Electrical Engineering Fundamentals*, Prentice Hall India, 1989.
2. D. P. Kothari and I. J. Nagrath, *Basic Electrical Engineering*, Tata McGraw-Hill, 2010.
3. D. C. Kulshreshtha, *Basic Electrical Engineering*, McGraw-Hill, 2009.
4. L. S. Bobrow, *Fundamentals of Electrical Engineering*, Oxford University Press, 2011.
5. E. Hughes, *Electrical and Electronics Technology*, Pearson, 2010.

(ii) LABORATORY

List of Experiments:

1. Experimental verification of electrical circuit problems using Ohms law and Kirchhoff's law.
2. Measurement of electrical quantities - voltage, current, power and power factor in R load.
3. Speed control of DC shunt motor.
4. Draw the equivalent circuit of single-phase transformer by conducting OC and SC test.
5. Measurement of energy using single-phase energy meter.

18BEAE111 ENGINEERING GRAPHICS AND DESIGN **Semester I**
5H-3C

Instruction Hours/Week: L:1 T:0 P:4 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To learn conventions and use of drawing tools in making engineering drawings.
- To impart knowledge on orthographic projection.
- To draw orthographic projections of points, line and plane surfaces.
- To draw orthographic projections of solids.
- To impart the basic concepts of isometric projections through simple examples.
- Recognise the conventions and apply dimensioning concepts while drafting simple objects.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Recognise the conventions and apply dimensioning concepts while drafting simple objects.
- Draw freehand sketching of multiple views from pictorial views of objects.
- Draw the orthographic projection of points, line and plane surfaces.
- Draw the orthographic projection of solids.
- Draw the isometric projection of the given objects.
- Demonstrate knowledge of the CAD software

Course Contents:

UNIT I INTRODUCTION

Principles of Engineering Graphics and their significance – usage of drawing instruments – lettering – layout of drawing sheets – sizes of drawing sheets – different types of lines used in drawing practice – geometric constructions – principles of dimensioning – linear, angular, aligned system, unidirectional system, parallel dimensioning, chain dimensioning – location dimension and size dimension – conic sections including the ellipse, parabola and hyperbola (eccentricity method only) – cycloid, epicycloid, hypocycloid and involute – scales – plain, diagonal and vernier scales.

UNIT II ORTHOGRAPHIC PROJECTIONS

Principles of orthographic projections – need for importance of multiple views and their placement – first angle projection – layout views – developing visualization skills through freehand sketching of multiple views from pictorial views of objects.

UNIT III PROJECTION OF POINTS, LINES AND PLANE SURFACES

Projections of points and lines located in the first quadrant inclined to both planes – determination of true lengths and true inclinations – projection of polygonal surface and circular lamina inclined to both reference planes.

UNIT IV PROJECTION OF SOLIDS

Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one reference plane by change of position method.

UNIT V ISOMETRIC PROJECTIONS AND COMPUTER GRAPHICS

Principles of isometric projection – isometric scale, isometric views, conventions – isometric views of lines, planes, simple solids, truncated prisms, pyramids, cylinders and cones – conversion of isometric views to orthographic views and vice-versa.

Overview of computer graphics – listing the computer technologies that impact on graphical communication – demonstrating knowledge of the theory of CAD software – introduction to 3D modelling packages.

Suggested Readings:

1. Venugopal K and Prabhu Raja V, *Engineering Graphics*, New Age International Publishers, 2009.
2. Agrawal C M and Basant Agrawal, *Engineering Graphics*, Tata McGraw-Hill, New Delhi, 2012.
3. James DBethune, *Engineering Graphics with AutoCAD 2015*, Pearson Education, 2016.
4. NarayanaKL and Kannaiah P, *Textbook on Engineering Drawing*, Scitech Publishers, 2008.
5. Bureau of Indian Standards, *Engineering Drawing Practices for Schools and Colleges SP 46-2003*, BIS, New Delhi, 2003.
6. Shah M Band Rana BC, *Engineering Drawing and Computer Graphics*, Pearson Education, 2008.
7. Bhatt N D, Panchal V Mand Ingle P R, *Engineering Drawing*, Charotar Publishing House, 2014.

18BEAE201	MATHEMATICS - II (Calculus, Ordinary Differential Equations and Complex Variable for Mechanical and Automobile Engineering)	Semester II 4H-4C

Instruction Hours/Week: L:3 T:1 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To acquaint the student with mathematical tools needed in evaluating multiple integrals and their usage.
- To evaluate first order differential equations including separable, homogeneous, exact and linear solvable for p, x and y, Clairaut's form.
- To solve the differential equation of certain type, power series solutions of Legendre polynomials and Bessel functions of the first kind.
- To enable the students to apply the knowledge of mathematics in various engineering fields by making them identify the functions in engineering problems as analytic function and their study as a function of complex variables.
- To develop an understanding of the standard techniques of complex variable theory.
- Apply integration to compute multiple integrals, area, volume, integrals in polarand Cartesian coordinates.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Apply integration to compute multiple integrals, area, volume, integrals in polarand Cartesian coordinates.
- Analyse first order differential equations utilizing the standard techniques for separable, exact, linear, Bernoulli cases.
- Evaluate analytic functions using the Cauchy-Riemann equations.
- Solve complex integrals using the Cauchy integral formula and the residue theorem.
- Explain the fundamentals and basic concepts of vector calculus
- Explain the fundamentals and basic concepts of ODE and complex functions.

Course Contents:

UNIT I MULTIVARIABLE CALCULUS (INTEGRATION)

Multiple integration: double and triple integrals (Cartesian and polar), change of order of integration in double integrals, applications: areas and volumes, centre of mass and gravity (constant and variable densities). Theorems of Green, Gauss and Stokes, simple applications involving cubes and rectangular parallelepipeds.

UNIT II FIRST ORDER ORDINARY DIFFERENTIAL EQUATIONS

Exact, linear and Bernoulli's equations, Euler's equations, equations not of first degree:equations solvable for p, equations solvable for y, equations solvable for x and Clairaut'stype.

UNIT III ORDINARY DIFFERENTIAL EQUATIONS OF HIGHER ORDERS

Second order linear differential equations with variable coefficients, method of variation ofparameters, Cauchy-Euler equation; power series solutions; Legendre polynomials, Besselfunctions of the first kind and their properties.

UNIT IV ANALYTIC FUNCTIONS

Cauchy-Riemann equations, analytic functions, harmonic functions, findingharmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm)and their properties; Conformal mappings, Mobius transformations.

UNIT V COMPLEX INTEGRATION

Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy integral formula(without proof), zeros of analytic functions, singularities, Taylor's series, Laurent's series,Residues, Cauchy residue theorem (without proof),Evaluation of definite integral involving sine and cosine.

Suggested Readings:

1. Hemamalini P.T., *Engineering Mathematics*, McGraw-Hill Education (India) Pvt. Ltd., New Delhi, 2014.
2. G.B. Thomas and R.L. Finney, *Calculus and Analytic Geometry*, Pearson, 2002.
3. Erwin Kreyszig, *Advanced Engineering Mathematics*, John Wiley & Sons, 2006.
4. W.E. Boyce and R.C. DiPrima, *Elementary Differential Equations and Boundary Value Problems*, Wiley India, 2009.
5. S.L. Ross, *Differential Equations*, Wiley India, 1984.
6. E.A. Coddington, *An Introduction to Ordinary Differential Equations*, Prentice Hall, India, 1995.
7. E.L. Ince, *Ordinary Differential Equations*, Dover Publications, 1958.
8. J.W. Brown and R.V. Churchill, *Complex Variables and Applications*, Mc-Graw Hill, 2004.
9. N.P. Bali and Manish Goyal, *A Textbook of Engineering Mathematics*, Laxmi Publications, 2008.
10. B.S. Grewal, *Higher Engineering Mathematics*, Khanna Publishers, 2010.

18BEAE202	CHEMISTRY – I (Theory and Laboratory)	Semester II 7H-6C

Instruction Hours/Week: L:3 T:1 P:3 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To understand the terminologies of atomic and molecular structure.
- To study the basics of periodic properties andintermolecular forces.
- To study about spectroscopic technique.
- To understand the thermodynamic functions.
- To comprehend the basic organic chemistry and to synthesis simple drug.
- Distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Analyse microscopic chemistry in terms of atomic and molecular orbitals and intermolecular forces.
- Rationalise periodic properties such as ionization potential, oxidation states and electronegativity.
- Distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques.
- Rationalise bulk properties and processes using thermodynamic considerations.
- List major chemical reactions that are used in the synthesis of molecules.
- Explain the synthesis of a commonly used drug molecule

(i) THEORY

Course Contents:

UNIT I ATOMIC AND MOLECULAR STRUCTURE

Schrodinger equation. Particle in a box solutions and their applications. Equations for atomic and molecular orbitals. Energy level diagrams of diatomic molecules. Pi-molecular orbitals of butadiene and benzene and aromaticity. Introduction to crystal field theory.

UNIT II PERIODIC PROPERTIES, INTERMOLECULAR FORCES AND POTENTIAL ENERGY SURFACES

Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers. Ionic, dipolar and van der Waals interactions. Equations of state of real gases and critical phenomena.Potential energy surfaces of H_2F and HCN and trajectories on these surfaces.

UNIT III SPECTROSCOPIC TECHNIQUES AND APPLICATIONS

Spectroscopy (principles and instrumentation only), electronic spectroscopy,vibrational and rotational spectroscopy,applications,surface characterization techniques, diffraction and scattering, fluorescence and its applications in medicine.

UNIT IV USE OF FREE ENERGY IN CHEMICAL EQUILIBRIA

Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Free energy and emf. Cell potentials, the Nernst equation and applications. Acid base, oxidation, reduction and solubility equilibria. Use of free energy considerations in metallurgy through Ellingham diagrams.

UNIT V ORGANIC REACTIONS AND SYNTHESIS OF A DRUG MOLECULE

Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization and ring openings. Synthesis of a commonly used drug molecule.

Suggested Readings:

1. B. H. Mahan, *University Chemistry*, Pearson Education, 2010.
2. M. J. Sienko and R. A. Plane, *Chemistry: Principles and Applications*, McGraw-Hill International, 1979.
3. C. N. Banwell, *Fundamentals of Molecular Spectroscopy*, McGraw-Hill, 1994.
4. B. L. Tembe, Kamaluddin and M. S. Krishnan, *Engineering Chemistry* (NPTEL Web-book)
5. P. W. Atkins, *Physical Chemistry*, Oxford University Press, 2009.
6. K. P. C. Volhardt and N. E. Schore, *Organic Chemistry: Structure and Function*, W.H. Freeman, 2014.
7. P C Jain and Monica Jain, *Engineering Chemistry*, DhanpatRai Publishing Company, 2015.

(i) LABORATORY

List of Experiments:

Choice of 10 experiments from the following:

1. Determination of surface tension and viscosity.
2. Determination of sodium carbonate and sodium hydrogen carbonate in a mixture using volumetric titration.
3. Determination of Ca/Mg using complex metric titration.
4. Thin layer chromatography.
5. Determination of chloride content of water.
6. Determination of the rate constant of a reaction.
7. Conductometry - Determination of cell constant and conductance of solutions.
8. pH metry - Determination of acid/base.
9. Potentiometry - Determination of redox potentials and EMFs.
10. Saponification/acid value of oil.
11. Determination of the partition coefficient of a substance between two immiscible liquids.
12. Adsorption of acetic acid by charcoal.

13. Use of the capillary viscosimeters to demonstrate of isoelectric point as the pH of minimum viscosity for gelatin sols and/or coagulation of the white part of an egg.

19BEAE203	ENGLISH	Semester II 4H-3C

Instruction Hours/Week: L:2 T:0 P:2 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To enable students to attain fluency and accuracy to inculcate proficiency in professional communication to meet the growing demand in the field of global communication.
- To help students acquire their ability to speak effectively in real-life situations.
- To inculcate the habit of reading and to develop their effective reading skills.
- To ensure that students use a dictionary to improve their active and passive vocabulary.
- To enable students to improve their lexical, grammatical and communicative competence.
- Compose business letters and other forms of technical writing.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Usethe English language for communication: verbal and non-verbal.
- Express comprehension and acquisition of speaking and writing ability.
- Demonstrate word power: lexical, grammatical and communication competence.
- Compose business letters and other forms of technical writing.
- Demonstrate oral communication in formal contexts.
- Do the writing practice

Course Contents:

UNIT I BASIC WRITING SKILLS

Sentence structures – use of phrases and clauses in sentences – importance of proper punctuation – creating coherence – organizing principles of paragraphs in documents – techniques for writing precisely.

UNIT II VOCABULARY BUILDING

The concept of word formation – root words from foreign languages and their use in English – acquaintancewith prefixes and suffixes from foreign languages in English to form derivatives – synonyms, antonyms, and standard abbreviations.

UNIT III GRAMMAR AND USAGE

Subject-verb agreement – noun-pronoun agreement – misplaced modifiers – articles – prepositions – redundancies – clichés.

UNIT IV LISTENING AND READING SKILLS

Note taking – viewing model interviews – listening to informal conversations – improving listening/reading comprehension – reading model prose/poems – reading exercise.

UNIT V WRITING PRACTICES

Comprehension – précis writing – essay writing listening comprehension – common everyday situations: conversations and dialogues – communication at workplace – interviews – formal presentations.

Note: Students shall have hands-on training in improving listening skill in the language laboratory attwo periods per each unit.

Suggested Readings:

1. Sangeeta Sharma and Meenakshi Raman, *Technical Communication: Principles and Practice*, Oxford University Press, New Delhi, 2015.
2. Sanjay Kumar and PushpLata, *Communication Skills*, Oxford University Press, 2011.
3. Liz Hamp-Lyons and Ben Heasly, *Study Writing*, Cambridge University Press, 2006.
4. F. T. Wood, *Remedial English Grammar*, Macmillan, 2007.
5. Michael Swan, *Practical English Usage*, Oxford University Press, 1995.

19BEAE204	PROGRAMMING FOR PROBLEM SOLVING (Theory and Laboratory)	Semester II 7H-5C

Instruction Hours/Week: L:3 T:0 P:4 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To identify and understand the working of key components of a computer program.
- To identify and understand the various kinds of keywords and different data types of C programming.
- To understand, analyse and implement software development tools like algorithm, pseudo codes and programming structure.
- To study, analyse and understand the logical structure of a computer program, and different construct to develop a program in C language.
- Test and execute the programs and correct syntax and logical errors.
- Implement conditional branching, iteration and recursion.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Formulate simple algorithms for arithmetic and logical problems.
- Translate the algorithms to programs (in C language).
- Test and execute the programs and correct syntax and logical errors.
- Implement conditional branching, iteration and recursion.
- Apply programming to solve matrix addition and multiplication problems and searching and sorting problems.
- Apply programming to solve simple numerical method problems, namely root finding of function, differentiation of function and simple integration.

(i) THEORY

Course Contents:

UNIT I INTRODUCTION TO PROGRAMMING, ARITHMETIC EXPRESSIONS AND PRECEDENCE

Introduction to programming – flow chart/pseudo code, compilation, variables including data types, arithmetic expressions and precedence.

UNIT II CONDITIONAL BRANCHING AND LOOPS

Conditional branching – loops writing and evaluation of conditionals and consequent branching, iteration and loops.

UNIT III ARRAYS AND BASIC ALGORITHMS

Arrays 1-D, 2-D, character arrays and strings, basic algorithms: searching, basic sorting algorithms, finding roots of equations, idea of time complexity.

UNIT IV FUNCTION AND RECURSION

Functions (including using built-in libraries), recursion with example programs such as quick sort, Ackerman function, etc.

UNIT V STRUCTURE, POINTERS AND FILE HANDLING

Pointers, structures including self referential structures e.g., linked list, notional introduction, file handling in C.

Suggested Readings:

1. E. Balagurusamy, *Computing Fundamentals and C Programming*, Tata McGraw-Hill Education, 2017.
2. E. Balagurusamy, *Programming in ANSI C*, Tata McGraw-Hill, 2017.
3. Byron Gottfried, *Schaum's Outline of Programming with C*, McGraw-Hill, 2017.
4. Brian W. Kernighan and Dennis M. Ritchie, *The C Programming Language*, Prentice Hall of India, 2015.

(ii) LABORATORY

List of Experiments:

1. Familiarization with the programming environment.
2. Simple computational problems using arithmetic expressions.
3. Problems involving if-then-else structures.
4. Iterative problems e.g., the sum of series.
5. 1D array manipulation.
6. Matrix problems and string operations.
7. Simple functions.
8. Numerical method problems.
9. Recursive functions.
10. Pointers and structures.
11. File operations.

18BEAE205	CONSTITUTION OF INDIA	Semester II 1H-0C

Instruction Hours/Week: L:1 T:0 P:0 **Marks:** Internal:**100** External:**0** Total:**100**

Course Objectives:

- To know about the Indian constitution.
- To know about the central and state government functionalities in India.
- To know about Indian society.
- Distinguish different culture among the people.
- Describe the structure and function of state government
- Understand the centre-state relations

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Explain the functions of the Indian government.
- State and abide by the rules of the Indian constitution.
- Distinguish different culture among the people.
- Describe the structure and function of state government
- Understand the centre-state relations
- Understand the Indian social structure

Course Contents:

UNIT I INTRODUCTION

Historical background – constituent assembly of India – philosophical foundations of the Indian constitution – preamble – fundamental rights – directive principles of state policy – fundamentalduties – citizenship – constitutional remedies for citizens.

UNIT II STRUCTURE AND FUNCTION OF CENTRAL GOVERNMENT

Union government – structures of the union government and functions – president – vice president– prime Minister – cabinet – parliament – Supreme Court of India – judicial review.

UNIT III STRUCTURE AND FUNCTION OF STATE GOVERNMENT

State government – structure and functions – governor – chief minister – cabinet – statelegislature – judicial system in states – high courts and other subordinate courts.

UNIT IV CONSTITUTION FUNCTIONS

Indian federal system – centre-state relations – president's rule – constitutional amendments – constitutional functionaries – assessment of working of the parliamentary system in India.

UNIT V INDIAN SOCIETY

Society: Nature, meaning and definition – Indian social structure – caste, religion, language in India – constitutional remedies for citizens – political parties and pressure groups – rights of women,children, scheduled castes, scheduled tribes and other weaker sections.

Suggested Readings:

1. Durga Das Basu, *Introduction to the Constitution of India*, LexisNexis, 2018.
2. Agarwal R C,*Political Theory (Principles of Political Science)*, S. Chand Publishing, 2018.
3. MacIver R M and Page C H, *Society: An Introductory Analysis*, Macmillan India, 1987
4. Sharma K L, *Social Stratification in India: Issues and Themes*, Sage Publications, New Delhi, 1997.
5. Brij Kishore Sharma, *Introduction to the Constitution of India*, Prentice Hall of India, New Delhi, 2005.
6. Gahai U R, *Indian Political System*, New Academic Publishing House, New Delhi, 1998.
7. Sharma, R N, *Indian Social Problems*, Media Promoters and Publishers Pvt. Ltd., New Delhi, 1987.

19BEAE211	WORKSHOP/MANUFACTURING PRACTICE LABORATORY	Semester II 5H-3C

Instruction Hours/Week: L:1 T:0 P:4 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To provide hands-on training for the fabrication of components using carpentry and welding equipment/tools.
- To gain the skills for making fitting joints and household pipeline connections using suitable tools.
- To develop the skills for preparing the green sand mould.
- To present the skills for making the simple household electrical connection.
- To develop the skills for making wood/metal models using suitable tools.
- Prepare green sand mould using suitable tools.

Course Outcomes:

- Fabricate simple components using carpentry and welding equipment/tools.
- Make fitting joints and household pipeline connections using suitable tools.
- Prepare green sand mould using suitable tools.
- Make simple household electrical connections using suitable tools.
- Make simple models using wood and metal.
- Make simple plumbing work

(i) Lectures andVideos:

1. Manufacturing methods - casting, forming, machining, joining, advanced manufacturing methods
2. CNC machining and additive manufacturing
3. Fitting operations and power tools
4. Electrical and electronics
5. Carpentry
6. Plastic moulding and glass cutting
7. Metal casting
8. Welding (arc welding and gas welding), brazing

(ii) Workshop Practice:

1. Machine shop
2. Fitting shop
3. Carpentry
4. Electrical and electronics
5. Welding shop
6. Casting
7. Smithy

8. Plastic moulding and glass cutting
9. Plumbing exercises

Suggested Readings:

1. JeyachandranKand Balasubramanian S, *A Premier on Engineering Practices Laboratory*, Anuradha Publications, Kumbakonam, 2007.
2. JeyapoovanT and SaravanapandianM, *Engineering Practices Lab Manual*, Vikas Puplishing House Pvt. Ltd, Chennai,2006.
3. Bawa H S, *Workshop Practice*, Tata McGraw-Hill, New Delhi, 2009.
4. Hajra Choudhury SK, Hajra ChoudhuryAKand Nirjhar Roy SK Choudhry,*Elements of Workshop TechnologyVolume I*, Indian Book Distributing Company, Kolkatta, 2008.
5. Hajra Choudhury SK, Hajra ChoudhuryAKand Nirjhar Roy SK Choudhry,*Elements of Workshop TechnologyVolume II*, Indian Book Distributing Company, Kolkatta, 2010.
6. Gowri S and Jeyapoovan T, *Engineering Practices Lab Manual*, Vikas Publishing House Pvt. Ltd., Chennai, 2017.
7. Kalpakjian S and Steven S Schmid, *Manufacturing Engineering and Technology*, Pearson Education, 2001.
8. Roy A Lindberg, *Processes and Materials of Manufacture*, Prentice Hall of India, 1997.
9. Rao P N, *Manufacturing Technology Volume I and II*, Tata McGraw-Hill, 2018.

18BEAE301	MATHEMATICS - III (PDE, Probability and Statistics)	Semester III 4H-4C

Instruction Hours/Week: L:3 T:1 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To introduce the basic concepts of PDE for solving standard partial differential equations.
- To acquaint with Fourier series techniques in solving heat flow problems.
- To provide an overview of probability and statistics.
- To introduce the basic concepts of two-dimensional random variables.
- To acquaint the knowledge of testing of hypothesis for small and large samples.
- Apply the basic concepts of probability and standard distribution.
- Analyze the basic concepts of one and two-dimensional random variables and apply in engineering applications.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Apply the fundamental concepts of partial differential equations and the various solution procedures for solving the first order non-linear partial differential equations.
- Appreciate the physical significance of Fourier series techniques in solving one- and two-dimensional heat flow problems and one-dimensional wave equations.
- Apply the basic concepts of probability and standard distribution.
- Analyze the basic concepts of one and two-dimensional random variables and apply in engineering applications.
- Formulate and solve problems involving random variables and apply statistical methods for analyzing experimental data.
- Summarize the concept of testing of hypothesis for small and large samples in real-life problems.

Course Contents:

UNIT I PARTIAL DIFFERENTIAL EQUATIONS

Formation of partial differential equations – singular integrals – solutions of standard types of first-order partial differential equations – Lagrange's linear equation – linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

UNIT II APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS

Classification of PDE – method of separation of variables – solutions of one-dimensional wave equation – one-dimensional equation of heat conduction – steady state solution of two-dimensional equation of heat conduction.

UNIT III PROBABILITY AND RANDOM VARIABLES

Probability – axioms of probability – conditional probability – Baye's theorem – discrete and continuous random variables– moment generating functions – binomial, Poisson and normal distributions.

UNIT IV TWO-DIMENSIONAL RANDOM VARIABLES

Joint distributions – marginal and conditional distributions – covariance – correlation and linear regression – transformation of random variables – central limit theorem (for independent and identically distributed random variables).

UNIT V TESTING OF HYPOTHESIS

Test of significance – large sample test for single proportion, difference of proportions – tests for single mean, difference of means – test for ratio of variances – chi-square test for goodness of fit and independence of attributes.

Suggested Readings:

1. Erwin Kreyszig, *Advanced Engineering Mathematics*, John Wiley & Sons, 2006.
2. Grewal B S, *Higher Engineering Mathematics*, Khanna Publishers, New Delhi, 2014.
3. Bali N P and Manish Goyal, *A text book of Engineering Mathematics*, Laxmi Publications, 2010.
4. Ramana B V, *Higher Engineering Mathematics*, McGraw-Hill Education, New Delhi, 2016.
5. Hoel P G, Port S C and Stone C J, *Introduction to Probability Theory*, Universal Book Stall, 2003.
6. Ross S, *A First Course in Probability*, Pearson Education, 2002.

18BEAE302	ENGINEERING MECHANICS	Semester III 4H-4C

Instruction Hours/Week: L:3 T:1 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To familiarisethe basic concepts and force systems in a real-world environment.
- To impart knowledge on the equilibrium of rigid bodies.
- To learn the concept of centroid, centre of gravity and moments of inertia.
- To understand the rectilinear motion and curvilinear motion.
- To enrich the understanding ofdynamic forces exerted in rigid body
- To provide knowledge onthe friction.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Determine the resultant force and moment for a given system of forces.
- Analyse the plane trusses having different types of supports and determine the forces in each member.
- Identify the location of centroid, centre of gravity and calculate the moment of inertia for different sections.
- Apply the equations of motion of particles to calculate displacement, velocity and acceleration.
- calculate dynamic forces exerted in rigid body
- Determine the friction and its effects by using the laws of friction.

Course Contents:

UNIT I STATICS OF PARTICLES

Introduction to mechanics – units and dimensions – laws of mechanics – principle of transmissibility – Lami's theorem, parallelogram and triangular law of forces – system of forces – composition of forces– resolution of force –resultant ofa force system – free body diagram – equilibrium of a particle.

UNIT II STATICS OF RIGID BODIES IN TWO DIMENSIONS

Momentsand couples – Varignon's theorem – resultant of non-concurrent force system– equilibrium of rigid bodies in two dimensions – types of supports – action and reaction forces – frames – types of frames – analysis of perfect frames – method of joints, method of sections and method oftension coefficient.

UNIT III PROPERTIES OF SURFACES AND SOLIDS

Centroid and centre of gravity – determination of centroid of areas, volumes and mass – Pappus and Guldinus theorems – moment ofinertia – parallel axis theorem and perpendicular axis theorem –

polar moment of inertia – radius of gyration – product of inertia and principal moment of inertia – massmoment of inertia.

UNIT IV DYNAMICS OF PARTICLES

Linear motion – Relationship between displacement, velocity and acceleration – relative motion – curvilinear motion –Newton's laws of motion – work-energy equation– impulse and momentum – impact of elasticbodies.

UNIT V FRICTION AND RIGID BODY DYNAMICS

Friction force – types of friction – laws of friction – friction on horizontal and inclinedplanes, ladder, wedge frictionand rope friction –velocity andacceleration for combined motion oftranslation and rotation of rigid bodies –general plane motion.

Suggested Readings:

1. Bansal R K, *Engineering Mechanics*, Laxmi Publications, New Delhi, 2016.
2. Bhavikatti S S, *Engineering Mechanics*, New Age International, New Delhi, 2019.
3. Hibbeler R C and Ashok Gupta, *Engineering Mechanics - Statics and Dynamics*, Pearson Education, New Delhi, 2009.
4. Irving H Shames and Krishna Mohana Rao G, *Engineering Mechanics: Statics and Dynamics*, Pearson Education, 2006.
5. Meriam J L, Kraige L G and Bolton J N, *Engineering Mechanics: Statics*, John Wiley & Sons, 2018.
6. Meriam J L, Kraige L G and Bolton J N, *Engineering Mechanics: Dynamics*, John Wiley & Sons, 2016.
7. Sankarasubramanian G and Rajasekaran S,*Engineering Mechanics Statics and Dynamics*, Vikas Publishing, 2005.
8. Ferdinand P Beer,Russell Johnston Jr.,David FMazurek,Brian S and Sanjeev Sanghi, *Vector Mechanics for Engineers: Statics and Dynamics*, McGraw-Hill Education, 2017.

18BEAE303	APPLIED THERMODYNAMICS	Semester III 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To impart knowledge onthe fundamentalsof thermodynamics, zeroth law, first law and second law of thermodynamics.
- To study the thermodynamic properties of pure substances and its phase change processes.
- To learn the gas power cycles and properties of gas mixtures.
- To acquaint the student with the concepts of air standard performance of heat engines.
- To familiarise the concept of psychrometry and its applications.
- To provide knowledge on the working principle and performance of air compressors and refrigerationsystems.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Apply the first law of thermodynamics to closed and open systems.
- Solve the problems related to cycles and cyclic devices using the second law of thermodynamics.
- Determine the thermodynamic properties of pure substances and its phase change processes.
- Evaluate the air standard performance of heat engines.
- Solve the psychrometric problems in various applications.
- Calculate the performance of air compressors and refrigeration systems.

Course Contents:

UNIT I BASIC CONCEPTS AND LAWS OF THERMODYNAMICS

Basic concepts – concept of continuum – macroscopic approach – thermodynamic systems – closed, open and isolated – zeroth law of thermodynamics – first law of thermodynamics – application to closed and open systems – steady flow process with reference to various thermal equipments – second law of thermodynamics – reversibility and irreversibility – Carnot cycle – reversed Carnot cycle – thermodynamic temperature scale – Clausius inequality – concept of entropy – entropy of ideal gas – principle of increase of entropy – Carnot theorem – absolute entropy – availability.

UNIT II PROPERTIES OF PURE SUBSTANCE AND GASES

Properties of steam – pure substance – phase – phase change process – property diagrams – PVT surface – gas mixtures – properties of ideal and real gases – equation of state – Avagadro's law – Vander Waal's equation of states – compressibility and its chart – Dalton's law of partial pressure – exact differentials – T-D relations – Maxwell relations – Clausius-Clapeyron relation – Joule Thomson coefficient.

UNIT III GAS POWER CYCLES

Air standard cycles – Otto, Diesel, dual cycles – work output, efficiency and mean effective pressurecalculations –comparison of the cycles with respect to compression ratio, heat addition, heat rejection, peak pressure, temperature and work output – simple Brayton cycle.

UNIT IV PSYCHROMETRY

Psychrometry andpsychrometriccharts – propertycalculationsofairvapourmixtures –psychrometric process – sensible and latent heat exchange processes.

UNIT V RECIPROCATING AIR COMPRESSORS AND REFRIGERATION CYCLES

Single acting and double acting air compressors – work required – effect of clearance volume – volumetric efficiency – isothermal efficiency – free air delivery – two-stage compression – condition for minimum work.

Fundamentals of refrigeration – coefficient of performance – reversed Carnot cycle – simple vapour compression refrigeration system – T-S and P-H diagrams – simple vapour absorption refrigeration system– refrigerant properties.

Suggested Readings:

1. Nag P K, *Engineering Thermodynamics*, McGraw-Hill Education, 2017.
2. Rathakrishnan E, *Fundamentals of Engineering Thermodynamics*, Prentice-Hall of India, New Delhi, 2006.
3. Rajput R K, *Applied Thermodynamics*, Laxmi Publications, New Delhi, 2016.
4. Arora C P, *Thermodynamics*, Tata McGraw-Hill, New Delhi, 2003.
5. Nag P K, *Basic and Applied Thermodynamics*, Tata McGraw-Hill, New Delhi, 2009.
6. Yunus A Cengel and Michael A Boles, *Thermodynamics*, McGraw-Hill Education, New Delhi, 2015.

18BEAE304	AUTOMOTIVE ENGINES	Semester III 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To impart basic knowledge onthe construction and operation of two-stroke and four-stroke engines.
- To study various components of the fuel feed system.
- To learn the combustion process and types of combustion chambers.
- To provide knowledge onthe supercharging, turbocharging and engine testing.
- To familiarise the types of cooling and lubrication systems.
- To provide knowledge on modern engine technologies

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Differentiate the construction and operation of two-stroke and four-stroke engines.
- Name and explain various components of the fuel feed system.
- Discuss the combustion process and combustion chambers.
- List and describe the different methods of supercharging and turbocharging.
- Explain the importance of cooling system.
- Explain the importance of lubrication system.

Course Contents:

UNIT I ENGINE CONSTRUCTION AND OPERATION

Constructional details and working of four-stroke Spark Ignition (SI) and Compression Ignition (CI) engines –two-stroke engine construction and operation – comparison of four-stroke and two-stroke engines – firing order and its significance – port timing and valve timing diagram of SI and CI engines.

UNIT II FUEL FEED SYSTEM

Carburettor – working principle – requirements – starting, idling, acceleration and normal circuits – compensation – maximum power devices – constant choke and constant vacuum carburettors – fuel feed system – mechanical and electrical fuel feed pumps – jerk pumps – distributor pumps – pintle and multi-hole nozzles – unit injector – injection pump calibration – governor – need and description.

UNIT III COMBUSTION AND COMBUSTION CHAMBERS

Combustion in SI engine – stages of combustion – flame propagation – delay period – uncontrolled combustion – effect of delay period – rate of pressure rise – abnormal combustion – detonation – effect of engine variables on knock – knock rating – combustion chamber and its types – combustion in CI engines – direct and indirect injection combustion chambers for CI engines – importance of swirl, squish and turbulence – factors influencing combustion chamber design.

UNIT IV SUPERCHARGING, TURBOCHARGING AND ENGINE TESTING

Supercharging and turbocharging – different methods of turbocharging – intercooling – turbocharger controls – wastegate, variable geometry, variable nozzle types – dynamometers – indicated thermal, brake thermal and volumetric efficiencies – measurement of friction – cylinder pressure measurement – engine performance maps – engine testing standards – Morse test.

UNIT V COOLING AND LUBRICATION SYSTEMS

Cooling system – need for cooling system – air cooling system, liquid cooling system, thermosyphon cooling system, forced circulation system and pressure cooling system – lubrication system – mist, dry sump and wet sump lubrication systems – properties of lubricants.

Suggested Readings:

1. Ganesan V, *Internal Combustion Engines*, McGraw-Hill Education, New Delhi, 2012.
2. Mathur M L & Sharma R P, *A Course in Internal Combustion Engines*, Dhanpat Rai & Sons, New Delhi, 2001.
3. Heinz Heisler, *Advanced Engine Technology*, Butterworth-Heinemann, 2005.
4. John B Heywood, *Internal Combustion Engine Fundamentals*, McGraw-Hill Education, 2011.
5. Heldt P M, *High-Speed Combustion Engines (Design: Production: Tests)*, Oxford & IBH Publishing Company, 1965.
6. Obert E F, *Internal Combustion Engines: Analysis and Practice*, International Textbook Company, 1988.
7. William H Crouse & Donald L Anglin, *Automotive Mechanics*, McGraw-Hill Education, 2006.
8. Willard W Pulkrabek, *Engineering Fundamentals of the Internal Combustion Engine*, Prentice Hall of India, 2003.

18BEAE305 ENGINEERING METROLOGY AND MEASUREMENTS **Semester III**
3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To familiarise the concepts of measurement and characteristics of instruments.
- To learn the procedure for various linear and angular measurements.
- To provide knowledge on the measurement of gear and thread terminologies using suitable instruments.
- To expose the procedure to measure the mechanical parameters using suitable instruments.
- To study the use of laser and advances in metrology for linear geometric dimensions.
- To impart knowledge on digital devices and computer aided inspectiondevices

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Explain the basic concept of measurement and characteristics of measuring instruments.
- Practice the appropriate linear and angular dimensions using precision measuring instruments.
- Examine the major terminologies for the gear and screw thread measurement.
- Explain the suitable type of instrument used to measure the mechanical parameters.
- Apply the advanced techniques in metrology to calculate the geometric dimensions.
- Practice the digital devices and computer aided inspectiondevices

Course Contents:

UNIT I CONCEPT OF MEASUREMENT

General concept – generalised measurement system – accuracy and precision – units and standards – measuring instrumentssensitivity – readability – range of accuracy – precision – static and dynamic response – repeatability – systematic and random errors – correction – calibration – interchangeability.

UNIT II LINEAR AND ANGULAR MEASUREMENTS

Definition of metrology – linear measurements: vernier, micrometer, interval measurement, slip gauges and its classification – interferometry – optical flats – limit gauges – comparators: mechanical, pneumatic and electrical types and its applications – angular measurements: sine bar, optical bevel protractor, angle decker – taper measurements.

UNIT III FORM MEASUREMENT

Measurement of screw threads – thread gauges – floating carriage micrometer – measurement of gears – tooth thickness – constant chord and base tangent method – Gleason gear testing machine – radius measurements – surface finish, straightness, flatness and roundness measurements.

UNIT IV MEASUREMENT OF MECHANICAL PARAMETERS

Measurement of force,torque and power: mechanical,pneumatic,hydraulicandelectricaltypes – flowmeasurement: venturimeter, orifice meter, rotameter, pitot tube – temperature: bimetallic strip, pressure thermometers, thermocouples, electrical resistance thermistor.

UNIT V MODERN METROLOGY

Precision instruments based on laser principles – laser interferometer – application in linear, angular measurements and machine tool metrology – coordinate measuring machine –constructional features – types and applications – digital devices – computer aided inspection.

Suggested Readings:

1. Jain R K, *Engineering Metrology*, Khanna Publishers, New Delhi, 2012.
2. Alan S Morris, *The Essence of Measurement*, Prentice Hall of India, 1997.
3. Gupta I C, *Engineering Metrology*, Dhanpat Rai and Sons, New Delhi, 2000.
4. Jayal A K, *Instrumentation and Mechanical Measurements*, Galgotia Publications, 2000.
5. Beckwith T G and Lewis Buck N, *Mechanical Measurements*, Addison-Wesley Publishing Company, 1991.
6. Donald P Eckman, *Industrial Instrumentation*, Wiley Eastern, 1985.

18BEAE306	BIOLOGY FOR ENGINEERS	Semester III 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To understand the basics of biology.
- To gain knowledge about different biomolecules.
- To get familiarise with human diseases.
- To learn about different clinical investigations.
- To know the recent advances in biology.
- Classify the communicable and non-communicable human diseases.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Summarise the cell structures and their functions.
- Explain the biomolecules functions.
- Classify the communicable and non-communicable human diseases.
- Illustrate the different organ function tests.
- Tell the applications of biology in environmental applications.
- Describe the concept of biomechanics.

Course Contents:

UNIT I BASICS OF BIOLOGY

Cell structure – prokaryotic and eukaryotic cells – animal and plant cell – cell cycle – mitosis – meiosis.

UNIT II BIOMOLECULES

Nucleic acid – DNA: structure, types, RNA: structure, types – proteins: classification, biological functions – carbohydrates: classification, biological functions – lipids: classification, biological functions – hormones: definition, importance – vitamins.

UNIT III HUMAN DISEASES

Communicable diseases: tuberculosis, chikungunya, dengue, influenza, HIV/AIDS – non-communicable diseases: diabetes, cancer, cardiovascular diseases.

UNIT IV ORGAN FUNCTION TESTS

Liver function tests: functions of liver, tests to assess liver function, bilirubin related liver test – renal function tests: tests to assess renal function, clearance test, creatine and urea, urine concentration test – gastric function tests: tests to assess gastric function, fractional test meal, alcohol test meal, insulin test meal – pancreatic function test: secretin test, lundh test.

UNIT V APPLICATIONS OF BIOLOGY

Environmental: waste water treatment, bioremediation – biomaterials and biopolymers for environmental applications – biosensors – biofuel: biogas, biodiesel – biomechanics:biofluid mechanics, biotribology.

Suggested Readings:

1. Dubey R C, *A Textbook of Biotechnology*, S. Chand Publishing, 2014.
2. Arthur T Johnson, *Biology for Engineers*, CRC Press, 2018.
3. Satyanarayana U and Chakrapani U, *Biochemistry*, Books and Allied, 2017.
4. Carol D Tamparo and Marcia A Lewis, *Diseases of the Human Body*, F.A. Davis Company, 2011.
5. Duane Knudson, *Fundamentals of Biomechanics*, Springer, 2007.

18BEAE311	AUTOMOTIVE ENGINE COMPONENTS AND MEASUREMENTS LABORATORY	Semester III 3H-2C

Instruction Hours/Week: L:0 T:0 P:3 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To give practical knowledge onthe dismantling and assembling of an engine.
- To study the various components of an engine.
- To learn the procedure for various linear and angular measurements.
- To provide knowledge on the measurement of gear and thread terminologies.
- To expose the procedure to measure the mechanical parameters using suitable instruments.
- To Study and acquire knowledge on the calibration of Vernier / micrometer / dial gauge

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Identify and assemble the components of an engine.
- Explain the function of various components of an engine.
- Practice the appropriate linear and angular dimensions using precision measuring instruments.
- Examine the major terminologies for the gear and screw thread.
- Explain the suitable type of instrument used to measure the mechanical parameters.
- Understand the calibration of Vernier / micrometer / dial gauge.

List of Experiments:

1. Dismantling and assembling of the spark ignition engine.
2. Study of the four-cylinder compression ignition engine.
3. Study of oil filter, fuel filter, fuel injection system, carburettor, MPFI and CRDI.
4. Study of ignition system components, coil, magneto and electronic ignition systems.
5. Study of engine cooling system and lubrication system components.
6. Ovality and taper measurement of the cylinder bore, crankshaft and comparison with standard specifications.
7. Calibration of vernier / micrometer / dial gauge.
8. Checking the dimensions of a part using slip gauges.
9. Measurement of gear tooth dimensions.
10. Measurement of straightness, flatness and thread parameters.
11. Measurement of displacement, force and vibration.

18BEAE312	COMPUTER AIDED MACHINE DRAWING LABORATORY	Semester III 3H-2C

Instruction Hours/Week: L:0 T:0 P:3 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To understand and interpret drawings of machine components.
- To acquire the ability in designing and making the assembly drawing of various components.
- To expose students todrawing of sleeve and cotter joint.
- To expose students toknuckle joint,gib and cotter joint
- To provide an overview ofdrawing of universal coupling,screw jack.
- To make the student acquire sound knowledge ofpiston and connecting rod

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Sketch the detailed drawing of sleeve and cotter joint.
- Sketch the detailed drawing of knuckle joint
- Sketch the detailed drawing of gib and cotter joint.
- Sketch the detailed drawing of universal coupling.
- Sketch the detailed drawing of screw jack.
- Create the assembly drawing of piston and connecting rod

List of Experiments:

1. Modelling and assembly of sleeve and cotter joint.
2. Modelling and assembly of knuckle joint.
3. Modelling and assembly of gib and cotter joint.
4. Modelling and assembly of muff coupling.
5. Modelling and assembly of flange coupling.
6. Modelling and assembly of universal coupling.
7. Modelling and assembly of Oldham’s coupling.
8. Modelling and assembly of screw jack.
9. Modelling of the piston.
10. Modelling of the connecting rod.

18BEAE313	THERMAL ENGINEERING LABORATORY	Semester III 3H-2C

Instruction Hours/Week: L:0 T:0 P:3 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To impart knowledge on the flash point, fire point and viscosity of the fuel.
- To learn the port timing and valve timing diagram of internal combustion engines.
- To study the performance of the internal combustion engine and refrigeration system.
- To understand the thermal conductivity, heat transfer and emissivity.
- To know the effectiveness of heat exchangers.
- To study the coefficient of performance of a refrigeration system

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Measure the flash point, fire point and viscosity of given sample.
- Draw the port timing diagramof two-stroke and valve timing diagram of four-stroke internal combustion engines.
- Evaluate the performanceof internal combustionengine and reciprocating air compressor.
- Calculate the coefficient of performance of a refrigeration system.
- Estimate the thermal conductivity of material, heat transfer from surface and emissivity of a grey surface.
- Calculate the effectiveness of a heat exchanger.

List of Experiments:

1. Determination of viscosity of oils.
2. Determination of flash point and fire point of fuels.
3. Valve and port timing diagrams.
4. Performance test on in-line multi-cylinder compression ignition engine.
5. Morse test on spark ignition engine.
6. Performance test on single/two stage reciprocating air compressor.
7. Determination of coefficient of performance of a refrigeration system.
8. Thermal conductivity measurement by guarded plate method.
9. Natural convection heat transfer from a vertical cylinder.
10. Heat transfer from pin fin (natural and forced convection modes).
11. Determination of emissivity of a grey surface.
12. Effectiveness of parallel/counter flow heat exchanger.

18BEAE351	SOFT SKILLS	Semester III 3H-0C

Instruction Hours/Week: L:1 T:0 P:2 **Marks:** Internal:**100** External:**0** Total:**100**

Course Objectives:

- To enhance the employability and career skills of students.
- To orient the students towards grooming as a professional.
- To develop an understanding of interview dynamics and techniques.
- To train the students to face interviews.
- Express the presentation skills
- Express the views in group discussions with confidence.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Demonstrate the adequate soft skills required for the workplace.
- Express the presentation skills
- Express the views in group discussions with confidence.
- Demonstrate the appropriate interview skills.
- Manage time effectively.
- Explain the stress management

Course Contents:

UNIT I INTRODUCTION

Introduction to soft skills – hard skills and soft skills – employability and career skills – grooming as aprofessional with values – general awareness of current affairs.

UNIT II PRESENTATION

Self-introduction – organizing the material – introducing oneself to the audience – introducing the topic –answering questions – individual presentation practice – presenting the visuals effectively – 5 minutepresentations.

UNIT III GROUP DISCUSSION

Introduction to Group Discussion (GD) – participating in group discussions – understanding group dynamics – brainstorming the topic – questioning and clarifying –GD strategies – activities to improve GD skills – mock GD.

UNIT IV INTERVIEW

Interview etiquette – resume – dress code – body language – attending job interviews– telephoneinterview – one to one interview and panel interview – frequently asked questions related to job interviews.

UNIT V INTERPERSONAL SKILLS

Interpersonal skills – timemanagement– stress management–professional networking – respecting social protocols.

Suggested Readings:

1. Jeff Butterfield,*Soft Skills for Everyone*,Cengage Learning, New Delhi,2011.
2. Barun K Mitra,*Personality Development and Soft Skills*,Oxford University Press,2011.
3. Rajiv K Mishra,*Personality Development*,Rupa & Company,2012.

18BEAE401 FLUID MECHANICS AND HEAT TRANSFER **SemesterIV 4H-4C**

Instruction Hours/Week: L:3 T:1 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To study the fluid laws
- To make the students conversant on properties and measurements.
- To expose the various fluid flow measuring devices and calculate the flow losses in pipes.
- To impart knowledge on various types of pumps and hydraulic turbines.
- To impart knowledge of the conduction heat transfer mechanisms.
- To learn the principles of convection and radiation.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Estimate the flow properties and pressure head using fundamental laws of fluid mechanics.
- Evaluate the discharge and loss of energy in flow through pipes.
- Analyse the performance of hydraulic pumps and turbines for a given application.
- Apply the heat conduction equation to compute the rate of heat transfer in simple and composite systems.
- Determine the rate of heat transfer in convection mode.
- Determine the rate of heat transfer in radiation mode.

Course Contents:

UNIT I BASIC CONCEPTS AND PROPERTIESOF FLUIDS

Definition of fluid– distinction between solid and fluid –units and dimensions – properties of fluids: density, specific weight, specific volume, specific gravity, temperature, viscosity, compressibility, vapour pressure, capillary and surface tension –fluid statics – concept of fluid static pressure, absolute and gauge pressures – pressure measurements by U-tube manometer.

UNIT II FLUID KINEMATICS AND DYNAMICS

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 – Bernoulli's equation – applications –venturimeter, orifice meter, pitot tube.

Incompressible fluid flow – viscous flow – Navier-Stokes equations– flow through pipes – Darcy-Weisbach equation – pipe roughness – friction factor – flow through pipes in series and in parallel – power transmission – introduction to the concept of boundary layer flows – boundary layer thickness – boundary layer separation – drag and lift coefficients.

UNIT III PUMPS AND TURBINES

Impact of jets – Euler's equation – theory of roto-dynamic machines – velocity component – centrifugal, reciprocating and rotary pumps.

Pelton wheel, Francis turbine and Kaplan turbine – performance curves – governing of turbines.

UNIT IV HEAT CONDUCTION

Basic concepts – mechanism of heat transfer – conduction, convection and radiation – general differential equation of heat conduction – Fourier's law of conduction – Cartesian and cylindrical coordinates – one dimensional steady state heat conduction – conduction through plane wall, cylinders, spheres and composite systems – conduction with internal heat generation – extended surfaces – unsteady heat conduction – lumpedanalysis–useofHeisler chart.

UNIT V CONVECTION AND RADIATION

Convective heat transfer coefficients – boundary layer concept –types of convection – dimensional analysis – external flow – flow over plates, cylinders and spheres – internal flow– laminar andturbulent flow – combined laminar and turbulent – flow over bank of tubes.

Laws of radiation – Stefan-Boltzmann law and Kirchhoff law –black bodyradiation –grey body radiation – shape factor algebra – radiationshields.

Note: Usage of approved data book is permitted in the examination.

Suggested Readings:

1. Bansal R K, *Fluid Mechanics and Hydraulic Machines*, Laxmi Publications, New Delhi, 2018.
2. Shiv Kumar, *Fluid Mechanics: Basic Concepts & Principles*, Ane Books Pvt. Ltd., New Delhi, 2015.
3. Yunus A Cengel and John M Cimbala, *Fluid Mechanics: Fundamentals and Applications*, McGraw-Hill Education, 2014.
4. Victor Lyle Streeter, Benjamin Wylie E, Keith W Bedford, *Fluid Mechanics*, McGraw-Hill Education, 2010.
5. Frank M White, *Fluid Mechanics*, McGraw-Hill Education, 2016.
6. Nag P K, *Heat and Mass Transfer*, McGraw-Hill Education, 2011.
7. Rajput R K, *Heat and Mass Transfer*, S. Chand & Company Pvt. Ltd., New Delhi, 2012.
8. Jack P Holman, *Heat Transfer*, McGraw-Hill Education, 2011.

18BEAE402	STRENGTH OF MATERIALS	SemesterIV 4H-4C

Instruction Hours/Week: L:3 T:1 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To study and estimate the mechanical properties of materials and their deformations under different loading conditions.
- To gain knowledge on the shear force and bending stress distribution in different beams under various loads.
- To impart knowledge on finding slope and deflection of beams and buckling of columns for various boundary conditions.
- To learn deformation of the shaft under torsion and deflection of closed helical springs.
- To acquire knowledge on the two-dimensional stress systems and stresses in thin cylinders and spherical shells.
- To introduce the concepts ofMohr's circle

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Evaluate the stresses and strains in simple and composite structures subjected to axial loads.
- Examine the shear force, bending moment and shear stress of various beams under different loading conditions.
- Examine the stresses induced in the shaft and closed coil helical springs subjected to torsion.
- Evaluate the slope and deflection of beams and buckling loads of columns with different boundary conditions.
- Examine the stresses in two-dimensional systems and thin cylinders.
- Familiar with construction of Mohr's circle

Course Contents:

UNIT I STRESS, STRAIN AND DEFORMATION OF SOLIDS

Stress – strain – types of stresses – stress and strain diagram – Hooke's law – Young's modulus – deformation of simple and compound bars subjected to axial loading – thermal stresses – elastic constants – Poisson's ratio – volumetric strain – bulk modulus – strain energy and impact loading.

UNIT II BEAMS - LOADS AND STRESSES

Types of beams, supports and loads – shear force and bending moment in beams – cantilever, simply supported and overhanging beams – stresses in beams – theory of simple bending – stress variation along the length and in the beam section – effect of shape of beam section on stress induced – composite beams – shear stresses in beams.

UNIT III TORSION

Analysis of torsion of circular shaft – shear stress distribution – power transmitted by solid and hollow circular shafts – strength of a shaft and torsional rigidity – stepped shaft – compound shafts – stress in helical springs – analysis of close-coiledhelical springs.

UNIT IV DEFLECTION OF BEAMS AND COLUMNS

Relationship between deflection, slope and moment – evaluation of beam deflection and slope using double integration method, Macaulay's method and moment-area method – columns – end conditions for long columns – equivalent length of a column – Euler'sformula – slenderness ratio – Rankine's formula for columns.

UNIT V ANALYSIS OF STRESSES IN TWO DIMENSIONS

Biaxial state of stresses – thin cylindrical and spherical shells – deformation and stresses in thin cylindrical and spherical shells subjected to internal pressure – biaxial stresses at a point – stresses on an inclined plane – principal planes and principal stresses – Mohr's circle.

Suggested Readings:

1. Bansal R K, *Strength of Materials*, Laxmi Publications, New Delhi, 2018.
2. Punmia B C, Ashok Kumar Jain and Arun Kumar Jain, *Strength of Materials*, Laxmi Publications, New Delhi, 2019.
3. Rattan S S, *Strength of Materials*, McGraw-Hill Education, New Delhi, 2016.
4. Popov E P, *Engineering Mechanics of Solids*, Prentice-Hall of India, New Delhi, 2002.
5. Kazimi S M A, *Solid Mechanics*, Tata McGraw-Hill, New Delhi, 2001.
6. Ryder G H, *Strength of Materials*, Macmillan India, New Delhi, 2002.
7. Ferdinand P Beer, E Russell Johnston Jr. E,John T DeWolf,David F Mazurek and Sanjeev Sanghi, *Mechanics of Materials*, McGraw-Hill Education, New Delhi, 2016.

18BEAE403	THEORY OF MACHINES	SemesterIV 4H-4C

Instruction Hours/Week: L:3 T:1 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To impart knowledge on the concept and kinematic analysis of simple mechanisms.
- To introduce the concept of friction drives in kinematic of machines.
- To calculate the speed ratio of various types of the gear train and construct the cam profile for the various types of follower motion.
- To provide knowledge on balancing of rotating and reciprocating masses.
- To learn the concept of free, forced and damped vibrations.
- To provide knowledge ontorsional vibration of shaft

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Identify the simple mechanisms based on a given application, and find velocity and acceleration of simple mechanisms.
- Estimate the amount of power transmitted by drive.
- Calculate the speed ratio of various types of the gear train and construct the cam profile for the various types of follower motion.
- Estimate the balancing mass for rotating and reciprocating masses by using the force and couple polygon.
- Evaluate the natural frequency of a single degrees of freedom system subjected to free and forced vibrations.
- Compute the torsional vibration of shaft

Course Contents:

UNIT I MECHANISMS

Machine structure – kinematic link, pair and chain – Gruebler's criteria – constrained motion – degrees of freedom – slider crank and crank rocker mechanisms – inversions – applications – kinematic analysis of simple mechanisms – determination of velocity and acceleration.

UNIT II FRICTION

Types of friction – friction in screw and nut – screw jack – pivot and collar – thrust bearing – plate and disc clutches – belt and rope drives – ratio of tensions – effect of centrifugal and initial tension – condition for maximum power transmission – open and crossed belt drive.

UNIT III GEARS AND CAMS

Gear profile and geometry – nomenclature of spur and helical gears – gear trains – simple, compound and epicyclic gear trains – determination of speed and torque – cams – types of cams – design of profiles for knife edged, flat faced and roller ended followers with and without offsets for various types of follower motions.

UNIT IV BALANCING

Static and dynamic balancing – single and several masses in different planes – balancing of reciprocating masses – primary balancing and concepts of secondary balancing – swaying couple – tractive force – hammer blow – balancing of coupled locomotives – governors and gyroscopic effects.

UNIT V VIBRATION

Free, forced and damped vibrations of single degree of freedom systems – force transmitted to supports – vibration isolation – vibration absorption – torsional vibration of shaft – single and multi rotor systems – geared shafts – critical speed of shaft.

Suggested Readings:

1. Rattan S S, *Theory of Machines*, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2014.
2. Ballaney P L, *Theory of Machines and Mechanisms*, Khanna Publishers, New Delhi, 2002.
3. Bansal R K, *Theory of Machines*, Laxmi Publications, New Delhi, 2012.
4. Rao J S and Dukkipati R V, *Mechanism and Machine Theory*, New Age International Publishers, New Delhi, 2006.
5. Malhotra D R and Gupta H C, *The Theory of Machines*, Satya Prakasam Tech. India Publications, 1989.
6. Amitabha Ghosh and Asok Kumar Mallik, *Theory of Mechanisms and Machines*, Affiliated East-West Press, New Delhi, 1988.
7. Shigley J E and Uicker J J, *Theory of Machines and Mechanisms*, McGraw-Hill Education, 1986.

18BEAE404	ENGINEERING MATERIALS AND METALLURGY	SemesterIV 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To provide knowledge on physical metallurgy of metals through the study of phase diagrams.
- To study the properties and applications of various metals and alloys used in engineering industries.
- To expose the various heat treatment processes of steels.
- To impart knowledge of the mechanical properties evaluation and testing methods of engineering materials.
- To introduce fundamentals of composites
- To provide fundamental knowledge of composites and their applications.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Explain the phase diagrams of different engineering materials.
- Recognise the properties and applications of various metals and alloys.
- Identify the appropriate heat treatment processes for the given applications.
- Test the mechanical properties of the given materials for real-time applications.
- Understand the fundamentals of composites
- Identify the appropriate composites for applications in the automotive industry.

Course Contents:

UNIT I CONSTITUTION OF ALLOYS AND PHASE DIAGRAMS

Constitution of alloys – solid solutions – substitutional and interstitial – phase diagrams – isomorphous, eutectic, peritectic, eutectoid and peritectoid reactions – iron-carbon equilibrium diagram– classification of steel and cast iron – microstructure, properties and application.

UNIT II FERROUS AND NON-FERROUS METALS

Effect of alloying additions on steel (Mn, Si, Cr, Mo, V, Ti and W) – stainless and tool steels – High-strength low-alloy steel – maraging steels – gray, white malleable, spheroidal – graphite – alloy cast irons – copper and copper alloys – brass, bronze and cupronickel – aluminium and Al-Cu – precipitation strengthening treatment – bearing alloys.

UNIT III HEAT TREATMENT

Purpose of heat treatment –annealing – types of annealing processes – normalising – hardening and tempering – isothermal transformation diagrams – cooling curves superimposed on isothermal transformation diagrams– critical cooling rate–hardenability – Jominy end quench test – austempering – martempering – case hardening – types of case hardening processes.

UNIT IV MECHANICAL PROPERTIES AND TESTING

Mechanism of plastic deformation, slip and twinning – types of fracture – testing of materials under tension, compression and shear loads – hardnessand testing methods– impact test – fatigue test – creeptest.

UNIT V INTRODUCTION TO COMPOSITES

Fundamentals of composites – need for composites – enhancement of properties – classification of composites – matrix – polymer matrix composites, metal matrix composites, ceramic matrix composites – reinforcement – particle reinforced composites, fibre reinforced composites – applications of various types of composites in automobiles.

Suggested Readings:

1. Kenneth G Budinski and Michael K Budinski, *Engineering Materials*, Prentice Hall of India, 2010.
2. Raghavan V, *Materials Science and Engineering*, Prentice Hall of India, 1999.
3. Bhagwan D Agarwal, Lawrence J Broutman and Chandrashekhara K, *Analysis and Performance of Fiber Composites*, John Wiley & Sons, 2017.
4. William D Callister Jr., *Materials Science and Engineering: An Introduction*, John Wiley & Sons, 2004.
5. Sidney H Avner, *Introduction to Physical Metallurgy*, Tata McGraw- Hill, 1997.
6. Ronald F Gibson, *Principles of Composite Material Mechanics*, CRC Press, 2016.

18BEAE441	AUTOMOTIVE CHASSIS AND TRANSMISSION	SemesterIV 6H-5C

Instruction Hours/Week: L:3 T:0 P:3 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To provide knowledge on the frame, front axle and steering system.
- To expose the different types of clutches and gearboxes.
- To study the various components in driveline, final drive and rear axle.
- To learn the types of suspension systems and wheels.
- To provide an overview oftyres – tyre construction – tyre designation
- To impart knowledge on construction and working principle of different types of brakes.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Discuss the types of frame, front axle and steering system.
- Sketch and explain the different types of clutches and gearboxes.
- Describe the components in driveline, final drive and rear axle.
- Describe the suspension systems and wheels.
- Familiar with tyres – tyre construction – tyre designation
- Explain the construction and working principle of different types of brakes.

Course Contents:

UNIT I FRAME, FRONT AXLE AND STEERING SYSTEM

Chassis and its classification – types, materials and load acting on frame – types of front and stub axles – steering geometry – conditions for true rolling motion of wheels during steering – Ackermannand Davis steering mechanisms – steering linkages – types of steering gearboxes – understeer and oversteer – steering ratio – reversible and irreversible steering – power steering.

UNIT II CLUTCH AND TRANSMISSION GEARBOX

Requirements of clutch – construction and working of different types of clutches – necessity of transmission – types of transmission – construction and operation of sliding mesh, constant mesh, synchromesh and epicyclic gearboxes – torque converter – overdrive – continuously variable transmissions.

UNIT III DRIVELINE, FINAL DRIVE AND REAR AXLE

Driveline – propeller shaft – universal joints – slip joint – final drive – Hotchkiss drive – torque tube drive – differential principle – construction and operation of differential unit – non-slip differential – differential locks – loads on a rear axle – types of rear axles – rear axle casing – multi-drive axle.

UNIT IV SUSPENSION, WHEELS AND TYRES

Requirements of a suspension system – types of suspension springs – constructional details and characteristics of leaf spring, coil spring, torsion bar and rubber spring – air and hydrolastic suspension systems – independent suspension – shock absorbers – types of wheels – types of tyres – tyre construction – tyre designation – tyre pressure and wear – factors affecting tyre life.

UNIT V BRAKES

Need for brake systems – stopping distance, time and braking efficiency – effect of weight transfer during braking – classification of brakes – drum and disc brakes – construction and working of mechanical, hydraulic and pneumatic brake systems – servo brake systems – power brakes – engine exhaust brakes – hand brake – retarders – Anti-lock Braking Systems (ABS).

Suggested Readings:

1. Kirpal Singh, *Automobile Engineering Volume. 1*, Standard Publishers, New Delhi, 2018.
2. Gupta R B, *Automobile Technology*, Satya Prakashan, New Delhi, 2016.
3. Giri N K, *Automobile Mechanics*, Khanna Publishers, New Delhi, 2008.
4. Peter Martin Heldt, *The Automotive Chassis*, Chilton Book Co., 1992.
5. Tim Gilles, *Automotive Chassis: Brakes, Suspension, and Steering*, Cengage Learning, 2005.

List of Experiments:

1. Servicing of the clutch assembly with play adjustment.
2. Servicing of the transmission gearbox assembly.
3. Servicing of the propeller shaft and universal joint assembly.
4. Servicing of the drive shaft assembly.
5. Servicing of the differential assembly.
6. Servicing of different types of rear axle assembly.
7. Servicing of the steering gearbox assembly.
8. Servicing of the suspension system.
9. Servicing of the brake system.
10. Study of two-wheeler, light motor vehicle and heavy motor vehicle chassis.

18BEAE442	AUTOMOTIVE ELECTRICAL AND ELECTRONICS SYSTEMS	Semester IV 6H-5C

Instruction Hours/Week: L:3 T:0 P:3 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To expose the different types of batteries and ignition systems.
- To provide knowledge on the working of starting system and charging system.
- To provide knowledge on automobile wiring system.
- To learn the automobile lighting system.
- To study the various sensors and actuators used in the automobile.
- To impart knowledge on the electronic engine management system.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Sketch and explain the working principle of battery and ignition system.
- Discuss working of the starting system and charging system.
- Illustrate the automobile wiring system.
- Illustrate the automobile lighting system.
- Identify the sensors and actuators used in the automobile.
- Explain the electronic engine management system.

Course Contents:

UNIT I BATTERY AND IGNITION SYSTEM

Different types of batteries – principle and construction of lead acid battery – batteryrating, testing, maintenance and charging – spark plugs – advance mechanisms – different types of ignition systems.

UNIT II STARTING SYSTEM AND CHARGING SYSTEM

Principle, construction and working of starter motor – starter motors characteristics,capacity requirements – drive mechanisms – starter switches – principle, construction and working of DC generators and alternators – characteristics of DC generators and alternators – control unit – cut out, electronic regulators.

UNIT III LIGHTING SYSTEM, WIRING SYSTEM AND ACCESSORIES

Vehicle interior lighting system – vehicle exterior lighting system – wiring requirements – lightingdesign – dashboard instruments – horn, wiper, trafficator.

UNIT IV SENSORS AND ACTUATORS

Classification of sensors – sensor for speed, throttle position, exhaust oxygen level, manifoldpressure, crankshaft position, coolant temperature, intake air temperature, exhaust temperature, air mass flow for engine application – solenoids, steppermotors and relay.

UNIT V ELECTRONIC ENGINE MANAGEMENT SYSTEM

Electronic engine control – input, output and control strategies – electronic fuel control system – fuelcontrolmodes – openloopandclosedloopcontrolatvariousmodes – exhaust gas recirculation (EGR) control – electronic ignition systems – spark advance correction schemes – fuel injection timing control.

Suggested Readings:

1. Young A P and Griffiths L, *Automobile Electrical Equipments*, ELBS & New Press, 1990.
2. William B Ribbens, *Understanding Automotive Electronics*, Butterworth-Heinemann, 2012.
3. Robert Bosch, *Bosch Automotive Electrics and Automotive Electronics*, Springer, 2014.
4. James D Halderman, *Automotive Electricity and Electronics*, Pearson Education, 2016.
5. Barry Hollembeak, *Automotive Electricity & Electronics*, Delmar Cengage Learning, 2011.
6. Arthur W Judge, *Modern Electrical Equipment for Automobiles*, Chapman & Hall, 1992.

List of Experiments:

A. Electrical Laboratory

1. Testing of batteries and battery maintenance.
2. Testing of starter motors.
3. Testing of alternators.
4. Fault diagnosis of the ignition system.
5. Study of automobile electrical wiring circuits.

B. Electronics Laboratory

1. Study of rectifiers and filters.
2. Study of logic gates.
3. Study of SCR and IC timer.
4. Interfacing A/D converter and simple data acquisition.
5. Display and keyboard interfacing with microcontroller.
6. Interfacing sensors using a microcontroller.

18BEAE411	FLUID MECHANICS AND STRENGTH OF MATERIALS LABORATORY	SemesterIV 3H-2C

Instruction Hours/Week: L:0 T:0 P:3 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To demonstrate the principles of fluid mechanics.
- To measure the energy losses in a pipe flow.
- To perform a characteristic study on non-positive and positive displacement pumps.
- To know the tensile and shear strength of materials.
- To study the hardness and impact strength of materials.
- To give exposure to compression strength of helical springs

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Calculate the rate of fluid flow and coefficient of discharge in fluid flow devices.
- Measure the losses associated in a pipe flow.
- Evaluate the performance ofnon-positive and positive displacement pumps.
- Measure the tensile and shear strength of materials.
- Evaluate the hardness and impact strength of materials.
- Evaluate thecompression strengthof helical springs

List of Experiments:

1. Determination of the coefficient of discharge of venturimeter and orifice meter.
2. Calculation of the rate of flow using rotameter.
3. Determination of the friction factor for a set of pipes.
4. Performance test on the centrifugal pump/submergible pump.
5. Performance test on the reciprocating pump.
6. Performance test on the gear pump.
7. Tension test on a mild steel rod.
8. Torsion test on a mild steel rod
9. Single shear and double shear test on metals.
10. Hardness test on metals.
11. Impact test on metals.
12. Compression test on helical springs.

18BEAE451	COURSE ORIENTED PROJECT - I	SemesterIV 1H-0C

Instruction Hours/Week: L:0 T:0 P:1 **Marks:** Internal:**100** External:**0** Total:**100**

Course Objectives:

- To develop the skills to formulate a technical project.
- To give guidance on the various tasks of the project and standard procedures.
- To provide the guidelines to prepare a technical report of the project.
- Apply technical ideas, strategies and methodologies.
- Design and conduct experiments, as well as analyse and interpret data.
- Familiar with cost-effectiveness analysis.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Identify a problemand develop the solutions.
- Identify, formulate and analyse problems and justify solutions using scientific knowledge.
- Apply technical ideas, strategies and methodologies.
- Design and conduct experiments, as well as analyse and interpret data.
- Familiar with cost-effectiveness analysis.
- Prepare technical report and oral presentations.

Guidelines:

- A maximum of three students per teamshould do the project work.
- At the end of the semester, a report and a technical presentation should be made by the students.

18BEAE452	FUELS AND LUBRICANTS	SemesterIV 1H-0C

Instruction Hours/Week: L:1 T:0 P:0 **Marks:** Internal:**100** External:**0** Total:**100**

Course Objectives:

- To provide knowledge on the theory of lubrication.
- To familiarise the manufacturing process of fuels and lubricants.
- To study the properties of lubricants and fuel.
- Define the various terminologies associated with fuel.
- Explain the manufacture of automotive lubricants
- Explain the Thermo-chemistry of fuels

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Explain the manufacturing process of fuels and lubricants.
- Describe the refining process
- Define the various terminologies associated with fuel.
- Explain the manufacture of automotive lubricants
- Explain the Thermo-chemistry of fuels
- Select the suitable lubrication type for a particularapplication.

Course Contents:

PART I MANUFACTURE OF FUELS AND LUBRICANTS

Engine friction – effect of engine variables on friction – hydrodynamic lubrication – elasto hydrodynamic lubrication – boundary lubrication – bearing lubrication – functions of the lubrication system.

Structure of petroleum – refining process – fuels – thermal cracking, catalytic cracking, polymerization, alkylation, isomerisation, blending – products of refining process – manufacture of automotive lubricants.

PART II LUBRICANTS, PROPERTIES AND TESTING OF FUELS

Specific requirements for automotive lubricants – oxidation, deterioration and degradation of lubricants – additives and additive mechanism – synthetic lubricants – classification of lubricating oils – properties of lubricating oils – tests on lubricants – greaseclassification and properties – test used in grease.

Thermo-chemistry of fuels – properties and testing of fuels: relative density, calorific value, flash point, fire point, distillation, vapour pressure, spontaneous ignition temperature, viscosity, pour point, flammability, ignitability, diesel index, American Petroleum Institute (API) gravity, aniline point, carbon residue, copper strip corrosion.

Suggested Readings:

1. George E Totten, Steven R Westbrook, Rajesh J Shah, *Fuels and Lubricants Handbook: Technology, Properties, Performance, and Testing*, ASTM International, 2003.
2. Lansdown A R, *Lubrication: A Practical Guide to Lubricant Selection*, Pergamon Press, 1982.

18BEAE501	DESIGN OF MACHINE ELEMENTS	SemesterV 4H-4C

Instruction Hours/Week: L:3 T:1 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To learn the design procedure of machine elements subjected to simple loads.
- To understand the various types of stresses induced in different machine members.
- To study the design procedure of shafts and couplings.
- To provide knowledge on the design of bolted and welded joints.
- To impart knowledge on the design of helical spring and flywheel.
- To study the selection procedure of sliding and rolling contact bearings.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Design machine elements subjected to simple loads.
- Design shaft for various engineering applications.
- Design couplings for various engineering applications.
- Design bolted and welded joints subjected to static and eccentric loading conditions.
- Design helical spring and flywheel for various engineering applications.
- Design and select journal bearings and rolling contact bearings for various machines.

Course Contents:

UNIT I STEADY STRESSES IN MACHINE MEMBERS

Introduction to the design process – factors influencing in machine design – selection of materials based on mechanical properties – direct, bending and torsional stress equations – impact and shock loading – calculation of principle stresses for various load combinations – eccentric loading – curved beams – factor of safety – theories of failure – stress concentration.

UNIT II SHAFTS AND COUPLINGS

Shafts – types of shafts – standard sizes of shafts – design of shafts based on strength and torsional rigidity – keys, keyways and splines – couplings – types of couplings – design of rigid and flexible couplings.

UNIT III TEMPORARY AND PERMANENT JOINTS

Threaded fasteners – types of threaded fasteners – terminology, classification and designation of screw threads – design of bolts – welded joints – types of welded joints – design of welded joints.

UNIT IV ENERGY STORING ELEMENTS

Springs – classification – applications – design of helical spring – flywheel – fluctuation of speed – turning moment diagram – fluctuation of energy – workdone per cycle – energy storing capacity of flywheel – design of flywheel.

UNIT V BEARINGS

Classification – rolling contact bearings – designation – design of rolling contact bearing – sliding contact bearings – terminology and design of hydrodynamic journal bearing – lubrication.

Note: Usage of approved data book is permitted in the examination.

Suggested Readings:

1. Bhandari V B, *Design of Machine Elements*, McGraw-Hill Education, 2016.
2. Robert C Juvinall and Kurt M Marshek, *Fundamentals of Machine Component Design*, John Wiley & Sons, 2011.
3. Robert L Mott, Edward M Vavrek and Jyhwen Wang, *Machine Elements in Mechanical Design*, Pearson, 2017.
4. Robert L Norton, *Design of Machinery*, McGraw-Hill, 2003.
5. William Orthwein, *Machine Component Design*, Jaico Publishing House, 2013.
6. Ansel C Ugural, *Mechanical Design: An Integrated Approach*, McGraw-Hill, 2004.
7. Spotts M F, Shoup T E and Hornberger L E, *Design of Machine Elements*, Pearson, 2003.

18BEAE502	IC ENGINE DESIGN	Semester V 4H-4C

Instruction Hours/Week: L:3 T:1 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To learn the design procedure of cylinder and piston.
- To study the design procedure of connecting rod.
- To provide knowledge on the design of crankshaft.
- To impart knowledge on the design of valves and valve actuating components.
- To study the design procedure of timing belt and pulley
- To acquaint the student with the concepts of sprocket and chain.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Design cylinder and piston for the specified power and torque.
- Design connecting rod of an engine.
- Design crankshaft of an engine.
- Design valves and valve actuating components.
- Select suitable timing belt and pulley.
- Select suitable transmission chains and sprockets

Course Contents:

UNIT I DESIGN OF CYLINDER AND PISTON

Material selection for cylinder and piston – piston friction, piston slap, piston failure – lubrication of piston assembly – design of cylinder, piston, piston pin and piston rings.

UNIT II DESIGN OF CONNECTING ROD

Material selection for connecting rod – design of connecting rod small end, big end and shank – design of connecting rod cap and bolt.

UNIT III DESIGN OF CRANKSHAFT

Materials selection for crankshaft – balancing of IC engines – significance of firing order – design of crankshaft under bending and twisting – balancing weight calculations.

UNIT IV DESIGN OF VALVES AND VALVE ACTUATING COMPONENTS

Materials selection for valves and valve actuating component – design of camshaft, push rod, rocker arm, rocker shaft, valves and valve spring.

UNIT V DESIGN OF TIMING BELT, PULLEY, SPROCKET AND CHAIN

Selection of V-belts and pulleys – selection of flat belts and pulleys – selection of transmission chains and sprockets – design of pulleys and sprockets.

Note: Usage of approved data book is permitted in the examination.

Suggested Readings:

1. Kulkarni S G, *Machine Design*, Tata McGraw-Hill, 2008.
2. Jain R K, *Machine Design*, Khanna Publishers, New Delhi, 1988.
3. Charles Fayette Taylor, *The Internal Combustion Engine in Theory and Practice*, The MIT Press, 1968.
4. Kolchin A and Demidov V, *Design of Automotive Engines*, Mir Publishers, Moscow, 1984.
5. John Fenton, *Engine Design*, Cambridge University Press, 1986.
6. Joseph E Shigley, Charles R Mischke, Richard G Budynas and Keith J Nisbett, *Mechanical Engineering Design*, McGraw-Hill Education, 2015.

18BEAE503	VEHICLE DYNAMICS	Semester V 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To study the fundamental concept of vibration of a single degree of freedom system.
- To acquire knowledge on the road vehicle dynamics, stability and handling.
- To develop an understanding of the relationships between vehicle design variables and vehicle dynamic behaviour.
- To apply modelling techniques to predict the dynamic behaviour of road vehicles.
- To introduce the concepts ofgradeability, tractive force, braking force and stopping distance
- To provide knowledge onsteady state cornering model to design the steering system.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Explain the basic elements of vibration of single degree of freedom system.
- Analyse the cornering and tractive property of a tyre.
- Understand the sources of vibration
- Design and analyse the suspension system of a vehicle.
- Analyse the gradeability, tractive force, braking force and stopping distance of a vehicle.
- Apply steady state cornering model to design the steering system of a vehicle.

Course Contents:

UNIT I BASICS OF VIBRATION

Mechanical vibrating systems – mechanical vibration and human comfort – single degree of freedom free vibration – forced and damped vibrations – magnification factor and transmissibility – modelling and simulation studies – vibration absorber – vibration measuring instruments.

UNIT II TYRES

Tyre forces and moments – tyre structure – longitudinal and lateral force at various slip angles – rolling resistance – tractive and cornering property of tyre – performance of tyre on wet surface – ride property of tyres – magic formula tyre model – estimation of tyre road friction – test on various road surfaces – tyre vibration.

UNIT III VERTICAL DYNAMICS

Two degree of freedom system –sources of vibration – modelling of passive, semi-active and active suspension using quarter car model, half car model and full car model – influence of suspension stiffness, suspension damping, and tyre stiffness – air suspension system and their properties.

UNIT IV LONGITUDINAL DYNAMICS

Aerodynamic forces and moments– tyre forces – rolling resistance – load distribution for three wheeler and four wheeler – calculation of maximum acceleration – reaction forces for different drives – braking and driving torque – prediction of vehicle performance – anti-lock braking system – stability control – traction control.

UNIT V LATERAL DYNAMICS

Steady-state handling characteristics – steady-state response to steering input – transient response characteristics – direction control of vehicle – roll centre, roll axis – vehicle underside forces – stability of vehicle on banked road, during turn – effect of suspension on cornering.

Suggested Readings:

1. Thomas D Gillespie, *Fundamentals of Vehicle Dynamics*, SAE, 1992.
2. Rajesh Rajamani, *Vehicle Dynamics and Control*, Springer, 2005.
3. Singiresu S Rao, *Mechanical Vibrations*, Pearson, 2016.
4. Hans B Pacejka, *Tyre and Vehicle Dynamics*, Butterworth-Heinemann, 2006.
5. Reza N Jazar, *Vehicle Dynamics:Theory and Application*, Springer, 2008.
6. Jan Zuijdijk, *Vehicle Dynamics and Damping*, AuthorHouse, 2013.

18BEAE504	ENVIRONMENTAL SCIENCES	Semester V 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To give a comprehensive insight into natural resources, ecosystem and biodiversity.
- To educate the ways and means of the environment.
- To protect the environment from various types of pollution.
- To impart some fundamental knowledge of human welfare measures.
- Express the importance of conservation of biodiversity.
- Explain the different types of pollution.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Name the renewable and non-renewable energy sources.
- Explain the concept of an ecosystem.
- Express the importance of conservation of biodiversity.
- Explain the different types of pollution.
- Describe the disaster management
- List the various social issues and possible solutions.

Course Contents:

UNIT I INTRODUCTION TO ENVIRONMENTAL STUDIES AND NATURAL RESOURCES

Definition – scope and importance – need for public awareness – forestresources – useandoverexploitation – deforestation – water resources – use and overutilizationofsurfaceandgroundwater – floods – drought – conflicts over water – land resources – land as a resource – land degradation – man induced landslides – soil erosion and desertification – mineral resources – use and exploitation – environmental effects of extracting and using mineral resources – food resources – world food problems – changes caused by agriculture and overgrazing – effects of modern agriculture – energy resources – growing energy needs – renewable and non-renewable energy sources – use of alternate energy sources – role of an individual in conservation of natural resources.

UNIT II ECOSYSTEM

Chemistry and environment – environmental segments – composition and structure of atmosphere – concept of an ecosystem – structure, components and function of an ecosystem – energyflow in the ecosystem – food chain, food web and ecological pyramids – structure and function of terrestrial ecosystem (forest, desert and grassland ecosystem) and aquatic ecosystem (freshwater and marine ecosystem).

UNIT III BIODIVERSITY

Definition – geneticdiversity, species diversity and ecosystem diversity – biogeographical classification of India – importance of biodiversity – value of biodiversity – hotspots of biodiversity – threats to biodiversity – endangered and endemic species of India – conservation of biodiversity – in-situ and ex-situ conservation of biodiversity.

UNIT IV ENVIRONMENTAL POLLUTION

Definition – causes, effects and control measures of air pollution, water pollution, soil pollution, marine pollution, noise pollution and thermal pollution – solid waste management – causes, effects and control measures of urban and industrial wastes– role of an individual in prevention of pollution–disaster management – earthquake, tsunami, cyclone and landslides.

UNIT V SOCIAL ISSUES AND ENVIRONMENT

From unsustainable to sustainable development – urban problems related to energy sources – water conservation, rainwater harvesting and watershed management – resettlement and rehabilitation of people, its problems and concerns – environmental ethics – issues and possible solutions – climate change – greenhouse effect and global warming – acid rain – ozone layer depletion – wasteland reclamation – environment protection act – human rights – value education – role of information technology in environment and human health – human safety – population growth – variation of population among nations – population explosion.

Suggested Readings:

1. Ravikrishnan A, *Environmental Science*, Sri Krishna Hitech Publishing Company Pvt. Ltd., Chennai, 2012.
2. Anubha Kaushik and Kaushik C P, *Environmental Science and Engineering*, New Age International (P) Ltd., New Delhi, 2010.
3. William P Cunningham, *Principles of Environmental Science*, Tata McGraw-Hill Publishing CompanyLtd., New Delhi, 2008.
4. Linda D Williams, *Environmental Science Demystified*, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2005.
5. Erach Bharucha, *The Biodiversity of India*, Mapin Publishing (P) Ltd., Ahmedabad, 2005.
6. Tyler Miller G Jr.,*Environmental Science*, Thomson & Thomson Publishers, New Delhi, 2004.
7. Trivedi R K and Goel P K,*Introduction to Air Pollution*, Techno-Science Publications, Jaipur, 2003.

18BEAE511 DYNAMICS AND MECHATRONICS LABORATORY **Semester V**
3H-2C

Instruction Hours/Week: L:0 T:0 P:3 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To study the working principle of governor and gyroscope.
- To familiarize the students to understandgyroscopic law and gyroscopic couple
- To provide knowledge on the balancing of rotating and reciprocating masses.
- To learn the concept of transverse and torsional vibration.
- To introduce the concept and working of sensors used in the mechatronic systems.
- To impart knowledge on working of microcontroller in the mechatronic systems.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Select the suitable governor for various engineering applications.
- Familiar with gyroscopic law and determine the gyroscopic couple
- Estimate the balancing mass for rotating and reciprocating masses.
- Calculate the natural frequency of transverse and torsional vibration.
- Select the different types of sensor for various mechatronics applications.
- Develop a controller using the microcontroller for mechatronic system.

List of Experiments:

1. Determination of range, sensitivity and effort of Watt, Porter and Proell governors.
2. Verification of gyroscopic law and determination of gyroscopic couple.
3. Determination of jump speed and profile of a cam.
4. Balancing of rotating and reciprocating masses.
5. Determination of moment of inertia of connecting rod and flywheel by oscillation method.
6. Determination of critical speed of a shaft with concentrated loads.
7. Determination of torsional frequencyof compound pendulum and flywheel.
8. Determination of natural frequency and deflection of the beam.
9. Design and testing of fluid power circuits to control velocity, direction and force of single and double acting actuators.
10. Design of circuits with logic sequence using electro-pneumatic trainer kits.
11. Simulation of basic hydraulic, pneumatic and electric circuits using the software.
12. Study of circuits with multiple cylinder sequences in electro-pneumatic using PLC.

18BEAE551	COURSE ORIENTED PROJECT - II	Semester V 1H-0C

Instruction Hours/Week: L:0 T:0 P:1 **Marks:** Internal:**100** External:**0** Total:**100**

Course Objectives:

- To develop the skills to formulate a technical project.
- To give guidance on the various tasks of the project and standard procedures.
- To provide the guidelines to prepare a technical report of the project.
- Analyse problems and justify solutions using scientific knowledge.
- Design and conduct experiments, as well as analyse and interpret data.
- Familiar with cost-effectiveness analysis.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Identify a problemand develop the solutions.
- Apply technical ideas, strategies and methodologies.
- Analyse problems and justify solutions using scientific knowledge.
- Design and conduct experiments, as well as analyse and interpret data.
- Familiar with cost-effectiveness analysis.
- Prepare technical report and oral presentations.

Guidelines:

- A maximum of three students per teamshould do the project work.
- At the end of the semester, a report and a technical presentation should be made by the students.

18BEAE552	TECHNICAL PRESENTATION	Semester V 1H-0C

Instruction Hours/Week: L:0 T:0 P:1 **Marks:** Internal:**100** External:**0** Total:**100**

Course Objectives:

- To develop self-learning skills of utilizing various technical resources to make a technical presentation.
- To promote technical presentation and communication skills.
- To understand the guidelines to prepare the slides and effectively use it for presentation.
- To promote the ability for interacting and sharing attitude.
- Learn, practice and acquire the skills necessary
- Use a structured presentation methodology to prepare presentation material and effective visual aids

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Refer and utilise various technical resources available from multiple fields.
- Demonstrate sound technical knowledge on a given topic.
- Learn, practice and acquire the skills necessary
- Use a structured presentation methodology to prepare presentation material and effective visual aids
- Determine and develop personal presentation style
- To deliver effective presentation with clarity

18BEAE553	IN-PLANT TRAINING	Semester V 0H-0C

Instruction Hours/Week: L:0 T:0 P:0 **Marks:** Internal:**100** External:**0** Total:**100**

Course Objectives:

- To expose the students to the realworking environment.
- To develop skills in the application of theory to practical work situations.
- To build the strength, teamwork spirit and self-confidence in students life.
- To enhance the ability to improve students creativity skills and sharing ideas.
- Learn, practice and acquire the skills necessary
- Acquire knowledge through interaction with professionals

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Apply theoretical knowledge to practical work situations.
- Become updated with all the modern changes in technological world.
- Learn, practice and acquire the skills necessary
- Acquire knowledge through interaction with professionals
- Prepare report and presentation with effective visual aids
- To deliver effective presentation with clarity

Guidelines:

- Students should undergo in-plant training for a minimum duration ofthree weeks duration during winter/summer vacation between III and V semesters.
- A report with an in-plant training completion certificate from the industry should be subsequently submitted to the department within a week after completion of in-plant training.
- The viva-voce examination will be conducted at the end of V semester.

18BEAE601 AUTOMOTIVE CHASSIS COMPONENTS DESIGN **SemesterVI 4H-4C**

Instruction Hours/Week: L:3 T:1 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To learn the design procedure of frame and springs.
- To study the design procedure of front axle and steering linkages.
- To provide knowledge on the design of clutches.
- To impart knowledge on the design of three speed and four speed gearboxes.
- To study the design of driveline components.
- To facilitate the understanding ofshafts

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Design the frame and springs for automotive.
- Analyse the loads, moments and stresses at different sections of front axle.
- Design a suitable clutch for various engineering applications.
- Design the gearbox for various engineering applications.
- Design the propeller shaft to transmit required torque.
- Design the rear axle shafts

Course Contents:

UNIT I VEHICLE FRAME AND SUSPENSION

Study of loads – moments and stresses on frame members – design of frame for passenger andcommercial vehicle – design of leaf springs, coil springs and torsion bar springs.

UNIT II FRONT AXLE AND STEERING SYSTEMS

Analysis of loads, moments and stresses at different sections of front axle – determination of bearingloads at kingpin bearings, wheel spindle bearings – choice of bearings – determination of optimumdimensions and proportions for steering linkages, ensuring minimum error in steering – design of frontaxle beam.

UNIT III CLUTCH

Design of single plate clutch, multi-plate clutch and cone clutch – torque capacity of clutch – design ofclutch components – design details of roller and sprag clutches.

UNIT IV GEARBOX

Gear train calculations – layout of gearboxes – calculation of bearing loads and selection of bearings – design of three speed and four speed gearboxes.

UNIT V DRIVELINE AND REAR AXLE

Design of propeller shaft – design details of final drive gearing – design details of full floating, semi-floating and three-quarter floating rear shafts – design aspects of final drive.

Suggested Readings:

1. Giri N K, *Automobile Mechanics*, Khanna Publishers, New Delhi, 2008.
2. Giancarlo Genta and Lorenzo Morello, *The Automotive Chassis: Volume 1: Components Design*, Springer Netherlands, 2014.
3. Dean Averns, *Automobile Chassis Design*, Iliffe Books Ltd., 2001.

18BEAE602	ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT	Semester VI 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To introduce the basics of economics and cost analysis related to engineering so as to take economically sound decisions.
- To acquire knowledge on laws of demand and supply.
- To emphasise the systematic evaluation of the costs, break-even point for return on economics and diseconomies.
- To acquaint in pricing methods, payback and competition in the modern market structure.
- To impart knowledge on economic liberalization, privatization and globalization
- To enrich the understanding ofengineering economics analysis

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Apply the major concepts and techniques of engineering economic analysis in real-time applications.
- Analyse the demand and supply and sketch a demand and supply curve.
- Determine the break-even point and find out the strength and weakness of the market structure.
- Compare the cost of multiple projects by using the methods learned, and make a quantitative decision between alternate facilities and/or systems.
- Understand economic liberalization, privatization and globalization
- Apply the appropriate engineering economics analysis methods for problem solving.

Course Contents:

UNIT I FUNDAMENTALS OF ENGINEERING ECONOMICS

Introduction to engineering economics – definition and scope – significance of engineering economics – demand and supply analysis – law of demand – elasticity of demand – demand forecasting – supply – law of supply – elasticity of supply – market mechanism.

UNIT II FINANCIAL MANAGEMENT

Objectives and functions of financial management – financial statements, working capital management – factors influencing working capital requirements – estimation of working capital – cost analysis – basic cost concepts – total cost, variable cost, total cost, marginal cost – cost output in the short and long run.

UNIT III CAPITAL MARKET

Stock exchanges – functions – listing of companies – role of Securities and Exchange Board of India – index numbers – capital market reforms – money and banking – money – functions – value

of money – inflation and deflation – commercial bank and its functions – central bank and its functions.

UNIT IV NEW ECONOMIC ENVIRONMENT

Economic systems, economic liberalization –privatization – globalization – overview of international trade – World Trade Organization – intellectual property rights – capital budgeting – need for capital budgeting – project appraisal methods – payback period – average rate of return – time value of money – discounted cash flow techniques – feasibility report.

UNIT V DEPRECIATION AND BREAK-EVEN ANALYSIS

Depreciation – causes for depreciation – methods of computing depreciation – break-even analysis and its objectives – break-even chart – simple problems – managerial uses of break-even analysis.

Suggested Readings:

1. Ramachandra Aryasri A and Ramana Murthy V V, *Engineering Economics and Financial Accounting*, Tata McGraw-Hill, New Delhi, 2003.
2. Varshney R L and Maheshwari K L, *Managerial Economics*, Sultan Chand & Sons, New Delhi, 2014.
3. Paul A Samuelson and William D Nordhaus, *Economics*, Tata McGraw-Hill, New Delhi, 2010.

18BEAE641 **MANUFACTURING TECHNOLOGY** **Semester VI**
6H-5C

Instruction Hours/Week: L:3 T:0 P:3 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To impart knowledge on the basic principle and manufacturing methods of components.
- To study the steps involved in the casting process.
- To learn the theory of metal cutting and calculate the forces involved in it.
- To introduce the basic concepts of integrated manufacturing.
- To introduce the basic concepts of grinding process
- To provide an exhaustive knowledge on various generic process and benefits of rapid prototyping techniques.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- List and explain the steps involved in the casting process.
- Understand the theory of metal cutting
- Select the suitable type of machine for machining operations.
- Describe the types of grinding process.
- Select the suitable material handling and storage system for flexible manufacturing systems.
- Select appropriate rapid prototyping process for engineering applications.

Course Contents:

UNIT I METAL CASTING

Casting process: introduction, steps involved, types, advantages, limitations and applications – pattern: design, types, materials and allowances– moulding sand:constituents, types and properties – core making – melting practice and furnace – casting defects: types, causes and remedies.

UNIT II THEORY OF METAL CUTTING AND MACHINE TOOLS

Mechanics of chip formation – single point cutting tool – forces in machining – types of chip – cutting toolnomenclature – orthogonal and oblique metal cutting – cutting tool materials – tool wear, tool life, surface finish – cutting fluids.

Classification, construction and specifications of lathe, shaper, planer, milling and drilling machines – machining time and cost estimation.

UNIT III MANUFACTURE OF COMPONENTS AND ABRASIVE PROCESSES

Production of axisymmetriccomponents – production of prismatic components – hole-making processes – gear manufacturing processes.

Abrasive processes: grinding wheel – specifications and selection – cylindrical grinding, surface grinding, centreless grinding and internal grinding – typical applications – concepts of surface integrity.

UNIT IV INTEGRATED MANUFACTURING SYSTEM

Definition – application – features – types of manufacturing systems – computer numerical control systems – direct numerical control systems – manufacturing cells – Flexible Manufacturing Systems (FMS) –transfer systems – head changing FMS – group technology.

UNIT V RAPID PROTOTYPING

Introduction – principle, process and applications of stereo-lithography,selective laser sintering, fused deposition modelling, laminated object manufacturing and three-dimensional printing– rapid tooling – indirect rapid tooling – direct rapid tooling.

Suggested Readings:

1. Rao P N, *Manufacturing Technology Volume-I and Volume-II*, McGraw-Hill Education, 2018.
2. Amitabha Ghosh and Asok Kumar Mallik, *Manufacturing Science*, Affiliated East-West Press, 2010.
3. Pham D T and Dimov S S, *Rapid Manufacturing*, Springer, 2001.
4. HMT, *Production Technology*, Tata McGraw-Hill, New Delhi, 2001.
5. Serope Kalpakjian and Steven R Schmid, *Manufacturing Engineering and Technology*, Pearson, 2014.
6. Chua C K, Leong K F and Lim C S, *Rapid Prototyping: Principles and Applications*, World Scientific Publishing, 2010.

List of Experiments:

1. Study of machine shop layout and machine tools.
2. Facing, plain and step turning.
3. Grooving and taper turning.
4. Knurling and thread cutting.
5. Drilling, reaming and counterboring.
6. Tapping.
7. Keyway cutting.
8. V-block shaping.
9. Polygon milling.
10. Study of forging processes.

18BEAE611	VEHICLE MAINTENANCE LABORATORY	Semester VI 3H-2C

Instruction Hours/Week: L:0 T:0 P:3 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam: 3 hours

Course Objectives:

- To study the garage layout and general procedure for servicing.
- To learn the tuning of gasolineengine.
- To expose students to tuning of diesel engines
- To impart knowledge on fault diagnosis in electrical and electronic ignition systems.
- To provide knowledge on troubleshooting of fuel feed system, charging system, starting system and lighting system.
- To familiarise with adjustment of the headlight beam.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- List the procedure for servicing of an automobile.
- Demonstrate the tuning of gasoline engines.
- Demonstrate the tuning of diesel engines.
- Identify the fault in electrical and electronic ignition systems.
- Analyse and troubleshoot the faults of fuel feed system, charging system, starting system and lighting system.
- Demonstrate the adjustment of the headlight beam.

List of Experiments:

1. Study of an automobile garage.
2. Study of general procedures for servicing and maintenance schedule.
3. Tuning of gasoline and diesel engines.
4. Fault diagnosis in electrical and electronic ignition systems.
5. Troubleshooting of gasoline and diesel fuel feed systems.
6. Troubleshooting of charging system and starting system.
7. Troubleshooting of lighting system and accessories.
8. Simple tinkering and soldering work of body panels.
9. Adjustment of the headlight beam.
10. Study of door lock and window glass rising mechanisms.

18BEAE651	MINI PROJECT	Semester VI 2H-1C

Instruction Hours/Week: L:0 T:0 P:2 **Marks:** Internal:**100** External:**0** Total:**100**

Course Objectives:

- To develop knowledge to identify a real-world problem.
- To identify various tasks of the project to determine standard procedures.
- To identify and learn new tools, algorithms and techniques.
- To understand the various procedures for validation of the product and cost-effectiveness analysis.
- Design and conduct experiments
- Analyse and interpret data.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Demonstrate sound technical knowledge of a selected project topic.
- Apply the knowledge of mathematics, science and engineering to solve complex engineering problems.
- Identify, formulate and analyse problems and justify solutions using scientific knowledge.
- Design and conduct experiments
- Analyse and interpret data.
- Prepare technical report and oral presentations.

Guidelines:

- A maximum of four students per group should do the mini project.
- At the end of the semester, a report and a technical presentation along with a demonstration should be made by the students.

18BEAE652 ENGINE AND VEHICLE MANAGEMENT SYSTEM **Semester VI**
1H-0C

Instruction Hours/Week: L:1 T:0 P:0 **Marks:** Internal:**100** External:**0** Total:**100**

Course Objectives:

- To learn the fundamentals of automotive electronics and the principle of engine management.
- To impart knowledge ofvehicle management systems.
- Explain the Microprocessor architecture
- Describe the working of the fuel system components
- Discuss the working of various vehicle management systems.
- Explain the vehicle security systems

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Sketch the layout and explain the working of engine management systems.
- Explain the Microprocessor architecture
- Describe the working of the fuel system components
- Discuss the working of various vehicle management systems.
- Explain the vehicle security systems
- To learn the fundamentals of automotive electronics and the principle of engine management.

Course Contents:

PART I FUNDAMENTALS OF AUTOMOTIVE ELECTRONICS AND SI ENGINE MANAGEMENT

Microprocessor architecture – open and closed loop control strategies – PID control – lookup tables – introduction to modern control strategies like fuzzy logic and adaptive control – parameters to be controlled in SI and CI engines and in the other parts of the automobile.

Layout and working of SI enginemanagement systems like Bosch L-Jetronic and LH-Jetronic – group and sequential injectiontechniques – working of the fuel system components – cold start and warm up phases, idle speedcontrol, acceleration and full load enrichment, deceleration fuel cut-off – fuel control maps – open loopcontrol of fuel injection and closed loop lambda control.

PART II VEHICLE MANAGEMENT SYSTEMS

ABS system, its need, layout and working – electronic control of suspension – damping control – electric power steering – supplementary restraint system of airbag system – crash sensor – seat belttightening – cruise control – vehicle security systems – alarms – vehicle tracking system – onboarddiagnostics – collision avoidance – radar warning system.

Suggested Readings:

1. William B Ribbens, *Understanding Automotive Electronics*, Butterworth-Heinemann, 2017.
2. Robert Bosch GmbH, *Gasoline-Engine Management*, John Wiley & Sons, 2006.

18BEAE653 ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE **Semester VI**
1H-0C

Instruction Hours/Week: L:1 T:0 P:0 **Marks:** Internal:**100** External:**0** Total:**100**

Course Objectives:

- To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the importance of roots of knowledge system.
- Know the need and importance of protecting traditional knowledge.
- Know the various government acts and rules for the protection of traditional knowledge.
- Understand the concepts of intellectual property to protect traditional knowledge.
- Know the traditional knowledge in different sectors like engineering, medicine, etc.
- Understand the importance of conservation and sustainable development of environment

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Understand the concept of traditional knowledge and its importance.
- Know the need and importance of protecting traditional knowledge.
- Know the various government acts and rules for the protection of traditional knowledge.
- Understand the concepts of intellectual property to protect traditional knowledge.
- Know the traditional knowledge in different sectors like engineering, medicine, etc.
- Understand the importance of conservation and sustainable development of environment

Course Contents:

UNIT I INTRODUCTION TO TRADITIONAL KNOWLEDGE

Define traditional knowledge – nature and characteristics – scope and importance – kinds of traditional knowledge – physical and social contexts in which traditional knowledge develop – historical impact of social change on traditional knowledge systems – indigenous knowledge – characteristics – traditional knowledge vis-à-vis indigenous knowledge – traditional knowledge vs. western knowledge – traditional knowledge vis-à-vis formal knowledge.

UNIT II PROTECTION OF TRADITIONAL KNOWLEDGE

Protection of traditional knowledge – need for protecting traditional knowledge – significance of traditional knowledgeprotection – value of traditional knowledge in global economy – role of government to harness traditional knowledge.

UNIT III GOVERNMENT ACTS

The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 – Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act)

The Biological Diversity Act, 2002 and Rules, 2004 – The Protection of Traditional Knowledge Bill, 2016 – Geographical Indicators Act, 2003.

UNIT IV INTELLECTUAL PROPERTY RIGHTS

Traditional knowledge and intellectual property – systems of traditional knowledge protection – legal concepts for the protection of traditional knowledge – certain non-IPR mechanisms of traditional knowledge protection – patents and traditional knowledge – strategies to increase protection of traditional knowledge – global legal forum for increasing protection of Indian traditional knowledge.

UNIT V TRADITIONAL KNOWLEDGE IN DIFFERENT SECTORS

Traditional knowledge and engineering – traditional medicine system – traditional knowledge and biotechnology – traditional knowledge in agriculture –traditional societies depend on it for their food and healthcare needs – importance of conservation and sustainable development of environment – management of biodiversity – food security of the country – protection of traditional knowledge.

Suggested Readings:

1. Amit Jha, *Traditional Knowledge System in India*, Atlantic Publishers & Distributors, 2009.
2. Basanta Kumar Mohanta, Vipin Kumar Singh, *Traditional Knowledge System & Technology in India*, Pratibha Prakashan, 2012.
3. Kapil Kapoor and Michel Danino, *Knowledge Traditions and Practices of India*, CBSE, 2012.

18BEAE701	TOTAL QUALITY MANAGEMENT	SemesterVII 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To learn concepts, dimension quality and philosophies of TQM.
- To study the TQM principles and its strategies.
- To expose the seven statistical quality and management tools.
- To impart knowledge on TQM tools for continuous improvement.
- To introduce the quality systems and procedures adopted.
- To acquaint the student with the concepts of quality management system

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Use the concepts, dimension of quality and philosophies of TQM.
- Apply the principles of TQM and its strategies in industries.
- Apply the statistical quality tools and seven management tools.
- Choose suitable TQM tools for continuous improvement.
- Understand the Failure Modes and Effects Analysis
- Use the concepts of quality management system in industries.

Course Contents:

UNIT I INTRODUCTION

Definition and dimensions of quality – quality costs – basic concepts of Total Quality Management (TQM)– principles of TQM – leadership concepts – role ofsenior management – quality council – quality statement – strategic planning –Deming philosophy – TQMimplementation barriers.

UNIT II TQM PRINCIPLES

Customer satisfaction – customer perception of quality – customer complaints – customer retention – employee involvement – motivation, empowerment, teams, recognition and reward, performance appraisal – continuous process improvement – Juran trilogy, Plan-Do-Study-Act (PDSA) cycle, 5S, Kaizen – supplier partnership – partnering, supplier selection, supplier rating – performance measures.

UNIT III STATISTICAL PROCESS CONTROL

The seven tools of quality – statistical fundamentals – measures of central tendency and dispersion – population and sample – normal curve – control charts for variables and attributes – process capability – concept of six sigma – new seven management tools.

UNIT IV TQM TOOLS

Benchmarking –quality function deployment –Taguchi quality loss function – total productive maintenance – Failure Modes and Effects Analysis (FMEA).

UNIT V QUALITY SYSTEM

Need – ISO 9000 quality system – quality system elements – implementation of quality system – documentation – QS 9000 –ISO/TS 16949 – ISO14000.

Suggested Readings:

1. Dale H Besterfield, Carol Besterfield-Michna, Glen Besterfield and Mary Besterfield-Sacre, *Total Quality Management*, Pearson Education, 2013.
2. James R Evans and William M Lindsay Evans, *The Management and Control of Quality*, Cengage Learning, 2012.
3. Janakiraman B and Gopal R K, *Total Quality Management: Text and Cases*, Prentice-Hall of India, 2006.
4. Suganthi L and Anand A Samuel, *Total Quality Management*, Prentice-Hall of India, 2011.

18BEAE711	COMPUTER AIDED DESIGN ANALYSIS LABORATORY	Semester VII 3H-2C

Instruction Hours/Week: L:0 T:0 P:3 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To introduce knowledge of the FEA software as a tool for analysis.
- To provide knowledge on contact stress analysis using FEA software.
- To impart knowledge on transient analysis using FEA software.
- To learn about temperature distribution for heat conduction using FEA software.
- To impart knowledge on coupled field analysis using FEA software.
- To expose students toanalysis of the simple structure using FEA software

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Analysis of piston and connecting rod using FEA software.
- Analysis of bumper using FEA software.
- Analysis of leaf spring using FEA software.
- Analysis of composite structure using FEA software
- Find the temperature distribution for heat conduction using FEA software.
- Dynamic analysis of the simple structure using FEA software.

List of Experiments:

1. Thermal analysis of piston.
2. Transient analysis of connecting rod.
3. Crash analysis of bumper.
4. Coupled field analysis of brake shoe.
5. Contact stress analysis of leaf spring.
6. Contact stress analysis of gear pair.
7. Stress analysis of the composite structure.
8. Study of combustion analysis.
9. Study of aerodynamic analysis.

18BEAE751 **INDUSTRIAL ROBOTICS** **Semester VII**
1H-0C

Instruction Hours/Week: L:1 T:0 P:0 **Marks:** Internal:**100** External:**0** Total:**100**

Course Objectives:

- To learn the construction and fundamentals of robots.
- To provide knowledge on types of drives and end effectors in robots.
- To impart knowledge on sensors and machine vision system.
- To provide knowledge on the applications of robots in industries.
- Select a suitable drive and an end effectfor industrial robots.
- Choose sensors and machine vision system for industrial robots.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Identify the components and construction of robot manipulator.
- Understand the sensors
- Select a suitable drive and an end effectfor industrial robots.
- Choose sensors and machine vision system for industrial robots.
- Discuss the usage and applications of robots in industries.
- Understand the economic analysis of robots

Course Contents:

PART I FUNDAMENTALS OF ROBOT

Robot – definition – robot anatomy – co-ordinate systems – work envelopetypes and classification – specifications – pitch, yaw, roll, joint notations, speed of motion, payload – robot parts and their functions – need for robots – different applications – pneumatic drives – hydraulic drives – mechanical drives – electrical drives – DC servo motors, stepper motor, AC servo motors –end effectors – grippers – requirements of a sensor– position sensors, proximity sensors, touch sensors – camera, frame grabber, sensing and digitizing image.

PART II ROBOT CELL DESIGN AND APPLICATIONS

Robot work cell design and control – sequence control, operator interface – mobile robot working principle – robot applications – material handling, machine loading and unloading, assembly, inspection,welding, spray painting and undersea robot – safety considerations forrobot operations – economic analysis of robots.

Suggested Readings:

1. Mikell P Groover, Mitchell Weiss, Roger N Nagel, Nicholas G Odrey, and Ashish Dutta, *Industrial Robotics: Technology, Programming and Applications*, McGraw-Hill Education, 2012.
2. John J Craig, *Introduction to Robotics: Mechanics and Control*, Pearson, 2018.
3. Deb S R and Deb S, *Robotics Technology and Flexible Automation*, McGraw-Hill Education, 2009.

18BEAE791	PROJECT PHASE - I	Semester VII 4H-2C

Instruction Hours/Week: L:0 T:0 P:4 **Marks:** Internal:**100** External:**0** Total:**100**

Course Objectives:

- To develop knowledge to identify a real-world problem.
- To identify the various tasks of the project to determine standard procedures.
- To identify and learn new tools, algorithms and techniques.
- To understand the various procedures for validation of the product and cost-effectiveness analysis.
- Identify, formulate and analyse problems and justify solutions using scientific knowledge.
- Design and conduct experiments, as well as analyse and interpret data.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Demonstrate a sound technical knowledge of their selected project topic.
- Apply the knowledge of mathematics, science and engineering to solve complex engineering problems.
- Identify, formulate and analyse problems and justify solutions using scientific knowledge.
- Design and conduct experiments, as well as analyse and interpret data.
- Familiar with cost-effectiveness analysis.
- Prepare technical report and oral presentations.

Guidelines:

- A maximum of four students per teamshould do the project work.
- At the end of the semester, a report and a technical presentation should be made by the students.

18BEAE801	PROFESSIONAL ETHICS AND ENTREPRENEURSHIP DEVELOPMENT	SemesterVIII 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam: 3 hours

Course Objectives:

- To create an awareness of human values and engineering ethics to instil moral and social values.
- To understand fundamental concepts and principles of management, including the basic roles, skills, and functions of management.
- To develop and strengthen entrepreneurial quality and motivation in students and to impart basic entrepreneurial skills to run a business efficiently and effectively.
- Implement the importance of ethics and professionalism.
- Practice the process of management's four functions.
- Understand the stress management

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Explain the human values.
- Implement the importance of ethics and professionalism.
- Practice the process of management's four functions.
- Understand the stress management
- Understand the budgetary and non-budgetary control technique
- Understand the entrepreneurial characteristics.

Course Contents:

UNIT I HUMAN VALUES

Morals, values and ethics – integrity – work ethic – service learning – civic virtue – respect forothers – living peacefully – caring – sharing – honesty – courage – valuing time – cooperation – commitment – empathy – self-confidence – character – spirituality – introduction to yoga andmeditation for professional excellence and stress management.

UNIT II ENGINEERING ETHICS

Senses of engineering ethics – variety of moral issues – types of inquiry – moral dilemmas – moral autonomy – Kohlberg's theory – Gilligan's theory – consensus and controversy – models of professional roles – theories about right action – self-interest – customs and religion – uses of ethical theories.

UNIT III INTRODUCTION TO MANAGEMENT, PLANNING AND ORGANISING

Definition of management – management and administration – development of management thought – contribution of Taylor and Fayol – functions of management – nature and purpose of planning – planning process – types of planning – objectives – setting objectives – policies –

planning premises – planning tools and techniques – decision making steps and process – nature and purpose of organising – formal and informal organization – organization chart – types.

UNIT IV DIRECTING AND CONTROLLING

Foundations of individual and group behaviour – motivation – motivation theories – motivational techniques – job satisfaction – job enrichment – leadership – types and theories of leadership – communication – process of communication – system and process of controlling – budgetary and non-budgetary control techniques – control and performance – direct and preventive control – reporting.

UNIT V ENTREPRENEURSHIP AND MOTIVATION

Entrepreneur – types of entrepreneurs – difference between entrepreneur and intrapreneur – entrepreneurship in economic growth – factors affecting entrepreneurial growth – major motives influencing an entrepreneur – achievement motivation training – self rating – business games – thematic apperception test – stress management – entrepreneurship development programs – need, objectives.

Suggested Readings:

1. Govindarajan M, Natarajan S and Senthil Kumar V S, *Professional Ethics and Human Values*, PHI Learning, New Delhi, 2013.
2. Tripathi P C and Reddy P N, *Principles of Management*, McGraw-Hill Education, 2012.
3. Khanka S S, *Entrepreneurial Development*, S. Chand Publishing, New Delhi, 2006.
4. Charles E Harris, Michael S Pritchard, Michael J Rabins, Ray James and Elaine Englehardt, *Engineering Ethics: Concepts and Cases*, Cengage Learning, 2013.
5. Stephen P Robbins, Mary A Coulter and David A De Cenzo, *Fundamentals of Management*, Pearson Education, 2017.
6. Sangeeta Sharma, *Entrepreneurship Development*, PHI Learning, New Delhi, 2016.

18BEAE891	PROJECT PHASE - II	Semester VIII 12H-6C

Instruction Hours/Week: L:0 T:0 P:12 **Marks:** Internal:**120** External:**180** Total:**300**

Course Objectives:

- To identify the various tasks of the project to determine standard procedures.
- To identify and learn new tools, algorithms and techniques.
- To understand the various procedures for validation of the product and cost-effectiveness analysis.
- Apply the knowledge of mathematics, science and engineering to solve complex engineering problems.
- Identify, formulate and analyse problems and justifysolutions using scientific knowledge.
- Design and conduct experiments, as well as analyse and interpret data.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Demonstrate sound technical knowledge of the project topic.
- Apply the knowledge of mathematics, science and engineering to solve complex engineering problems.
- Identify, formulate and analyse problems and justifysolutions using scientific knowledge.
- Design and conduct experiments, as well as analyse and interpret data.
- Execute the project based on the design developed during phase - I.
- Prepare technical report and oral presentations.

Guidelines:

- A maximum of four students per teamshould do the project work.
- At the end of the semester, a report and a technical presentation should be made by the students.

18BEAE5E01 AUTOMOTIVE EMISSIONS AND NVH CONTROL **Semester V**
3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To impart knowledge on the mechanism of pollutant formation in engines.
- To understand the importance of post-combustion treatments to control pollution.
- To study the pollution treatment and control techniques.
- To provide knowledge on the laws and regulations related to automotive emission levels.
- To introduce properties of tyres affecting vibration and noise
- To learn the noise and vibration control techniques.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Explain the mechanism of pollutant formation in engines.
- Apply the knowledge of post-combustion treatments to control pollution.
- Discuss the control techniques and instrumentation for pollution measurements.
- State the laws and regulations related to automotive emission levels.
- Discuss the properties of tyres affecting vibration and noise
- Design the systems to reduce noise andvibration.

Course Contents:

UNIT I MECHANISM OF POLLUTANT FORMATION AND POST-COMBUSTIONTREATMENTS

Introduction – pollutants – sources – formation of hydrocarbon(HC) and carbon monoxide (CO) in SI engines – nitrogen oxides (NOx) formation in SI and CI engines – particulate emission from SI and CI engines – smoke emission in CI engines – effect of operating variables on emission formation.

Post-combustion treatments: physical conditions and exhaust gas compositions before treatment – catalytic mechanism – thermal reactions – installation of catalyst in exhaust lines – NOx treatment in diesel engines – diesel trap oxidizers.

UNIT II CONTROL TECHNIQUES AND INSTRUMENTATION FOR POLLUTION MEASUREMENTS

Crankcase emission control – fuel evaporation and control – exhaust gas recirculation – intake temperature control – air injected exhaust – thermal reactors – selective catalytic reduction – catalytic converters – types – catalytic mechanism – tuning ofmechanicalsystems – air-fuel ratio control – non-dispersive infrared analyser – flameionization detectors – chemiluminescentanalyser – smoke meters – gas chromatograph – onboard diagnostic system.

UNIT III LAWS AND REGULATIONS

Historical background – regulatory test procedures (European cycles) – exhaust gas pollutants – particulate pollutants – European statutory values – inspection ofvehicles in circulation – influence of actual traffic conditions and influence of vehiclemaintenance – Indian emission standards.

UNIT IV NOISE CONTROL

Identification of noise sources – quantification – control of airborne noise – use of noise absorber, barrier, different materials – criteria for the selection of materials – control of structure-borne noise – treatments for vibration damping materials for hood liner and headliner – resonance and ill effects of resonance – characteristics of vehicle noise – sources of vehicle noise – engine noise, techniques for locating and measuring engine noise – engine noise control techniques – inlet and exhaust noise mechanism and control – noise from cooling system – transmission noise and tyre noise – anechoic chamber.

UNIT V VIBRATION CONTROL

Introduction – vibration analysis – sources of vibration – damping of vibration – rubber mountings – vibration isolation and absorption – constrained and extensive layer damping – engine anddrivetrain vibration – vehicle and chassis vibration – application of plastics and composites in automobiles – properties of tyres affecting vibration and noise.

Suggested Readings:

1. George S Springer and Donold J Patterson, *Engine Emissions*, Plenum Press, 1990.
2. Crouse W M and Anglin A L, *Automotive Emission Control*, McGraw-Hill, 1995.
3. John B Heywood, *Internal Combustion Engine Fundamentals*, McGraw-Hill, 2011.
4. Matthew Harrison, *Vehicle Refinement: Controlling Noise and Vibration in Road Vehicles*, Elsevier, 2004.
5. Ganesan V, *Internal Combustion Engines*, Tata McGraw-Hill, New Delhi, 2012.
6. Patterson D J and Henin N A, *Emission from Combustion Engine and their Control*, Anna. Arbor Science Publication, 1985.
7. Heinz Heisler, *Advanced Engine Technology*, Butterworth-Heinemann, 2005.
8. Robert Hickling and Mounir M Kamal, *Engine Noise: Excitation, Vibration and Radiation*, Plenum Press, New York, 1982.
9. White R G and Walker J G, *Noise and Vibration*, Ellis Horwood Ltd., 1982.

18BEAE5E02	VEHICLE BODY ENGINEERING	Semester V 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam: 3 hours

Course Objectives:

- To understand the vehicle aerodynamics.
- To impart knowledge on body construction of the car, bus and commercial vehicles.
- To study the body materials, mechanisms and repair.
- To impart knowledge on the safety aspect of bus body
- To introduce the concepts of regulations
- To expose students to material used in bodybuilding, tools used and body repairs

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Distinguish the various aerodynamic forces and moments.
- Explain different aspects of the car body, bus body and commercial vehicle.
- Describe the safety aspect of bus body
- Describe the commercial vehicle bodies
- Explain the regulations.
- Describe the material used in bodybuilding, tools used and body repairs.

Course Contents:

UNIT I VEHICLE AERODYNAMICS

Objectives – vehicle drag and types – various types of forces and moments – effects of forces and moments – side wind effects on forces and moments – various body optimization techniques for minimum drag – wind tunnels – principle of operation – types – wind tunnel testing such as flow visualization techniques, airflow management test – measurement of various forces and moments by using wind tunnel.

UNIT II CAR BODY

Types of car body – saloon, convertibles, limousine, estate van, racing and sports car – visibility regulations – driver's visibility, improvement in visibility and tests for visibility – driver seat design – car body construction – various panels in car bodies – safety aspect of car body.

UNIT III BUS BODY

Types of bus body based on capacity, distance travelled and construction – bus body layout for various types – types of metal sections used – regulations – constructional details of conventional and integral – driver seat design – safety aspect of bus body.

UNIT IV COMMERCIAL VEHICLE BODY

Types of commercial vehicle bodies – light commercial vehicle body – construction details of commercial vehicle body – flat platform body, trailer, tipper body and tanker body – dimensions of driver's seat in relation to controls – drivers cab design – regulations.

UNIT V BODY MATERIALS, TRIM, MECHANISMS AND BODY REPAIR

Types of materials used in body construction – steel sheet, timber, plastics, Glass Reinforced Plastic (GRP) – properties of materials – body trim items – body mechanisms – hand tools – power tools – panel repair – repairing sheet metal – repairing plastics – body fillers – passenger compartment service – anticorrosion methods – modern painting process procedure – paint problems.

Suggested Readings:

1. James E Duffy, *Body Repair Technology for 4-Wheelers*, Cengage Learning, 2009.
2. Powloski J, *Vehicle Body Engineering*, Business Books Ltd., 1998.
3. BraithwaiteJB, *Vehicle Body Building and Drawing*, Heinemann Educational Books Ltd., London, 1997.
4. Dieler Anselm, *The Passenger Car Body*, SAE International, 2000.
5. GilesGJ, *Body Construction and Design*, Illiffe Books Butterworth & Co., 1991.
6. John Fenton, *Vehicle Body Layout and Analysis*, Mechanical Engineering Publication Ltd., London, 1992.

18BEAE5E03 18BEAEOE02	TWO AND THREE WHEELER TECHNOLOGY	Semester V 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To impart technical knowledge on construction and working of the power train and drive train of two and three wheeler vehicles.
- To familiarise with maintenance procedures of the engine and subsystems of two and three wheelers.
- To impart knowledge on types of transmission systems
- To impart knowledge on types of steering and suspension systems
- To impart knowledge on types of wheels, tyres and brakes for two and three wheelers
- To make the students conversant on servicing of two and three wheelers.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Construct the frames of two and three wheelers of different layouts.
- Demonstrate the constructional details and principle of operation of various engine components.
- Identify and explain the types of transmission systems.
- Identify and explain the types of steering and suspension systems.
- Classify and describe the types of wheels, tyres and brakes for two and three wheelers.
- Explain the servicing of two and three wheelers.

Course Contents:

UNIT I INTRODUCTION

History of two and three wheelers – classification and layouts of two wheelers – classification and layouts of three wheelers – main frame for two wheelers and types – main frame for three wheelers and types.

UNIT II INTERNAL COMBUSTION ENGINES

Classification of engines – selection criteria of engine for two and three wheelers – design considerations for two and three wheeler engines – construction and working of two-stroke and four-stroke engines – fuel feed system – lubricating system – cooling system – scavenging system – cranking system – kick start and auto-start mechanisms.

UNIT III TRANSMISSION, STEERING AND SUSPENSION SYSTEMS

Clutch – single plate, multiple plate and centrifugal clutches – primary reduction – transmission gearbox – gear shifting mechanisms – automatic transmission – final drive and differential for three wheelers – steering geometry – steering column construction – steering system for three wheelers – front and rear suspension systems – spring and shock absorber assembly.

UNIT IV WHEELS, TYRES AND BRAKES

Spoked wheels, pressed steel wheels and alloy wheel – tyre construction – tyre with tube and tubeless tyre – theory of brake action – drum and disc brakes – brake links layout for front and rear wheels – mechanical and hydraulic brake control systems – anti-lock braking system.

UNIT V TWO AND THREE WHEELERS CASE STUDY

Case study of mopeds, scooters, motor cycles, sports bikes, auto rickshaws, pickup vans, delivery vans and trailers – servicing – factors affecting fuel economy and emission.

Suggested Readings:

1. Dhruv U Panchal, *Two and Three Wheeler Technology*, PHI Learning, New Delhi, 2015.
2. Ramalingam K K, *Two Wheelers and Three Wheelers: Theory, Operation and Maintenance*, Scitech Publications, Chennai, 2017.
3. Irving P E, *Motorcycle Engineering*, Veloce Enterprises, USA, 2017.
4. Dennis Bailey and Keith Gates, *Bike Repair and Maintenance for Dummies*, John Wiley & Sons, USA, 2009.
5. Chris Grissom, Matt Spitzer, Bruce A Johns and David D Edmundson, *Motorcycles: Fundamentals, Service, Repair*, Goodheart-Willcox, 2019.

18BEAE5E04	TRACTOR AND FARM EQUIPMENTS	Semester V 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To familiarise the components of a tractor and its controls.
- To impart knowledge on thevarious farm equipment.
- To expose students to the types of tractors.
- To familiarize the students to understand the performance characteristics of a tractor engine.
- To facilitate the understanding ofcooling and lubrication system for troubleshooting.
- To impart knowledge on tractorattachments

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Classify the types of tractors.
- Explain the performance characteristics of a tractor engine.
- Discuss the construction and operation of the valve mechanism.
- Analyse the cooling and lubrication system for troubleshooting.
- Discuss the tractorattachments
- List and explain the various farm equipment.

Course Contents:

UNIT I GENERAL DESIGN OF TRACTORS

Classification of tractors –main components of tractor –safety rules.

UNIT II CONTROL OF THE TRACTOR AND FUNDAMENTALS OF ENGINE OPERATION

Tractor controls and the starting of the tractor engines –basic notions and definition –engine cycles – operation of multi-cylinder engines –general engine design –basic engine performance characteristics.

UNIT III ENGINE FRAMEWORK AND VALVE MECHANISM OF TRACTOR

Cylinder and pistons –connecting rods and crankshafts – engine balancing –construction and operation of the valve mechanism –valve mechanism components –valve mechanism troubles.

UNIT IV COOLING, LUBRICATION AND FUEL SYSTEM

Cooling system –classification –liquid cooling system –components – lubrication system –servicing and troubles – fuel tanks and filters –fuel pumps –air cleaner and turbocharger.

UNIT V FARM EQUIPMENT

Tractorattachments –farm equipment –classification –auxiliary equipment –trailers and body tipping mechanism.

Suggested Readings:

1. RodichevV and Rodicheva G, *Tractors and Automobiles*, Mir Publishers, Moscow, 1984.
2. Kolchin A and Demidov V, *Design of Automotive Engines*, Mir Publishers, Moscow, 1984.
3. John B Liljedahl, Walter M Carleton, Paul K Turnquist and David W Smith, *Tractors and their Power Units*, Avi Publishing, 1985.

18BEAE5E05	VIBRATION AND NOISE CONTROL	Semester V 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To impart knowledge on the basics of vibration and noise.
- To understand the importance of single degree and two degrees of freedom vibration systems.
- To equip them with skills to Calculate the total sound pressure level
- To enrich the understanding offrequency analysis
- To understandthe sources of vibration and noise.
- To learn the vibration and noise control techniques.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- List and explain the types of vibrations.
- Analyse a single degree and two degrees of freedom vibration systems.
- Calculate the total sound pressure levelproduced by two sounds of different levels.
- Apply frequency analysis
- Identify the sources of vibrationin automobiles.
- Design the systems to reduce vibration and noise.

Course Contents:

UNIT I BASICS OF VIBRATION

Introduction – classification of vibration – free and forced vibration – undamped and damped vibration – linear and non-linear vibration – response of damped and undamped systems under harmonic force – analysis of single degree and two degree of freedom systems – torsional vibration – determination of natural frequencies.

UNIT II BASICS OF NOISE

Introduction – amplitude, frequency, wavelength and sound pressure level – addition, subtraction and averaging decibel levels – noise dose level – legislation – measurement and analysis of noise – measurement environment – equipment – frequency analysis – tracking analysis – sound quality analysis.

UNIT III AUTOMOTIVE NOISE SOURCES

Noise characteristics of engines – engine overall noise levels – assessment of combustion noise – assessment of mechanical noise – engine radiated noise – intake and exhaust noise – engine necessary contributed noise – transmission noise – aerodynamic noise – tyre noise – brake noise.

UNIT IV VIBRATION CONTROL TECHNIQUES

Vibration isolation – tuned absorbers – untuned viscous dampers – damping treatments – application – dynamic forces generated by IC engines – engine isolation – crankshaft damping – modal analysis of the mass elastic model – shock absorbers.

UNIT V NOISE CONTROL

Methods for control of engine noise, combustion noise, mechanical noise – predictive analysis – palliative treatments and enclosures – automotive noise control principles – sound in enclosures – sound energy absorption – sound transmission through barriers.

Suggested Readings:

1. Singiresu S Rao, *Mechanical Vibrations*, Pearson Education, 2017.
2. Kewal Pujara, *Vibrations and Noise for Engineers*, Dhanpat Rai Publishing, 2013.
3. Ramamurti V, *Mechanical Vibration Practice and Noise Control*, Narosa Publishing House, 2017.
4. Shabana A A, *Theory of Vibration*, Springer-Verlag New York, 1996.
5. William T Thomson, Marie Dillon Dahleh and Chandramouli Padmanabhan, *Theory of Vibrations with Applications*, Pearson Education, 2008.
6. Rao J S and Gupta K, *Introductory Course on Theory and Practice of Mechanical Vibrations*, New Age International, 1999.
7. David A Bies and Colin H Hansen, *Engineering Noise Control: Theory and Practice*, CRC Press, 2017.

18BEAE5E06	COMPOSITE MATERIALS	Semester V 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To provide fundamental knowledge on the reinforcement and matrix materials.
- To expose the characteristics and different fabrication techniques of polymer matrix composites.
- To impart knowledge on the metal matrix composites.
- To provide knowledge on the ceramic matrix composites.
- To impart knowledge on the advanced composites.
- To provide knowledge onapplications of composite in various industries.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Identify suitable reinforcement and matrix materials for different applications.
- Select appropriate fabrication technique for the specific application of polymer matrix composite.
- Selectsuitable processing method for the fabrication of metal matrix composites.
- Select suitable fabrication method for the specific application of ceramic matrix composite.'
- Describes the sol-gel technique
- Identify the advanced composites for appropriate applications.

Course Contents:

UNIT I INTRODUCTION TO COMPOSITES

Fundamentals of composites – need for composites– enhancement of properties – classification of composites – matrix – Polymer Matrix Composites (PMC), Metal Matrix Composites (MMC), Ceramic Matrix Composites (CMC) – reinforcement – particle reinforced composites, fibre reinforced composites – applications of various types of composites.

UNIT II POLYMER MATRIX COMPOSITES

Polymer matrix resins – thermosetting resins, thermoplastic resins – reinforcement fibres – rovings – woven fabrics – non-woven random mats – various types of fibres – PMC processes –hand layup processes – spray-up processes – compression moulding – reinforced reaction injection moulding – resin transfer moulding – pultrusion – filament winding – injection moulding – Fibre Reinforced Plastics (FRP), Glass Fibre Reinforced Plastics (GRP).

UNIT III METAL MATRIX COMPOSITES

Characteristics ofMMC – various types of MMC – alloy vs. MMC – advantages and limitations of MMC – metal matrix reinforcements – particles – fibres – effect of reinforcement –volume fraction – rule of mixtures – processing of MMC – powder metallurgy process – diffusion bonding – stir casting – squeeze casting.

UNIT IV CERAMIC MATRIX COMPOSITES

Engineering ceramic materials– properties – advantages – limitations – monolithic ceramics –need for CMC – ceramic matrix –various types of CMC – oxide ceramics – non-oxide ceramics – aluminium oxide – silicon nitride – reinforcements – particles – fibres – whiskers – sintering – hot pressing – cold isostatic pressing – hot isostatic pressing.

UNIT V ADVANCES IN COMPOSITES

Carbon/carbon composites – advantages and limitations of carbon matrix – carbon fibre – chemical vapour deposition of carbon on carbon fibre perform – sol-gel technique – composites for aerospace applications.

Suggested Readings:

1. Bhagwan D Agarwal, Lawrence J Broutman and Chandrashekhara K, *Analysis and Performance of Fiber Composites*, John Wiley & Sons, 2017.
2. Krishan K Chawla, *Composite Materials: Science and Engineering*, Springer-Verlag New York, 2012.
3. Sharma S C, *Composite Materials*, Narosa Publishing House, 2000.
4. Clyne T W and Withers P J, *An Introduction to Metal Matrix Composites*, Cambridge University Press, 1993.
5. Brent Strong A, *Fundamentals of Composites Manufacturing*, SME, 2007.
6. Matthews F L and Rawlings R D, *Composite Materials: Engineering and Science*, Woodhead Publishing, 1999.
7. Ronald F Gibson, *Principles of Composite Material Mechanics*, CRC Press, 2016.

18BEAE6E01 **ADVANCED THEORY OF IC ENGINES** **Semester VI**
3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To impart knowledge on advancement in IC engine construction and combustion process.
- To familiarise the combustion modelling.
- To enrich the understanding of advances in IC Engines
- To expose students to performance of the IC engines
- To facilitate the understanding ofcomputer control of engine parameters
- To impart knowledge onperformance maps

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Explain the operating cycles of SI engines, CI engines and gas turbines.
- Understand the IC engine combustion processes.
- Analyse the causes of knocking in combustion.
- Apply new techniques to improve the performance of the IC engines.
- Explain the computer control of engine parameters for pollution control
- Explain the performance maps.

Course Contents:

UNIT I CYCLE ANALYSIS

Operating cycles of SIengines, CIengines and gas turbines– comparison of air standard cycle –fuel-air cycle and actual cycle.

UNIT II COMBUSTION OF FUELS

Combustion stoichiometry of petrol, diesel, alcohol and hydrogen fuels –chemical energy and heating values –chemical equilibrium and maximum temperature – SI engine combustion –flame velocity and area of flame front – CI engine combustion – fuel spray characteristics – droplet size, penetration and atomization.

UNIT III COMBUSTION MODELLING

Basic concepts of engine simulation – governing equation –flow models – thermodynamic models – SI engine and CI engine models.

UNIT IV ADVANCES IN IC ENGINES

Adiabatic and Low Heat Rejection (LHR) engines – MAN combustion chamber and multi-fuel engines –stratified charged and lean burn engines –locomotive and marine engines.

UNIT V OPERATION AND PERFORMANCE OF ENGINES

Computer control of engine parameters for pollution control and better efficiency –closed-loop control of engine parameters –hybrid operation – performance maps.

Suggested Readings:

1. Ganesan V, *Internal Combustion Engines*, McGraw-Hill Education, New Delhi, 2012.
2. Ganesan V, *Computer Simulation of Spark-Ignition Engine Processes*, Universities Press, Hyderabad, 1996.
3. John B Heywood, *Internal Combustion Engine Fundamentals*, McGraw-Hill Education, 2011.

18BEAE6E02 **AUTOMOTIVE AIRCONDITIONING** **Semester VI**
3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To gain knowledge offundamentals of the automotive air conditioning.
- To study the working ofautomotive cooling and heating systems.
- To provide knowledge on air conditioning controls, delivery system and refrigerants.
- To impart knowledge on working of automatic temperature control.
- To learn the system servicing and testing.
- To impart knowledge on special tools for servicing

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Apply the psychrometry principles.
- Explain the components of vehicle air conditioning systems.
- Describe the air conditioning controls.
- Select the suitable sensors and actuators for automatic temperature control.
- Discover and troubleshoot the fault in vehicle air conditioning systems.
- Describe the special tools for servicing vehicle air conditioning

Course Contents:

UNIT I AUTOMOTIVE AIRCONDITIONING FUNDAMENTALS

Purposes of heating, ventilation and air conditioning – environmental concerns – ozone layer depletion – location of air conditioning components in a car – schematic layout of a vehicle refrigeration system – psychrometry – basic terminology and psychrometric mixtures – psychrometric chart.

UNIT II AUTOMOTIVE COOLING AND HEATING SYSTEM

Vehicle refrigeration system and related problems – fixed thermostatic and orifice tube system – variable displacement thermostatic and orifice tube system – vehicle air conditioning operation – types of compressor – compressor clutches – compressor clutch electrical circuit – compressor lubrication – condensers – evaporators – expansion devices – evaporator temperature and pressure controls – receiver – drier – accumulators – refrigerant hoses, connections and other assemblies – heating system.

UNIT III AIR CONDITIONING CONTROLS, DELIVERY SYSTEM AND REFRIGERANTS

Types of control devices – preventing compressor damage – preventing damage to other systems – maintaining driveability – preventing overheating – ram air ventilation – air delivery components – control devices – vacuum controls containers – handling refrigerants – discharging, charging and leak detection – refrigeration system diagnosis – diagnostic procedure – ambient conditions affecting system pressures.

UNIT IV AUTOMATIC TEMPERATURE CONTROL

Different types of sensors and actuators used in automatic temperature control – fixed and variable displacement temperature control – semi-automatic – controller design for fixed and variable displacement type air conditioning system.

UNIT V SYSTEM SERVICING AND TESTING

Special tools for servicing vehicle air conditioning – diagnosing components and air conditioning systems – diagnosing cooling system – air delivery system – automatic temperature control system diagnosis and service.

Suggested Readings:

1. James D Halderman, *Automotive Heating and Air Conditioning*, Pearson, 2018.
2. Warren M Farnell, *Automotive Heating, Ventilation and Air Conditioning Systems: Classroom Manual*, Pearson, 2004.
3. Warren M Farnell, *Automotive Heating, Ventilation and Air Conditioning Systems: Shop Manual*, Pearson, 2004.
4. William H Crouse and Donald L Anglin, *Automotive Air Conditioning*, McGraw-Hill Inc., 1990.
5. Mitchell Information Services, Inc., *Mitchell Automatic Heating and Air Conditioning Systems*, Prentice Hall Inc., 1989.
6. Paul Weisler, *Automotive Air Conditioning*, Reston Publishing Co. Inc., 1990.

18BEAE6E03	AUTOMOTIVE SAFETY	Semester VI 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam: 3 hours

Course Objectives:

- To understand automotive safety in the broader context of transportation safety.
- To evaluate effects of the collision of vehicles on the human body.
- To acquire knowledge on the importance and use of safety systems in road vehicles.
- To provide knowledge oncrash injuries and human safety using crash test
- To expose students to various comfort and convenience systems
- To introduce the concepts ofenvironment information system

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Analyse the different types of active and passive safety system used in automobiles.
- Examine the crash testing and evaluation of vehicle safety using crash test.
- Analyse the different types of vehicle safety systems used in automobiles.
- Examine the crash injuries and human safety using crash test.
- Explain the various comfort and convenience systems.
- Explain the environment information system

Course Contents:

UNIT I INTRODUCTION

Design of the body for safety – energy equation – engine location – deceleration of vehicle inside passenger compartment – deceleration on impact with stationary and movable obstacle – concept of crumble zone – safety sandwich construction.

UNIT II SAFETY CONCEPTS

Active safety – driving safety – conditional safety – perceptibility safety – operating safety – passive safety – exterior safety – interior safety – deformation behaviour of vehicle body – speed and acceleration characteristics of passenger compartment on impact.

UNIT III SAFETY EQUIPMENT

Seat belt – regulations – automatic seat belt tightener system – collapsible steering column – tiltable steering wheel – airbags – electronic system for activating airbags – bumper design for safety.

UNIT IV COLLISION WARNING AND AVOIDANCE

Collision warning system – causes of rear-end collision – frontal object detection – rear vehicle object detection system – object detection system with braking system interactions.

UNIT V COMFORT AND CONVENIENCE SYSTEM

Steering and mirror adjustment – central locking system – garage door opening system – tyre pressure control system – rain sensor system – environment information system.

Suggested Readings:

1. Ljubo Vlacic, Michael Parent and Fumio Harashima, *Intelligent Vehicle Technologies*, Butterworth-Heinemann, UK, 2001.
2. Heinz Heisler, *Advanced Vehicle Technology*, Butterworth-Heinemann, UK, 2002.
3. James E Duffy, *Modern Automotive Technology*, Goodheart-Willcox, USA, 2017.
4. Bosch, *Automotive Handbook*, SAE Publication, 2011.
5. Powloski J, *Vehicle Body Engineering*, Business Books Ltd., London, 1969.
6. RonaldKJurgen, *Automotive Electronics Handbook*, McGraw-Hill Inc., 1999.

18BEAE6E04	OFF-ROAD VEHICLES	Semester VI 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To impart knowledge ofthe construction layout and applications of the off-road vehicles.
- To learn the variousearth moving constructional machines.
- To study the construction and working details of industrial vehicles.
- To acquire knowledge on the working of tractor attachments and military vehicles.
- To provide knowledge on the mechanism of brake, suspension and steering in off-road vehicles.
- To impart knowledge on earth moving machines

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Explain the construction layout and features of off-road vehicles.
- Select earth moving constructional machine for a particular application.
- Describe the construction details and working of industrial vehicles.
- State the special features of tractor attachments and military vehicles.
- Illustrate the mechanism of brake
- Illustrate the mechanism of suspension and steering

Course Contents:

UNIT I CLASSIFICATION AND REQUIREMENTS OF OFF-ROAD VEHICLES

Constructionlayout,capacityandapplicationsofoff-roadvehicle – primemover,chassisand transmission – multi-axle vehicles.

UNIT II EARTH MOVING CONSTRUCTIONAL MACHINES

Dumpers – safetyfeatures,safewarningsystemfordumper –designaspectsondumperbody, articulated dumpers, loaders – single bucket, multi-bucket and rotary types – bulldozers, kinematics for loaderandbulldozerswithoperationallinkages – excavators,backhoeloaders,scrapers,motor graders, power shawl, bush cutters, stumpers, rippers.

UNIT III INDUSTRIAL APPLICATIONS

Constructionalandworkingdetailsof jibcrane,concrete ready mixers, compactors, forklift, utility vehicles, man-lift, scissors, lift trucks, material handlers and power generators.

UNIT IV FARM EQUIPMENT, MILITARY AND COMBAT VEHICLES

Tractors – classification – working attachments: power take off, special implements, paddy harvester, sugarcane harvester, feller bunchers – special features and constructional details of military tankers, Armoured Vehicle Launched Bridge (AVLB), gun carriers and transport vehicles.

UNIT V VEHICLE SYSTEMS

Brake system and actuation – oil cooled disc brakesand dry disc caliper brakes – body hoist and bucket operational hydraulics – hydro-pneumaticsuspensioncylinders – powersteeringsystem – articulatedsteering assembly – power and capacity of earth moving machines.

Suggested Readings:

1. Nakra C P, *Farm Machines and Equipments*, Dhanpat Rai Publishing, 2006.
2. Robert L Peurifoy, Clifford J Schexnayder and Aviad Shapira, *Construction Planning, Equipment, and Methods*, McGraw-Hill Education, 2010.
3. Abrosimov K, Bromberg A and Katayev F, *Road-Making Machinery*, Mir Publishers, Moscow, 1971.
4. Wong J Y, *Theory of Ground Vehicles*, John Wiley & Sons, 2008.
5. Bart H Vanderveen, *Tanks & Transport Vehicles: World War 2*, F. Warne, 1974.
6. Ageikin S, *Off the Road Wheeled and Combined Traction Devices: Theory and Calculation*, Ashgate Publishing Company, 1988.
7. Erich J Schulz, *Diesel Equipment I & II*, McGraw-Hill, 1981.

18BEAE6E05 DESIGN FOR MANUFACTURE AND ASSEMBLY **Semester VI**
3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To introduce the way of specifying dimension and tolerance in engineering drawing by using geometric dimensioning and tolerancing.
- To indicate the design considerations while casting, welding and forming of components.
- To familiarise with the concept and design guidelines for manufacturing parts by different machining processes.
- To study the factors affecting the easy assembly of parts into a final product.
- To impart knowledge on the environmental impact of products manufactured and engineering ways to minimiseit.
- To Study and acquire knowledge on disassembly, recyclability, remanufacture

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Apply geometric dimensioning and tolerancing techniques in engineering drawing.
- Apply design considerations to minimise the difficulty in fabrication of components by casting, welding and forming processes.
- Apply design for manufacturing concept to reduce the machining time and manufacturing cost.
- Perform the parts assembly of the given component using design for assembly guidelines.
- Design components taking into consideration the environmental impact.
- Describedisassembly, recyclability, remanufacture,

Course Contents:

UNIT I GEOMETRIC DIMENSIONING AND TOLERANCING

Tolerance chains and identification of functionally important dimensions – international tolerance grades – surface finish – attainable tolerance grades and different machining processes – geometric dimensioning and tolerancing – location, form and feature tolerance – tolerance limits for assembly – cumulative effect of tolerances – sure fit law, normal law and truncated normal law – tolerance zone conversions.

UNIT II DESIGN CONSIDERATIONS FOR CASTINGS, WELDING AND FORMING

Casting – pattern, mould, parting line – cast, cored and machined holes – redesign of castings based on parting line considerations – minimizing core requirements – welding – stresses in welding – measures to combat contraction stresses – welding sequence – joints in welding – weldability of steel – design of welded structures – form design aspects for forging and sheet metal components.

UNIT III DESIGN FOR MANUFACTURE - MACHINING CONSIDERATIONS

Design for manufacture guidelines – design features to facilitate machining – drills – milling cutters – keyways – doweling procedures – counter sunk screws – reduction of machined area – simplification by separation – simplification by amalgamation – design for manufacture: machinability, economy, clampability, accessibility, assembly – redesign for manufacture.

UNIT IV DESIGN FOR ASSEMBLY

Design for Assembly (DFA) guidelines – minimizing number of parts – insertion and fastening – design guidelines for part handling – effect of part symmetry, part thickness, part size, weight on handling time – types of manual assembly methods – effect of assembly layout on part acquisition time – assembly efficiency – DFA index.

UNIT V DESIGN FOR ENVIRONMENT

Environmental objectives – global issues, regional and local issues – basic design for environment methods – design guidelines – lifecycle assessment – weighted sum assessment method – lifecycle assessment method – techniques to reduce environmental impact – design to minimise material usage – design for disassembly, recyclability, remanufacture, energy efficiency – design to regulations and standards.

Suggested Readings:

1. Gene RCogorno, *Geometric Dimensioning and Tolerancing for Mechanical Design*, McGraw-Hill Professional, New Delhi, 2011.
2. Harry Peck, *Designing for Manufacture*, Pitman Publishing, London, 1973.
3. Robert Matousek, *Engineering Design - A Systematic Approach*, Blackie and Son Ltd., London, 1974.
4. Spotts M F, *Dimensioning and Tolerance for Quantity Production*, Prentice Hall, New Jersey, 2007.
5. Bralla J G, *Hand Book of Product Design for Manufacturing*, McGraw-Hill Publications, New Delhi, 2000.
6. Kevin Otto and Kristin Wood, *Product Design: Techniques in Reverse Engineering and New Product Development*, Pearson Education, 2001.

18BEAE6E06	INDUSTRIAL ENGINEERING ANDOPERATIONS RESEARCH	Semester VI 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To familiarise the production planning methodologies and layout design.
- To learn the concept of work study.
- To impart knowledge on the basics of linear programming techniques.
- To understand the transportation and assignment models.
- To provide knowledge on the importance of inventory control.
- To provide knowledge on economicorderquantity

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Select suitable production planning methodologies, production system and plant layout for the industry.
- Execute an effective work study and ergonomics for better productivity.
- Formulate and select a suitable method to solve the linear programming problem.
- Solve different transportation and assignment based models.
- Solve the inventory decision-making problem usingmathematical modelling.
- Describe the economicorderquantity

Course Contents:

UNIT I PRODUCTION SYSTEM AND WORK STUDY

Industrial engineering – concept, history and development – applications – productivity – factors influencing productivity – plant layout – criteria for good layout – types of layout – work study – method study – work measurement – ergonomics.

UNIT II PRODUCTION MANAGEMENT

Objectives of production management – types of production – classification of production system – new product design – demand forecasting – production planning and control – capacity planning – material requirement planning – process planning – project scheduling – production control – make or buy decisions.

UNIT III LINEAR PROGRAMMING

OperationsResearch:introduction,scope,objectives,phasesanditslimitations – Linear ProgrammingProblem (LPP)– formulation – graphicalmethod – Simplexmethod – artificialvariable techniques – Big-M method.

UNIT IV DISTRIBUTION AND ASSIGNMENT MODEL

Transportation problem – Vogel's approximation method – optimalitytestusingMODImethod – Assignment problem – Hungarian method – travelling salesman problem – sequencing problem –

processing‘n’jobsthroughtwomachinesandthreemachines – processingtwojobs through ‘m’ machines.

UNIT V INVENTORY CONTROL

Types of inventory – inventory costs – variables in the inventory problem – other factors involved in inventory analysis – deterministic inventory model – inventory models with probabilistic demand – re-order level and optimum buffer stock – economicorderquantity with price breaks.

Suggested Readings:

1. Frederick S Hillier and Gerald J Lieberman,*Introduction to Operations Research*, Tata McGraw-Hill, New Delhi, 2006.
2. Elwood SBuffa, *Modern Production/Operations Management*, Wiley Eastern, New Delhi, 2007.
3. Kanti Swarup, Gupta P K and Man Mohan, *Operations Research*, Sultan Chand & Sons, New Delhi, 1995.
4. Dharani Venkatakrishnan S, *Operations Research*, Keerthi Publication House, Coimbatore, 1991.
5. Gupta P K and Hira D S, *Operations Research*, S. Chand and Company, New Delhi, 2012.
6. Panneerselvam R, *Production and Operations Management*, Prentice-Hall of India, New Delhi, 2007.

18BEAE7E01	AUTOMOTIVE AERODYNAMICS	Semester VII 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To provide knowledge on the fundamentals of aerodynamics and vehicle body optimisation.
- To introduce the use of wind tunnels in testing the vehicles.
- various aerodynamic shapes of car
- To introduceaerodynamics for design of the vehicle body
- To study the features ofcharacteristics of forces and moments
- To understand the importance computational fluid dynamics analysis

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Explain the importance of aerodynamics for automobiles.
- Apply principles of aerodynamics for design of the vehicle body.
- Analyse the various aerodynamic shapes of car.
- Discuss the characteristics of forces and moments.
- Apply the concept of wind tunnel for the aerodynamic design of automobiles.
- Apply the computational fluid dynamics analysis.

Course Contents:

UNIT I INTRODUCTION

Scope – historical developments – fundamental of fluid mechanics – flow phenomenon related to vehicles – external and internal flow problem – resistance to vehicle motion – performance – fuel consumption – performance potential of vehicle aerodynamics.

UNIT II AERODYNAMIC DRAG OF CARS

Cars as a bluff body – flow field around car – drag force – types of drag force – analysis of aerodynamic drag – drag coefficient of cars – strategies for aerodynamic development – low drag profiles.

UNIT III SHAPE OPTIMIZATION OF CARS

Front end modification – front and rear windshield angle – boat tailing, hatchback, fastback, square back, dust flow patterns at the rear – effects of gap configuration – effect of fasteners – case studies on modern vehicles.

UNIT IV VEHICLE HANDLING

The origin of forces and moments on a vehicle – lateral stability problems – methods to calculate forces and moments – vehicle dynamics under side winds – the effects of forces and moments – characteristics of forces and moments – dirt accumulation on the vehicle – wind noise – drag reduction in commercial vehicles and racing cars.

UNIT V WIND TUNNELS FOR AUTOMOTIVE AERODYNAMICS

Introduction – principle of wind tunnel technology – limitation of simulation – stress with scale models – full-scale wind tunnels – measurement techniques – equipment and transducers – road testing methods – numerical methods – computational fluid dynamics analysis.

Suggested Readings:

1. Fred Browand, Rose McCallen and James Ross, *The Aerodynamics of Heavy Vehicles: Trucks, Buses, and Trains*, Springer, 2004.
2. Wolf-Heinrich Hucho, *Aerodynamic ofRoad Vehicles*, Butterworth-Heinemann, 1997.
3. Jewel B Barlow, William H Rae and Alan Pope, *Low-Speed Wind Tunnel Testing*, John Wiley & Sons, 1999.
4. *Automotive Aerodynamic: Update SP-706*, Society of Automotive Engineers,1987.
5. *Vehicle Aerodynamics: SP-1145*, Society of Automotive Engineers,1996.

18BEAE7E02	AUTOMOTIVE TESTING	Semester VII 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To provide knowledge on the automotive testing methods and their importance.
- To study the various testing standards and guidelines.
- To provide knowledge on all the automotive testing regulations while testing a vehicle.
- To understand the importance of the effectiveness and efficiency of all components.
- To provide an overview of energy testing
- To expose students to analyse the vehicle and report the results

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Prepare the vehicle for testing according to standards.
- Test the vehicle in static and dynamic conditions.
- Incorporate all the automotive testing regulations while testing a vehicle.
- Test the effectiveness and efficiency of all components.
- Describe the energy testing
- Analyse the vehicle and report the results.

Course Contents:

UNIT I VEHICLE WIND TUNNEL TESTING AND BODY TESTING

Wind tunnel test requirements – ground boundary simulation – wind tunnel selection and Reynolds number capability – model details – mounting of model – test procedure – body test – dynamics simulation sled testing – dolly rollover test – dolly rollover fixture – vehicle roof strength test – door system crash test.

UNIT II COLLISION AND CRASH TESTING

Crash testing – human testing – dummies – crash worthiness – pole crash testing – near crash testing – vehicle to vehicle impact – side impact testing – crash test sensor – sensor mounting positions – crash test data acquisition – braking distance test.

UNIT III TESTING OF WHEELS AND BRAKES

Wheelsdynamic cornering fatigue, dynamic radial fatigue tests – procedures – bending moment and radial load calculations – impact test – road hazard impact test for wheel and tyre assemblies test procedures – failure criteria and performance criteria.

UNIT IV ENERGY TESTING

Engine cooling fan, air conditioning and brake compressors, hydraulic pumps power consumptions – ABS energy consumption.

UNIT V FUEL CONSUMPTION TESTING

Test route selection – vehicle test speeds – cargo, weights, driver selection, tested data, finding and calculations – test on rough terrain, pothole with laden and unladen conditions.

Suggested Readings:

1. Thomas G Beckwith, Roy D Marangoni and John H Lienhard V, *Mechanical Measurements*, Pearson Education, 2013.
2. *SAE Handbook - Vol 3*, SAEPublications, 2000.
3. Tim Grilles, *Automotive Service*, Delmar Publishers, 1998.
4. William HCrouse and Donald LAnglin, *Automotive Mechanics*, Tata McGraw-Hill, New Delhi, 2006.

18BEAE7E03 ALTERNATE FUELS AND ENERGY SYSTEMS **Semester VII**
3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To acquire knowledge of alternative fuels and changes in the engine design for handling them.
- To learn the various energy systems for use in the automobiles.
- To equip them with skills to modify the engines
- To make the students conversant of biofuels
- To make the students conversant of synthetic fuels
- To give exposure tocombustion, performance and emission characteristics of engines

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Analyse the thermodynamics of combustion characteristics of alternative fuels.
- Distinguish the various types of alternative fuels based on need and scope.
- Modify the engines according to the type of alternative fuel.
- Explain the biofuels
- Explain the synthetic fuels
- Analyse the combustion, performance and emission characteristics of engines

Course Contents:

UNIT I GASEOUS FUELS

Properties – composition – production – storage – engine modifications – combustion –performance and emission characteristics in SI and CI engines – advantages and disadvantages of Compressed Natural Gas (CNG), Liquefied Petroleum Gas (LPG), hydrogen and ammonia.

UNIT II ALCOHOL FUELS

Properties – composition – production – storage – engine modifications – blends – combustion – performance and emission characteristics in SI and CI engines – advantages and disadvantages of methanol, ethanol and butanol.

UNIT III BIO-FUELS

Properties – composition – production– engine modifications – treatment – blends – performance and emission characteristics – advantages and disadvantages of straight vegetable oils, bio-diesel and biogas.

UNIT IV SYNTHETIC FUELS

Properties – composition – material compatibility – engine modifications – performance and emission characteristics – advantages and disadvantages of hydrogen with CNG, dimethyl ether, diethyl ether, syngas, producer gas and plastic fuel.

UNIT V DUAL-FUEL AND MULTI-FUEL ENGINES

Technology – working principle – conversion of engine – operation – combustion, performance and emission characteristics – advantages and disadvantages.

Suggested Readings:

1. Thipse SS, *Alternate Fuels: Concepts, Technologies and Developments*, Jaico Publishing House, Delhi, 2010.
2. Richard LBechfold, *Alternative Fuels Guidebook*, SAE International, Warrendale, 1997.
3. Ganesan V, *Internal Combustion Engines*, McGraw-Hill Education, New Delhi, 2012.
4. Mathur L and Sharma RP, *Internal Combustion Engines*, Dhanpat Rai Publications, New Delhi, 2002.
5. *Alcohols as Motor Fuels: Progress in Technology Series No. 19*, SAE Publication, USA, 1980.

18BEAE7E04 APPLIED HYDRAULICS AND PNEUMATICS **Semester VII**
3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To impart knowledge on the various types of hydraulic pumps and actuators.
- To learn the various hydraulic components and their functions.
- To provide knowledge on the selection of hydraulic components.
- To study the various types of pneumatic components and servo systems.
- To learn the fluid power circuit design methods and its applications.
- To provide knowledge on the application of accumulator and intensifier circuit.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Identify suitable hydraulic pumps and actuators for different applications.
- Choose suitable hydraulic components for several applications.
- Select suitable fluid power components for various uses.
- Choose suitable pneumatic components for different applications.
- Design the fluid power circuit for given applications.
- Explain the application of accumulator and intensifier circuit.

Course Contents:

UNIT I HYDRAULIC PUMPS AND ACTUATORS

Introduction to fluid power system – applications of Pascal's law – hydraulic pumps – pumping theory – classification – construction and working principles of gear pump, vane pump, piston pump, lobe pump – fluid power actuators – construction and working principles of single acting, double acting, cushioning and telescopic cylinder – gear motors – vane motors.

UNIT II HYDRAULIC COMPONENTS

Direction control valve – check valve – shuttle valve – 3/2, 4/2 and 4/3 way valve and solenoid valve – actuation methods – pressure control valves – pressure relief valve – compound pressure relief valve – pressure reducing valve – unloading valve – sequence valve – counterbalance valve – flow control valves and its types – accumulators and intensifier – types.

UNIT III SELECTION OF HYDRAULIC COMPONENTS

Selection factors – selection of pumps – actuators – cylinders – motors versus load – piston rod buckling – selection of hydraulic pipe and hoses, valves, reservoir, filters, accumulators and intensifiers.

UNIT IV PNEUMATIC COMPONENTS

Compressors – Filter, Regulator, Lubricator (FRL) unit – mufflers – valves – direction control valves – shuttle valve – two-way air piloted valve – push button valve – quick exhaust valve – lever control valve and solenoid valve – pneumatic actuators – servo system – hydro-mechanical, electro-hydraulic and proportional valve.

UNIT V DESIGN OF FLUID POWER CIRCUIT

Fluid power circuits – speed control circuits – synchronizing circuit – sequential circuit – design for simple application using cascade and stepper sequencer method – application of accumulator and intensifier circuit.

Suggested Readings:

1. Anthony Esposito, *Fluid Power with Applications*, Pearson Education, New Delhi, 2011.
2. Majumdar S R, *Oil Hydraulics*, Tata McGraw-HillPublishing Company, New Delhi, 2004.
3. Majumdar S R, *Pneumatic Systems: Principles and Maintenance*, Tata McGraw-HillPublishing Company, New Delhi, 2008.
4. Ilango S,*Introduction to Hydraulics and Pneumatics*, Prentice Hall of India, New Delhi, 2007.
5. Andrew Parr, *Hydraulics and Pneumatics*, Jaico Publishing House, 2006.

18BEAE7E05 OPTIMIZATION FOR ENGINEERING DESIGN **Semester VII**
3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To formulate design optimization problems for engineering applications.
- To provide knowledge on single variable unconstrained problems.
- To learn multi-objective unconstrained optimization problems.
- To introduce concepts of constrained non-linear optimization problems.
- To interpret non-traditional optimization techniques for engineering problems.
- To study the features ofneural network-based optimization

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Formulate design optimization problem from real-world applications.
- Compute the solution for single variable unconstrained optimization problems.
- Determine the solution for multivariable unconstrained optimization problems.
- Find the solution for the constrained non-linear optimization problems.
- Apply non-traditional optimization techniques to solve engineering problems.
- Apply the neural network based optimization

Course Contents:

UNIT I INTRODUCTION

Introduction to design optimization – historical development – design process – conventional vs.optimum design process – statement of an optimization problem – optimum design problemformulation – process steps – problem formulation for engineering applications – classifications of optimization problems.

UNIT II SINGLE VARIABLE NONLINEAR UNCONSTRAINED OPTIMIZATION ALGORITHMS

Optimality criteria – unimodal function – eliminating methods – exhaustive search, dichotomoussearch, interval halving method, Fibonacci search method, golden section search method – pointestimation method (Powell's algorithm) – gradient-based methods – Newton-Raphson method(Taylor's series expansion), bisection method, secant method, cubic search method.

UNIT III MULTIVARIABLE NONLINEAR UNCONSTRAINED OPTIMIZATION ALGORITHMS

Optimality criteria – unidirectional search – direct search methods – evolutionary optimizationmethod, random search methods, Simplex search method, Hooke-Jeeves pattern search method – indirect search (gradient) methods – Cauchy's (steepest descent) method, Newton's method, conjugategradient method.

UNIT IV CONSTRAINED NONLINEAR OPTIMIZATION ALGORITHMS AND SPECIALISED PROGRAMMING

Introduction, characteristics – indirect search methods – transformation methods, penalty functionmethod, method of multipliers – sensitivity analysis – Kuhn-Tucker conditions, theorems – direct search minimization methods – variableelimination method, complex search method and random search methods – feasible directionmethod – integer programming – penalty function method, branch and bound method.

UNIT V NON-TRADITIONAL OPTIMIZATION TECHNIQUES

Genetic Algorithms (GA) – principle, difference and similarities between GA and traditional methods – constrained optimization – GA operators – real-coded and advanced GAs – simulated annealing – neural network based optimization.

Suggested Readings:

1. Singiresu S Rao, *Engineering Optimization: Theory and Practice*, Wiley India, Delhi, 2009.
2. Kalyanmoy Deb, *Optimization for Engineering Design: Algorithms and Examples*, PHI Learning, New Delhi,2012.
3. Jasbir Singh Arora, *Introduction to Optimum Design*, Elsevier India, New Delhi, 2011.
4. Saravanan R, *Manufacturing Optimization through Intelligent Techniques*, Taylor & Francis Publications, CRC Press, New Delhi, 2006.

18BEAE7E06	MECHATRONICS	Semester VII 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To introduce the concept and working of sensors used in the mechatronic system.
- To study different types of actuators used in the mechatronic system.
- To provide knowledge on feedback mechanism for improving the reliability of the mechatronic system.
- To impart knowledge on working of microcontroller in the mechatronic system.
- To learn the Programmable Logic Controller (PLC) used in the mechatronic system.
- To expose students toprogram for PLC

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Select the different types of sensor for various mechatronics applications.
- Identify suitable actuator used in a mechatronic system.
- Design a feedback controller for mechatronic systems.
- Develop a controller using microcontroller for the mechatronic system.
- Describe the PLC
- Write a program for PLC used in the mechatronic systems.

Course Contents:

UNIT I SENSORS

Components of mechatronics system –sensor – terminology and mathematical equation – potentiometer – linear variable differential transformer – strain gauge – piezoelectric sensor – optical encoder – hall effect sensor – thermistor – thermocouple – light sensor.

UNIT II ACTUATORS

Terminology – mathematical equation of mechanical actuation system – cam, gear, belt and chain, ball screw – mechanical aspects of motor selection – pneumatic and hydraulic actuation system – electrical actuation system – relay and solenoid – working and control of brush and brushless DC motor – working and control of stepper and servo motor.

UNIT III FEEDBACK CONTROL

Transfer function – mathematical modelling of mechanical and electrical system – electrical analogy – electro-mechanical system – first order system – second order system – proportional control –derivative control – integral control – PID control – controller tuning – concept of stability.

UNIT IV MICROCONTROLLER

Architecture of 8051 – I/O pins, ports and circuits – memory, counter, timer – interrupt – instruction set – moving data – logical,arithmetic operation – jump and call instruction – LCD and keyboard interfacing – examples – windscreen wiper motion – car engine management.

UNIT V PROGRAMMABLE LOGIC CONTROLLER

Basic structure – input/output processing – programming – mnemonics – timers, internal relays and counters – shift registers – master and jump controls – data handling – analogue input/output – selection of PLC – examples – pick and place robot – car park barrier system.

Suggested Readings:

1. W. Bolton, *Mechatronics*, Pearson Education, New Delhi, 2012.
2. Godfrey Onwubolu, *Mechatronics: Principles and Applications*, Butterworth-Heinemann, 2005.
3. Nitaigour Premchand Mahalik, *Mechatronics: Principles, Concepts and Applications*, Tata McGraw-Hill Publishing Company, New Delhi, 2008.
4. Krishna Kant, *Microprocessors and Microcontrollers*, Prentice Hall of India, 2007.
5. Ramachandran K P, Vijayaraghavan G K and Balasundaram M S, *Mechatronics: Integrated Mechanical Electronic Systems*, Wiley India, New Delhi 2008.

18BEAE7E07 18BEAEOE04	MODERN VEHICLE TECHNOLOGY	Semester VII 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To impart knowledge on trends in the vehicle power plants.
- To learn the various advanced driver assistance systems.
- To study the working of advanced suspension and braking systems in an automobile.
- To giveinformationaboutmotor vehicle emission and noise pollution control.
- To provide knowledge ofthe vehicle telematics.
- To give information about the noise control techniques

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Distinguish and describe the various modern vehicle power plant systems.
- List and explain the various driver assistant mechanisms.
- Identify and describe the working of advanced suspension and braking systems.
- Apply the knowledge of motor vehicle emission and noise pollution control.
- Describe the noise control techniques
- Describe the vehicle telematics and its applications.

Course Contents:

UNIT I TRENDS IN POWER PLANTS

Hybrid vehicles – stratified charged/learn burn engines – hydrogen engines – battery vehicles – electric propulsion with cables – magnetic track vehicles.

UNIT II DRIVER ASSISTANCE SYSTEMS

Adaptive cruise control – intelligent speed adaptation – lane departure warning systems – traction control systems – driver drowsiness detection system – collision avoidance systems – hill descent control – anti-spin regulation – parking assistance systems – night-vision systems – pedestrian detection.

UNIT III SUSPENSION, BRAKES AND SAFETY

Interconnected air and liquid suspensions – hydrolastic suspension system – hydragas suspension – closed loop suspension – indirect floating caliper disc brake – self energising disc brake – anti-skid braking system – retarders – regenerative braking – auto emergency braking – crumple zone – safety cage – airbags – seat belts – headrests.

UNIT IV EMISSION AND NOISE POLLUTION CONTROL

Engine emissions – types of catalytic converters – open loop and closed loop operation to the oxidizing catalytic converter – evaporative emission – internal and external noise – identification of noise sources – noise control techniques – adaptive noise control.

UNIT V VEHICLE TELEMATICS

Building blocks of vehicle telematics system – Global Positioning System (GPS) and Geographic Information System (GIS) for vehicle tracking – automotive navigation system – road recognition system – wireless vehicle safety communications – UsageBased Insurance (UBI).

Suggested Readings:

1. Ljubo Vlacic, Michael Parent and Fumio Harashima, *Intelligent Vehicle Technologies*, Butterworth-Heinemann, UK, 2001.
2. Ronald K Jurgen, *Navigation and Intelligent Transportation Systems*, SAE International, USA, 1998.
3. Heinz Heisler, *Advanced Vehicle Technology*, Butterworth-Heinemann, UK, 2002.
4. James E Duffy, *Modern Automotive Technology*, Goodheart-Willcox, USA, 2017.
5. William B Ribbens, *Understanding Automotive Electronics*, Butterworth-Heinemann, UK, 2017.
6. *Bosch Automotive Handbook*, Robert Bosch, Germany, 2018.

18BEAE7E08 INTELLIGENT VEHICLE TECHNOLOGY **Semester VII**
3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To learn the various advanced driver assistance systems.
- To provide knowledge ofthe vehicle telematics.
- To impart knowledge on safety and security systems.
- To study the various comfort systems.
- To introduce the adaptive control systems.
- To introduce the concepts of the global positioning systems

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- List and explain the various driver assistant systems.
- Discuss the global positioning systems
- Describe the vehicle telematics and its applications.
- Explain the safety and security systems for automotive.
- Discuss the various comfort systems.
- Explain the adaptive control systems.

Course Contents:

UNIT I DRIVER ASSISTANCE SYSTEMS

Introduction – driver support systems – driver information – driver perception – driver convenience – driver monitoring – vehicle support systems – general vehicle control – collision avoidance – vehicle status monitoring.

UNIT II TELEMATICS

Global positioning systems – geographical information systems – navigation systems – automotive vision system – road recognition – driver assistance systems.

UNIT III SAFETY AND SECURITY SYSTEMS

Airbags – seat belt tightening system – collision warning systems – child lock – anti-lock braking system – anti-theft technologies – smart card system – number plate coding.

UNIT IV COMFORT SYSTEMS

Active suspension systems – requirement and characteristics – different types – power steering – collapsible and tiltable steering column – power windows.

UNIT V ADAPTIVE CONTROL SYSTEMS

Adaptive cruise control – adaptive noise control – anti-spin regulation – traction control systems – cylinder cut-off technology.

Suggested Readings:

1. Ljubo Vlacic, Michael Parent and Fumio Harashima, *Intelligent Vehicle Technologies*, Butterworth-Heinemann, 2001.
2. Ronald K Jurgen, *Navigation and Intelligent Transportation Systems*, SAE International, 1998.
3. Heinz Heisler, *Advanced Vehicle Technology*, Butterworth-Heinemann, 2002.
4. James E Duffy, *Modern Automotive Technology*, Goodheart-Willcox, 2017.

18BEAE7E09 MANUFACTURING OF AUTOMOTIVE COMPONENTS **Semester VII**
3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To impart knowledge on basic principle and production methods of automotive components.
- To learn the surface coating technologies used in the automotive industry.
- To understand the importance of suitable process for the manufacturing automotive components.
- To enrich the understanding of casted and forged engine components
- To know the application of the emission control system
- To expose students to the stretch forming of auto body panels

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Select the materials for the components based on its functionality.
- Analyse suitable process for the manufacturing automotive components.
- List the casted and forged engine components.
- Select suitable surface coating technologiesfor the components.
- Describe the emission control system
- Explain the stretch forming of auto body panels.

Course Contents:

UNIT I CASTED ENGINE COMPONENTS

Material selection and manufacturing methods for piston, piston rings, cylinder block, wet and dry liners, engine head, oil pan, carburettors– thermal barrier coating of engine head and valves.

UNIT II FORGED ENGINE COMPONENTS

Material selection and manufacturing methods for crankshaft, connecting rod, camshaft, valve, piston pin, push rod, rocker arm, tappets, spark plug.

UNIT III TRANSMISSION SYSTEM

Material selection and manufacturing methods for clutch, clutch lining, gearbox, gear, propeller shaft, differential, axle shaft, bearing, fasteners, wheel drum.

UNIT IV VEHICLE CHASSIS

Material selection and manufacturing methods for chassis, dead axle, leaf spring, coil spring, shock absorbers, wheel housing, steering system, brake shoes, wheel rim, tyres – heat treatment procedures.

UNIT V RECENT DEVELOPMENTS

Surface treatment – plastics – plastics in automobile vehicles – processing of plastics – emission control system – catalytic converter – hydroforming of exhaust manifold and lamp housing – stretch forming of auto body panels – metal matrix composite liners – selection of materials for auto components – use of robots in body weldment.

Suggested Readings:

1. Heldt P M, *High Speed Combustion Engines*, Oxford Publishing Co., New York, 1990.
2. Gupta K M, *Automobile Engineering Volume I & II*, Umesh Publishers, 2000.
3. Kirpal Singh, *Automobile Engineering Volume I & II*, Standard Publishers, New Delhi, 2018.
4. Serope Kalpakjian and Steven R Schmid, *Manufacturing Processes for Engineering Materials*, Pearson Education, 2008.
5. Mohammed A Omar, *The Automotive Body Manufacturing Systems and Processes*, John Wiley & Sons, 2011.

18BEAE7E10 COMPUTATIONAL FLUID DYNAMICS **Semester VII**
3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To introduce governing equations of viscous fluid flows.
- To introduce numerical modelling and its role in the field of fluid flow and heat transfer.
- To provide knowledge on the various discretization methods, solution procedures and turbulence modelling.
- Analyse finite difference and finite volume methods for diffusion.
- Analyse finite volume method for convective diffusion.
- Analyse the flow field problems.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Derive the governing equations and boundary conditions for fluid dynamics.
- Analyse finite difference and finite volume methods for diffusion.
- Analyse finite volume method for convective diffusion.
- Analyse the flow field problems.
- Explain and solve the turbulence models and mesh generation techniques.
- Use software tools.

Course Contents:

UNIT I GOVERNING EQUATIONS AND BOUNDARY CONDITIONS

Basics of computational fluid dynamics – governing equations of fluid dynamics – continuity, momentum and energy equations – chemical species transport – physical boundary conditions – time-averaged equations for turbulent flow – turbulent-kinetic energy equations – mathematical behaviour of PDEs on CFD – elliptic, parabolic and hyperbolic equations.

UNIT II FINITE DIFFERENCE AND FINITE VOLUME METHODS FOR DIFFUSION

Derivation of finite difference equations – simple methods – general methods for first and second order accuracy – finite volume formulation for steady-state – one, two and three -dimensional diffusion problems –parabolic equations – explicit and implicit schemes – example problems on elliptic and parabolic equations – use of finite difference and finite volume methods.

UNIT III FINITE VOLUME METHOD FOR CONVECTION DIFFUSION

Steady one-dimensional convection and diffusion – central, upwind differencing schemes – properties of discretization schemes – conservativeness, boundedness, transportiveness, hybrid, power-law, QUICK schemes.

UNIT IV FLOW FIELD ANALYSIS

Finite volume methods – representation of the pressure gradient term and continuity equation – staggered grid – momentum equations – pressure and velocity corrections – pressure correction equation – SIMPLE algorithm and its variants – PISO algorithms.

UNIT V TURBULENCE MODELS AND MESH GENERATION

Turbulence models – mixing length model – two-equation models – high and low Reynolds number models – structured grid generation – unstructured grid generation – mesh refinement – adaptive mesh – software tools.

Suggested Readings:

1. Ghoshdastidar P S, *Computer Simulation of Flow and Heat Transfer*, Tata McGraw-Hill Publishing Company Ltd., 2017.
2. Versteeg H K and Malalasekera W, *An Introduction to Computational Fluid Dynamics: The Finite Volume Method*, Pearson Education Ltd., 2007.
3. Anil W Date, *Introduction to Computational Fluid Dynamics*, Cambridge University Press, 2005.
4. Chung T J, *Computational Fluid Dynamics*, Cambridge University Press, 2002.
5. Ghoshdastidar P S, *Heat Transfer*, Oxford University Press, 2005.
6. Muralidhar K and Sundararajan T, *Computational Fluid Flow and Heat Transfer*, Narosa Publishing House, New Delhi, 2014.
7. Patankar S V, *Numerical Heat Transfer and Fluid Flow*, Hemisphere Publishing Corporation, 2004.

18BEAE7E11	NEW PRODUCT DEVELOPMENT	Semester VII 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To understand the importance of new product development to firm performance.
- To understand the needs of the customer.
- To provide knowledge on creative thinking methods.
- To impart knowledge on decision-making.
- To learn the methods of developing cost estimates.
- To introduce the concepts ofdecision making and product architecture

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Demonstrate an understandingoftheoverview of all the product development processes.
- Demonstrate the knowledge of concept generation and selection tools.
- List the systematic methods for designing.
- Explain the decision-making process.
- Discuss the methods of developing cost estimates.
- Explain the decision making and product architecture

Course Contents:

UNIT I INTRODUCTION

Need for developing products – the importance of engineering design – types of design –design process – relevance of product lifecycle issues in design –designing to codes and standards – societal considerations in engineering design –generic product development process – various phases of product development – planning for products –establishing markets – market segments – relevance of market research.

UNIT II CUSTOMER NEEDS

Identifying customer needs–voice of customer –customer populations – hierarchy of human needs – need gathering methods – affinity diagrams – needs importance – establishing engineeringcharacteristics – competitive benchmarking – quality function deployment – house of quality –productdesign specification – case studies.

UNIT III CREATIVE THINKING

Creative thinking –creativity and problem solving – creative thinking methods – generating designconcepts – systematic methods for designing – functional decomposition – physical decomposition –functional representation –morphological methods – Theory of Inventive Problem Solving (TRIZ) – axiomatic design

UNIT IV DECISION MAKING AND PRODUCT ARCHITECTURE

Decision making –decision theory –utility theory –decision trees –concept evaluation methods – Pughconcept selection method – weighted decision matrix –analytic hierarchy process – introduction toembodiment design –product architecture – types of modular architecture –steps in developingproduct architecture.

UNIT V DESIGN AND COST ANALYSIS

Industrial design – human factors design –user-friendly design – design for serviceability – design for environment – prototyping and testing – cost evaluation –categories of cost – overhead costs – activity based costing –methods of developing cost estimates – manufacturing cost –value analysis in costing.

Suggested Readings:

1. Anita Goyal, Karl T Ulrich and Steven D Eppinger, *Product Design and Development*, Tata McGraw-Hill Education, 2009.
2. Kevin Otto and Kristin Wood, *Product Design*, Pearson Education, 2015.
3. Clive L Dym and Patrick Little, *Engineering Design: A Project-based Introduction*, John Wiley & Sons, 2009.
4. George E Dieter and Linda C Schmidt, *Engineering Design*, McGraw-Hill International, 2009.
5. Yousef Haik and Shahin T M M, *Engineering Design Process*, Cengage Learning, 2010.

18BEAE7E12	LEAN MANUFACTURING	Semester VII 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To acquire the general knowledge to deliver consistently high quality and value added products and services to the customer in a lean environment.
- To understand the terminology relating to lean operations in both service and manufacturing organizations.
- To impart knowledge on principles of lean manufacturing on the shop floor
- To enrich the understanding of just in time concept
- To expose students toconcepts of visual management, 5Sand total productive maintenance
- To expose students to Jidoka principle

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Summarise the quality requirements to provide products and services in a lean environment.
- Apply the principles of lean manufacturing on the shop floor.
- Explain the just in time
- Explain the concepts of visual management, 5Sand total productive maintenance.
- Examine the Jidoka principle.
- Illustrate the culture of lean management.

Course Contents:

UNIT I INTRODUCTION

The mass production system – origin of lean production system – necessity – lean revolution in Toyota – systems and systems thinking – basic image of lean production – customer focus – muda(waste).

UNIT II STABILITY OF LEAN SYSTEM

Standards in the lean system – 5S system – total productive maintenance – standardized work – elements of standardized work – charts to define standardized work – manpower reduction – overallefficiency – standardized work and Kaizen – common layouts.

UNIT III JUST IN TIME (JIT)

Principles of JIT – JIT system – Kanban – Kanban rules – expanded role of conveyance – productionleveling – pull systems – value stream mapping.

UNIT IV JIDOKA (AUTOMATION WITH A HUMAN TOUCH)

Jidoka concept – Poka-Yoke (mistake proofing) systems – inspection systems and zone control – types and use of Poka-Yoke systems – implementation of Jidoka.

UNIT V WORKER INVOLVEMENT AND SYSTEMATIC PLANNING METHODOLOGY

Involvement – activities to support involvement – quality circle activity – Kaizen training – suggestion programs – Hoshin planning system (systematic planning methodology) – phases of Hoshin planning – lean culture.

Suggested Readings:

1. Dennis P, *Lean Production Simplified: A Plain-Language Guide to the World's Most Powerful Production System*, Productivity Press, 2015.
2. Liker J, *The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer*, McGraw-Hill, 2004.
3. Michael L G, *Lean Six Sigma: Combining Six Sigma Quality with Lean Production Speed*, McGraw-Hill, 2002.
4. Taiichi Ohno, *Toyota Production System: Beyond Large-Scale Production*, Taylor & Francis, 1988.
5. Mike Rother and John Shook, *Learning to See: Value-Stream Mapping to Add Value and Eliminate Muda*, The Lean Enterprise Institute, 2003.

18BEAE7E13	FINITE ELEMENT ANALYSIS	Semester VII 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To impart basic knowledge on the finite element method.
- To provide knowledge on one- and two-dimensional elements.
- To study heat conduction problems using finite element method.
- To present knowledge on the higher order and isoparametric elements.
- To Study and acquire knowledge on numerical methods
- To provide knowledge on Gaussian quadrature method

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Apply the numerical methods to formulate the simple finite element problems.
- Apply the one-dimensional finite element method to solve bar, beam and truss type problems.
- Apply the finite element method for plane stress, plane strain and axisymmetric conditions.
- Determine the temperature distribution of one and two dimensional heat transfer problems using one and two dimensional finite elements.
- Apply the numerical methods to formulate the higher order and isoperimetric problems.
- Apply Gaussian quadrature method.

Course Contents:

UNIT I INTRODUCTION

Relevance and scope of finite element methods – strain vs displacement relations – stresses and equilibrium – natural and essential boundary conditions – Rayleigh-Ritz method – Galerkin method – FEM procedure –discretization of domain – element shapes, types, size, location and numbers.

UNIT II ONE-DIMENSIONAL (1D) ELEMENTS

Coordinate system types: global, local and natural – shape function of 1D bar element – finite element formulation – stiffness matrix, load vector, boundary condition and assembly of global equation –1D bar element and two node truss element – problems in 2D truss – introduction to beam element.

UNIT III TWO-DIMENSIONAL (2D) ELEMENTS

Shape function for linear triangular element – finite element formulation – Constant Strain Triangular (CST) element – plane stress, plane strain – axisymmetric elements.

UNIT IV HEAT TRANSFER APPLICATIONS

Shape function for 1D and 2D triangular element heat conduction – stiffness matrix, load vector and assembly of global equation for 1D and 2D triangular element heat conduction – heat generation with convective boundary conditions for linear element.

UNIT V HIGHER ORDER AND ISOPARAMETRIC ELEMENT

Selection of order of polynomial – linear, simplex, complex and multiplex elements – mesh refinementmethods and convergence requirements – iso, sub and super parametric element – shape functions for a 2D four nodded and eight nodded isoparametric rectangular element using natural coordinate system – Gaussian quadrature method.

Suggested Readings:

1. Rao S S, *Finite Element Method in Engineering*, Elsevier India, 2005.
2. David V Hutton, *Fundamentals of Finite Element Analysis*, Tata McGraw-Hill Publishing Company, New Delhi,2005.
3. Robert D Cook, David S, Malkucs Michael E Plesha, *Concepts and Applications of Finite Element Analysis*, John Wiley, New Delhi, 2007.
4. Chandrupatla T R and Belegundu A D, *Introduction to Finite Elements Engineering*, Pearson Education, New Delhi, 2002.
5. Bhavikati S S, *Finite Element Analysis*, New Age International Publishers, 2015.

18BEAE7E14	HYBRID VEHICLE TECHNOLOGY	Semester VII 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To introduce the working of different configurations of electric vehiclesand their components.
- To impart knowledge on modelling of battery.
- To introduce the basic principle and operation of the fuel cell.
- To provide knowledge on the design of electric and hybrid electric vehicles.
- To learn the power electronic converter for battery charging.
- To impart knowledge on energy storage design

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Explain the working of different configurations of electric vehicles.
- Analyse the performance characteristics of the battery.
- State the basic principle of operation of the fuel cell.
- Design series and parallel hybrid electric drive trains.
- Discuss the various charging methods for the battery.
- Discuss the energy storage design.

Course Contents:

UNIT I ELECTRIC AND HYBRID ELECTRIC VEHICLES

Configuration of electric vehicles – performance of electric vehicles – traction motor characteristics – tractive effort and transmission requirement – vehicle performance – tractive effort in normal driving – energy consumption – concept of hybrid electric drive trains – architecture of hybrid electric drive trains – series hybrid electric drive trains – parallel hybrid electric drive trains.

UNIT II ENERGY STORAGE

Energy storage requirements – battery parameters – types of batteries – modelling of battery – fuel cell basic principle and operation – types of fuel cells – Polymer Exchange Membrane Fuel Cell (PEMFC) and its operation – modelling of PEMFC, supercapacitors.

UNIT III ELECTRIC PROPULSION

EV consideration – DC motor drives and speed control – induction motor drives – permanent magnet motor drives – switch reluctance motor drive for electric vehicles – configuration and control of drives.

UNIT IV DESIGN OF ELECTRIC AND HYBRID ELECTRIC VEHICLES

Series hybrid electric drive train design: operating patterns – control strategies – sizing of major components – power rating of traction motor – power rating of engine/generator – design of photonic power system.

Parallel hybrid electric drive train design: control strategies of parallel hybrid drive train – design of engine power capacity – design of electric motor drive capacity – transmission design – energy storage design.

UNIT V POWER ELECTRONIC CONVERTER FOR BATTERY CHARGING

Charging methods for battery – termination methods – charging from grid – Z-converter, isolated bidirectional DC-DC converter – design of Z-converter for battery charging – high-frequency transformer based isolated charger topology – transformerless topology.

Suggested Readings:

1. Iqbal Husain, *Electric and Hybrid Vehicles: Design Fundamentals*, CRC Press, 2010.
2. Mehrdad Ehsani, Yimin Gao, Stefano Longo and Kambiz Ebrahimi, *Modern Electric, Hybrid Electric, and Fuel Cell Vehicles*, CRC Press, 2018.
3. Tom Denton, *Electric and Hybrid Vehicles*, CRC Press, 2016.
4. Sheldon S Williamson, *Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles*, Springer, 2013.
5. John Fenton and Ron Hodkinson, *Lightweight Electric/Hybrid Vehicle Design*, Butterworth-Heinemann, 2001.
6. Chan C C and Chau K T, *Modern Electric Vehicle Technology*, Oxford University Press, 2001.
7. Chris Mi, Abul Masrur M and David Wenzhong Gao, *Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives*, John Wiley & Sons, 2011.

18BEAE7E15 **FUEL CELL TECHNOLOGY** **Semester VII**
3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To address the need and promise of alternative clean energy.
- To introduce the concept of fuel cells for use in automobiles.
- To learn the fuel cell components and their impact on performance.
- To impart knowledge on thefuel cycle analysis.
- To provide knowledge onperformance characteristics of the fuel cell.
- To expose students to the impact of the fuel cell system in automobiles

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- List the types of fuel cells.
- Explain the thermodynamics and electrochemical kinetics of fuel cells.
- Describe the fuel cell performance characteristics
- Explain the various components of the fuel cell.
- Analyse the performance characteristics of the fuel cell.
- Analyse the impact of the fuel cell system in automobiles.

Course Contents:

UNIT I INTRODUCTION TO FUEL CELLS

Introduction – working and types of fuel cell – low, medium and high temperature fuel cell – liquid and methanol types – proton exchange membrane fuel cell – solid oxide, hydrogen fuelcells – thermodynamics and electrochemical kinetics of fuel cells.

UNIT II FUEL CELLS FOR AUTOMOTIVE APPLICATIONS

Fuel cells for automotive applications – technology advances in fuel cell vehicle systems –onboard hydrogen storage – liquid hydrogen and compressed hydrogen – metal hydrides – fuel cell control system – alkaline fuel cell – road map to market.

UNIT III PERFORMANCE OF FUEL CELL COMPONENTS

Fuel cell performance characteristics – current/voltage, voltage efficiency and power density,ohmic resistance, kinetic performance, mass transfer effects – membrane electrode assemblycomponents, fuel cell stack, bi-polar plate, humidifiers and cooling plates.

UNIT IV FUELLING

Hydrogen storage technology – pressure cylinders, liquid hydrogen, metal hydrides, carbonfibres – reformer technology – steam reforming, partial oxidation, auto-thermal reforming –CO removal, fuel cell technology based on removal like biomass.

UNIT V FUEL CYCLE ANALYSIS

Introduction to fuel cycle analysis – application to fuel cell and other competing technologieslike battery powered vehicles, SI engine fuelled by natural gas and hydrogen and hybridelectric vehicle.

Suggested Readings:

1. Viswanathan B and Aulice Scibioh M, *Fuel Cells: Principles and Applications*, CRC Press, 2008.
2. Shripad T Revankar and Pradip Majumdar, *Fuel Cells: Principles, Design, and Analysis*, CRC Press, 2014.
3. James Larminie and Andrew L Dicks, *Fuel Cell Systems Explained*, John Wiley & Sons, 2003.
4. Gregor Hoogers, *Fuel Cell Technology Handbook*, CRC Press, 2002.

18BEAE7E16 PROCESS PLANNING AND COST ESTIMATION **Semester VII**
3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To introduce the process planning concepts.
- To impart importance of the cost estimation process and procedures.
- To study the procedure to calculate direct, indirect and overhead expenses.
- To facilitate the understanding ofthe production cost of forging, welding, and foundry.
- To learn the procedure to estimate the various machining costs.
- To acquire the procedure to estimate the machining time for lathe, drilling, boring, shaping, milling and grinding operations.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Explain the concepts of process planning and cost estimation.
- Assess the importance of cost estimation process and its procedures.
- Compute direct, indirect and overhead expenses.
- Determine the production cost of forging, welding, and foundry.
- Calculate the machining time for lathe, drilling, boring and shaping operations.
- Calculate the machining time for milling and grinding operations.

Course Contents:

UNIT I PROCESS PLANNING

Definition – objective – scope – process planning activities – approaches – manual, computer aided process planning –retrieval, generative and semi-generative – selection processes – machine selection – material selection parameters – set of documents for process planning – production time calculation – selection of cost optimal processes.

UNIT II INTRODUCTION TO COST ESTIMATION

Objectives and functions of estimating – costing – importance and aims of costing – difference between costing and estimation – methods of costing – types of estimates – methods of estimates – importance of realistic estimates – estimating procedure.

UNIT III ELEMENTS OF COST

Introduction – material cost – direct and indirect – labour cost – direct, indirect and determination of direct labour cost – expenses – direct and indirect – analysis of overhead expenses – administrative expenses – selling and distributing expenses – allocation of overhead expenses – depreciation – causes and methods of depreciation.

UNIT IV PRODUCTION COST ESTIMATION

Estimation in forging shop – losses in forging and forging cost –estimation in gas cutting and welding shop – material cost, labour cost and finish on cost –estimation in foundry shop – pattern cost, foundry cost and casting cost.

UNIT V ESTIMATION OF MACHINING TIME

Importance of machine time calculations – estimation of machining time for lathe, drilling, boring, shaping, milling and grinding operations.

Suggested Readings:

1. Kesavan R, Elanchezhian E and Vijaya Ramnath B, *Process Planning and Cost Estimation*, New Age International Publications, 2008.
2. Adithan M, *Process Planning and Cost Estimation*, New Age International Publications, 2007.
3. Peter Scallan, *Process Planning: The Design/Manufacture Interface*, Elsevier, 2003.
4. Sinha B P, *Mechanical Estimating and Costing*, Tata McGraw-Hill, 2001.
5. Mukhopadhyay S K, *Production Planning and Control: Text and Cases*, Prentice Hall of India, 2007.
6. Chitale A V and Gupta R C, *Product Design and Manufacturing*, Prentice Hall of India, 2000.

18BEAE7E17 PRODUCT LIFECYCLE MANAGEMENT **Semester VII**
3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To understand the concepts of Product Lifecycle Management (PLM).
- To impart knowledge on the product development process and methodologies.
- To study the product modelling and analysis tools.
- To provide knowledge of the product data management technology.
- To expose the recent trends in PLM.
- To give exposure toIntelligent information systems

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Explain the concepts of PLM.
- List and explain phases of the product development process.
- Demonstrate how the new product development process works.
- Explain the functions of product data management.
- Describe the recent trends in PLM.
- Explain the Intelligent information systems

Course Contents:

UNIT I INTRODUCTION TO PRODUCT LIFECYCLE MANAGEMENT (PLM)

Background, overview, need, benefits, concept of PLM – components / elements of PLM, – emergence of PLM – significance of PLM – customer involvement – product data and product workflow – company's PLM vision – PLM strategy – principles for PLM strategy – preparing for the PLM strategy – developing a PLM strategy – strategy identification and selection – change management for PLM.

UNIT II PRODUCT DEVELOPMENT PROCESS AND METHODOLOGIES

Integrated product development process –conceive phase – design phase – realize phase – service phase– bottom-up design, top-down design, front-loading design workflow, design in context, modular design – concurrent engineering – work structuring and team deployment – product and process systemization – problem identification and solving methodologies – product reliability – mortality curve.

UNIT III PRODUCT MODELLING AND ANALYSIS TOOLS

Product modelling– definition of concepts – fundamental issues – role of process chains and product models – types of product models – model standardization efforts – types of process chains – industrial demands – design for manufacturing – machining – casting and metal forming – optimum design – design for assembly and disassembly – probabilistic design concepts –Failure Mode Effects Analysis(FMEA) –Quality Function Deployment (QFD)– Taguchi Method for design

of experiments – design for product life cycle – estimation of manufacturing costs – reducing the component costs and assembly costs – minimise system complexity.

UNIT IV PRODUCT DATA MANAGEMENT (PDM) TECHNOLOGY

Introduction to concepts, benefits and terminology of PDM – CIM data – PDM functions – definition and architectures of PDM systems – product data interchange – portal integration – PDM acquisition and implementation.

UNIT V RECENT ADVANCES

Intelligent information systems – knowledge based product and process models – applications of soft computing in product development process – advanced database design for integrated manufacturing.

Suggested Readings:

1. Michael Grieves, *Product Lifecycle Management*, Tata McGraw-Hill Education, 2006
2. Antti Saaksvuori and Anselmi Immonen, *Product Life Cycle Management*, Springer, 2005.
3. John Stark, *Product Lifecycle Management: 21st Century Paradigm for Product Realisation*, Springer London, 2011.
4. Karl T Ulrich and Steven D Eppinger, *Product Design and Development*, McGraw-Hill, New York, 2016.

18BEAE7E18 COMPUTER INTEGRATED MANUFACTURING **Semester VII**
3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To introduce basic concepts of the Computer Integrated Manufacturing (CIM).
- To provide knowledge on the group technology and computer aided process planning.
- To impart knowledge on the shop floor control and Flexible Manufacturing Systems (FMS).
- To learn the various CIM implementation and data communication techniques.
- To provide knowledge on the concept of manufacturing automation protocol, technical office protocol and database terminology.
- To familiarize the students to understand the advantages of database and relational database

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Assess CAD/CAM integration for changing manufacturing and management scene.
- Construct a machine cell using the concepts of group technology and computer aided process planning.
- Select suitable material handling and storage system for FMS.
- Choose suitable CIM implementation and data communication techniques.
- Explain various protocols and database terminology in CIM.
- Explain advantages of database and relational database

Course Contents:

UNIT I INTRODUCTION

The changing manufacturing and management scene – external communication – islands of automationand software – dedicated and open systems – manufacturing automation protocol – introduction to CAD/CAM integration.

UNIT II GROUP TECHNOLOGY AND COMPUTER AIDED PROCESS PLANNING

Classification and coding – DCLASS, MICLASS and OPITZ coding systems – facility design usingGT – Benefits of GT – cellular manufacturing – process planning – role of process planning in CAD/CAM integration – approaches to computer aided process planning – variant approach and generative approaches.

UNIT III SHOP FLOOR CONTROL AND FMS

Shop floor control phases – factory data collection system – automatic identification methods – bar code technology – automated data collection system – FMS – components of FMS – types – FMS workstation – material handling and storage systems – FMS layout – computer control systems – application and benefits.

UNIT IV CIM IMPLEMENTATION AND DATA COMMUNICATION

System modelling tools – ICAM definition (IDEF) models – activity cycle diagram – CIM Open SystemArchitecture (CIMOSA) – manufacturing enterprise wheel – CIM architecture – product datamanagementimplementation – software – communication fundamentals – Local Area Networks (LAN) – topology – LAN implementations – network management and installations.

UNIT V OPEN SYSTEM AND DATABASE FOR CIM

Open systems – open system inter-connection – manufacturing automation protocol and technical office protocol(MAP/TOP) – development of databases – database terminology – architecture of database systems – data modelling and data associations– relational databases – database operators – advantages of database and relational database.

Suggested Readings:

1. Mikell P Groover,*Automation of Production Systems and Computer Integrated Manufacturing*, Pearson Education, 2008.
2. Lee Kunwoo, *CAD/CAM/CAE Systems*, Addison Wesley, 1999.
3. Kant Vajpayee S, *Principles of Computer Integrated Manufacturing*, Prentice Hall, New Delhi, 2003.
4. Radhakrishnan P, Subramanyan S and Raju V, *CAD/CAM/CIM*, New Age International Pvt. Ltd., New Delhi, 2000.

18BEAE8E01 18BEAEOE03	VEHICLE MAINTENANCE	Semester VIII 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To understand the need for vehicle maintenance and its importance.
- To familiarise the maintenance procedure for various components of an automobile.
- To familiarize the students to understand servicing of transmission and driveline components.
- To make the students conversant on the procedure for steering and suspension
- To make the students conversant on the procedure for wheel and brake maintenance.
- To Study and acquire knowledge on the fault diagnosis in theelectrical and air conditioner systems.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Describe and differentiate the types of maintenance.
- List the procedure for dismantling, servicing and assembling of engine components.
- Demonstrate the servicing of transmission and driveline components.
- Discuss the procedure for steering and suspension
- Discuss the procedure for wheel and brake maintenance.
- Explain the fault diagnosis in theelectrical and air conditioner systems.

Course Contents:

UNIT I MAINTENANCE OF RECORDS AND SCHEDULES

Need for maintenance – preventive and breakdown maintenance – requirements of maintenance – preparation of checklists – inspection schedule – maintenance ofrecords, log sheets and other forms – safety precautions in maintenance – workshop layout, tools and equipment.

UNIT II ENGINE AND ENGINE SUBSYSTEM MAINTENANCE

General engine service – dismantling of engine components – engine repair – service of basic engine parts, cooling and lubricating system, fuel system, intake and exhaust system – engine tune-up.

UNIT III TRANSMISSION AND DRIVELINE MAINTENANCE

General checks, adjustment and service of clutch – dismantling, identifying, checking and reassembling transmission, transaxle – road testing – removing and replacing propeller shaft – servicing of cross and yoke joint, and constant velocity joint – rear axle service points – removing axle shaft and bearings – servicing differential assemblies – fault diagnosis.

UNIT IV STEERING, SUSPENSION, WHEEL AND BRAKE MAINTENANCE

Inspection, maintenance and service of steering linkage, steering column, rack and pinion steering, recirculating ball steering, worm type steering, power steering system – inspection, maintenance and service of MacPherson strut, coil spring, leaf spring, shock absorbers – wheel alignment and balance – removing and fitting of tyres – tyre wear and tyre rotation – inspection, maintenance and service of hydraulic brake, drum brake, disc brake, parking brake – bleeding of brakes.

UNIT V ELECTRICAL AND AIR CONDITIONER MAINTENANCE

Maintenance of batteries, starting system, charging system and body electrical – fault diagnosis using scan tools – maintenance of air conditioning parts like compressor, condenser, expansion valve, evaporator – replacement of hoses – leak detection – air conditioner charging – fault diagnosis – vehicle body repair like panel beating, tinkering, soldering, polishing, painting.

Suggested Readings:

1. Tim Gilles, *Automotive Service: Inspection, Maintenance, Repair*, Cengage Learning, USA, 2015.
2. Philip Knott and Adam Roylance, *An Introductory Guide to Motor Vehicle Maintenance: Light Vehicles*, EMS Publishing, UK, 2010.
3. James D Halderman and Curt Ward, *Advanced Engine Performance Diagnosis*, Pearson, USA, 2016.
4. Ed May and Les Simpson, *Automotive Mechanics Volume 1*, McGraw-Hill Australia, 2006.
5. James E Duffy, *Modern Automotive Technology*, Goodheart-Willcox, USA, 2017.
6. Service manuals of various OEMs.

18BEAE8E02 18BEAEOE05	FLEET MANAGEMENT	Semester VIII 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To impart knowledge on the personnel management, selection process, training methods and motor vehicle act.
- To plan the vehicle routes, scheduling of vehicles and fare structure.
- To design the vehicle maintenance systems.
- To Study and acquire knowledge on fare structure and analyse the methods of fare collection
- To introduce the concepts ofvehicle parts, supply management and data processing
- To Study and acquire knowledge on electronically controlled vehicle maintenance system

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Apply the knowledge of personnel management and analyse the selection process and training methods.
- Apply the motor vehicle act in terms of registration and describe the various vehicles and conduct the test of competence to drive.
- Construct a fare structure and analyse the methods of fare collection.
- Analyse the vehicle parts, supply management and data processing.
- Describe the scheduled and unscheduled maintenance
- Demonstrate an electronically controlled vehicle maintenance system and analyse the work schedule.

Course Contents:

UNIT I INTRODUCTION

Personnel management – objectives and functions of personnel management – psychology, sociology and their relevance to an organization – selection process: job description, employment tests, interviewing, introduction to training objectives, methods of training, training procedure and psychological tests.

UNIT II MOTOR VEHICLE ACT

Schedules and sections of the motor vehicle act – traffic signs, fitness certificate, registration requirements, permit, insurance and constructional regulations – description of vehicle: goods carrier, tankers, tippers, delivery vans, recovery vans, power wagons and fire fighting vehicles – spread over, running time, test of competence to drive.

UNIT III SCHEDULING AND FARE STRUCTURE

Route planning – scheduling of transport vehicles – preparation of timetable – preparation of vehicle and crew scheduling – principal features of operating costs for transport vehicles – fare structure and method of drawing up of a fare table – methods of fare collection.

UNIT IV VEHICLE PARTS, SUPPLY MANAGEMENT AND BUDGET

Cost of inventory – balancing inventory cost against downtime – parts control – bin tag systems – time management – time record keeping – budget activity and capital expenditures – classification of vehicle expenses – fleet management and data processing – data processing systems – computer controlling of fleet activity.

UNIT V MAINTENANCE

Scheduled and unscheduled maintenance – preventive maintenance – evaluation of Preventive Maintenance Inspection (PMI) programme – work scheduling – overtime – breakdown analysis – control of repair backlogs – cost of options – electronically controlled vehicle maintenance system.

Suggested Readings:

1. Robert P Currie, Michelle BCurrie and George M Keen, *Fleet Management*, Wandering Brothers Publishing, USA, 2006.
2. John Dolce, *Fleet Management*, McGraw-Hill, 1984.
3. SCC Editorial, *Motor Vehicles Act, 1988*, Eastern Book Company, New Delhi, 2019.
4. Rex W Faulks, *Bus and Coach Operation*, Butterworth-Heinemann, UK, 1987.
5. John E Dolce, *Analytical Fleet Maintenance Management*, SAE International, USA, 2009.

18BEAE8E03	NON-DESTRUCTIVE TESTING	Semester VIII 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To learn the different surface inspection techniques.
- To provide knowledge of the magnetic particle testing.
- To impart knowledge of the ultrasonic testing method.
- To present knowledge of the radiography testing method.
- To impart knowledge of acoustic emissiontesting principle
- To study the various special non-destructive testing methods.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Select appropriate surface inspection techniques for the components to be inspected.
- Explain the magnetic particle testing method for ferrous materials.
- Select and explain the suitable testing method for testing internal defects.
- Apply radiography testing methods for different suitable applications.
- Understand the acoustic emissiontesting principle
- Choose a suitable special non-destructive technique for various applications.

Course Contents:

UNIT I SURFACE TECHNIQUES

Concepts of Non-Destructive Testing (NDT) – discontinuities and defects in various manufacturing component – types of NDT techniques – introduction to standards and specifications (ASME, ASTM, AWS) – visual or optical testing – direct and remote visual inspection and aides –liquid penetrant testing principles – types and properties of liquid penetrants and developers – preparation of test materials – advantages and limitations – application of penetrants to parts – fluorescent penetrant test.

UNIT II MAGNETIC PARTICLE TESTING

Magnetic particle testing principles – applications – magnetization methods – magnetic particles – dry particle technique and wet fluorescent particle technique – demagnetization, advantages and limitations – magnetic flux leakage testing principle – instrumentation and applications – electromagnetic induction techniquesprinciple – instrumentation and applications of eddy current testing.

UNIT III ULTRASONIC TESTING

Ultrasonic testing principle – types and characteristics of ultrasonic waves – attenuation, couplants, probes – inspection methods: pulse echo, transmission and phased array techniques– types of scanning and displays – angle beam inspection of welds – calibration of ASTM test blocks – International Institute of Welding (IIW) reference blocks – applications.

UNIT IV RADIOGRAPHY TESTING

Radiographic testingprinciple – sources of X-rays and gamma rays and their characteristics – absorption, scattering – filters and screens, imaging modalities – film radiography and digital radiography – problems in shadow formation, exposure factors, film handling and storage – inverse square law – exposure chartsand radiographic equivalence – penetrometers – safety in radiography – applications.

UNIT V SPECIAL TECHNIQUES

Acoustic emissiontesting principle – advantages and limitations – instrumentation andapplications – infrared thermography– contact and non-contact inspection methods – pressureand leak testing – testing procedure and applications – laser shearography– typical applications – requirements – advantages and disadvantages.

Suggested Readings:

1. Baldev Raj, Jayakumar T and Thavasimuthu M, *Practical Non-Destructive Testing*, Narosa Publishing, 1997.
2. Mc Gonnagle, *Non-Destructive Testing*, McGraw-Hill Book Co., 1988.
3. Barry Hull and Vernon John, *Non Destructive Testing*, Macmillan, 1989.
4. Ravi Prakash, *Non-Destructive Testing Techniques*, New Age International Publishers, 2010.

18BEAE8E04 NON-TRADITIONAL MACHINING PROCESSES **Semester VIII**
3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To introduce the basics of non-traditional machining processes.
- To study the mechanical energy based non-traditional machining processes.
- To provide knowledge on electrical energy based non-traditional machining process.
- To impart knowledge on chemical and electrochemical energy based processes.
- To present knowledge on thermal energy based machining processes.
- To introduce the basics of laser beam machining and plasma arc machining

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Explain the basics of non-traditional machining processes.
- Select suitable mechanical energy based non-traditional machining processes for the given industrial applications.
- Find suitable machining processes for machining electrically conductive materials.
- Choose an appropriate chemical and electrochemical energy based processes for precision machining.
- Select suitable thermal energy based process for cutting and machining of the hard materials.
- Explain the laser beam machining and plasma arc machining

Course Contents:

UNIT I UNCONVENTIONAL MACHINING PROCESSES

Introduction – need – classification – energies employed in the processes – brief overview of abrasive jet machining, water jet machining, ultrasonic machining, electric discharge machining, electrochemical machining, electron beam machining, laser beam machining and plasma arc machining.

UNIT II MECHANICAL ENERGY BASED PROCESSES

Working principle,equipment, process parameters, material removal rate, applications of abrasive jet machining, water jet machining and ultrasonic machining.

UNIT III ELECTRICAL ENERGY BASED PROCESSES

Electric Discharge Machining (EDM) working principle, equipment, process parameters, materialremoval rate, electrode/tool, power circuits, tool wear, dielectric, flushing – wire cut EDM – applications.

UNIT IV CHEMICAL AND ELECTRO-CHEMICAL ENERGY BASED PROCESSES

Chemical machining: etchants, maskants, techniques – workingprinciple, equipment, process parameters, material removal rate, electrical circuit of electrochemical machining – electrochemical grinding – electrochemical honing – applications.

UNIT V THERMAL ENERGY BASED PROCESSES

Principle, equipment, material removal rate of laser beam machining and plasma arc machining – principle, equipment, types, beam control techniques, material removal rate of electron beam machining – applications.

Suggested Readings:

1. Mishra P K, *Non Conventional Machining*, Narosa Publishing House, New Delhi, 2007.
2. Pandey P C and Shan H S, *Modern Machining Processes*, Tata McGraw-Hill PublishingCompany, New Delhi, 2008.
3. Joao Paulo Davim, *Nontraditional Machining Processes: Research Advances*, Springer, New York, 2013.
4. Paul De Garmo, Black J T and Ronald A Kohser, *Material and Processes in Manufacturing*, Prentice Hall of India, New Delhi, 2011.
5. Vijaya Kumar Jain, *Advanced Machining Processes*, Allied Publishers, New Delhi, 2005.
6. Hassan El-Hofy, *Advanced Machining Processes: Nontraditional and Hybrid Machining Processes*, McGraw-Hill Professional, New Delhi, 2005.

18BEAE8E05	QUALITY CONTROL AND RELIABILITY ENGINEERING	Semester VIII 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To introduce the concept of Statistical Quality Control (SQC).
- To familiarise with various statistical process control methods.
- To study the methods and characteristics of sampling.
- To describe the concept of reliability and its models.
- To impart knowledge on the design of reliability process.
- To describe the concept of product life cycles

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Summarise the concept of quality and process control for variables.
- Apply the process control for attributes.
- Explain the importance of sampling methods and their characteristics.
- Explain the concept of life testing.
- Evaluate the reliability concept with their models.
- Explain the product life cycles

Course Contents:

UNIT I INTRODUCTION AND PROCESS CONTROL FOR VARIABLES

Introduction – definition of quality – basic concept of quality – definition of SQC – benefits and limitationof SQC – quality assurance – quality control – quality cost – variation in process – causes of variation – theory of control chart – uses of control chart –X chart, R chart and U chart – process capability –process capability studies – six sigma concepts.

UNIT II PROCESS CONTROL FOR ATTRIBUTES

Control chart for attributes –control chart for nonconformities – p chart and np chart – C and U charts – state of control and process out of control identification in charts – pattern study.

UNIT III ACCEPTANCE SAMPLING

Lot by lot sampling – types – probability of acceptance in single, double, multiple samplingtechniques – Operating Characteristic (OC) curves – producer's risk and consumer's risk – Acceptable Quality Level (AQL), Lot Tolerance Percent Defective(LTPD), Average Outgoing Quality Limit (AOQL)concepts – standard sampling plans for AQL and LTPD – uses of standard sampling plans.

UNIT IV LIFE TESTING - RELIABILITY

Life testing – Objective – failure data analysis – mean failure rate, mean time to failure, mean timebetween failure, hazard rate – Weibull model – system reliability, series, parallel and mixed configuration – maintainability and availability – acceptance sampling based on reliability test.

UNIT V QUALITY AND RELIABILITY

Reliability improvements – techniques – use of Pareto analysis – design for reliability – redundancy unit and standby redundancy – optimization in reliability – product design – product analysis – product development– product life cycles.

Note: Usage of approved statistical table is permitted in the examination.

Suggested Readings:

1. Besterfield D H, *Quality Control*, Prentice Hall, 2013.
2. Patrick O'Connor and Andre Kleyner, *Practical Reliability Engineering*, John Wiley, 2012.
3. Danny Samson, *Manufacturing and Operations Strategy*, Prentice Hall, 1991.
4. Eugene L Grant, *Statistical Quality Control*, McGraw-Hill, 2017.
5. Gupta R C, *Statistical Quality Control*, Khanna Publishers, 2001.

18BEAE8E06	INTELLECTUAL PROPERTY RIGHTS	Semester VIII 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To introduce the basic concepts of Intellectual Property Rights (IPR).
- To compare and contrast the different forms of intellectual property protection in terms of their key differences and similarities.
- To study the various agreements and legislation related to IPR.
- To learn digital products and law.
- To provide knowledge on enforcement of IPRs.
- To provide knowledge on the Infringement of IPRs

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Outline the basic concepts of intellectual property rights.
- Explain the registration of copyrights, trademarks, patents, geographical indications, trade secrets and industrial design registration.
- State the various agreements and legislation related to IPR.
- Describe digital products and law.
- Explain the enforcement measures of IPRs.
- Explain the Infringement of IPRs

Course Contents:

UNIT I INTRODUCTION

Introduction to IPRs – basic concepts and need for intellectual property, patents, copyrights, geographical indications – IPR in India and abroad – genesis and development – the way from WTO to WIPO –TRIPS – nature of intellectual property, industrial property, technological research, inventions and innovations – important examples of IPR.

UNIT II REGISTRATION OF IPRs

Meaning and practical aspects of registration of copyrights, trademarks, patents, geographical indications, trade secrets and industrial design registration in India and abroad.

UNIT III AGREEMENTS AND LEGISLATIONS

International treaties and conventions on IPRs – TRIPS agreement – PCT agreement – Patent Act of India – Patent Amendment Act – Design Act – Trademark Act – Geographical Indication Act.

UNIT IV DIGITAL PRODUCTS AND LAW

Digital innovations and developments as knowledge assets – IP laws, cyber law and digital content protection – unfair competition – meaning and relationship between unfair competition and IP laws – case studies.

UNIT V ENFORCEMENT OF IPRs

Infringement of IPRs – enforcement measures – emerging issues – case studies.

Suggested Readings:

1. Satarkar S V, *Intellectual Property Rights and Copyrights*, Ess Ess Publications, New Delhi, 2002.
2. Scople Vinod V, *Managing Intellectual Property*, Prentice Hall of India, 2012.
3. Deborah E Bouchoux, *Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets*, Cengage Learning, 2012.
4. Prabuddha Ganguli, *Intellectual Property Rights: Unleashing the Knowledge Economy*, McGraw-Hill Education, 2011.
5. Derek Bosworth and Elizabeth Webster, *The Management of Intellectual Property*, Edward Elgar Publishing Ltd., 2013.

18BEBMEOE01	ROBOTICS IN MEDICINE	3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To understand the basics of robotics and kinematics.
- To understand the basics of inverse kinematics.
- To explore various kinematic motion planning solutions for various robotic configurations.
- To explore various applications of robots in medicine.
- Express the various kinematic motion planning solutions for various robotic configurations.
- Describe the task planning, task level programming

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Explain the basics of robotics and kinematics.
- Describe the basics of inverse kinematics.
- Express the various kinematic motion planning solutions for various robotic configurations.
- Describe the task planning, task level programming
- Explain thebiologically inspired robots
- State the various applications of robots in medicine.

Course Contents:

UNIT I INTRODUCTION

Automation and robots, classification, application, specification, notations, direct kinematics, dot and cross products, coordinate frames, rotations, homogeneous coordinates, link coordinates, arm equation, five-axis robot, four-axis robot, six-axis robot.

UNIT II KINEMATICS

Inverse kinematics – general properties of solutions, tool configuration, fiveaxis robots, three-four axis, six axis robot, workspace analysis and trajectory planning, work envelope and examples, workspace fixtures, pick and place operations, continuous path motion, interpolated motion, straight-line motion.

UNIT III ROBOT VISION

Robot vision, image representation, template matching, polyhedral objects, shape analysis,segmentation – thresholding, region labelling, shrink operators, swell operators, Euler numbers,perspective transformation, structured illumination, camera calibration.

UNIT IV PLANNING

Task planning, task level programming, uncertainty, configurationspace, gross motionplanning, grasp planning, fine-motion planning, simulation of planar motion, source and goal scenes, task planner simulation.

UNIT V APPLICATIONS

Applications in biomedical engineering – bio engineering, biologically inspired robots, neural engineering, application in rehabilitation – interactive therapy, bionic arm, clinical and surgical– gynaecology, orthopaedics, neurosurgery.

Suggested Readings:

1. Robert J. Schilling, *Fundamentals of Robotics: Analysis and Control*, Prentice Hall, 1990.
2. John J. Craig, *Introduction to Robotics: Mechanics and Control*, Pearson Education, 2005.
3. Andrew C. Staugaard, *Robotics and AI: An Introduction to Applied Machine Intelligence*, Prentice Hall, 1987.
4. Mikell P Groover,Mitchell Weiss, Roger N Nagel, Nicholas G Odrey and Ashish Dutta, *Industrial Robotics: Technology, Programming and Applications*, McGraw-Hill Education, 2012.
5. Wolfram Stadler, *Analytical Robotics and Mechatronics*, McGraw-Hill, 1995.
6. Saeed B. Niku, *Introduction to Robotics: Analysis, Control, Applications*, John Wiley & Sons, 2010.
7. K. S. Fu, Ralph C. Gonzalez and C. S. G. Lee, *Robotics*, McGraw-Hill, 2008.

18BEBMEOE02 VIRTUAL REALITY AND AUGMENTED REALITY 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To introduce the relevance of this course to the existing technology through demonstrations, case studies and applications with a futuristic vision along with socio-economic impact and issues.
- To understand virtual reality, augmented reality and using them to build biomedical engineering applications.
- To know the intricacies of these platform to develop PDA applications with better optimality.
- State the side effects ofexposures to virtual reality environment.
- List the applications of virtual reality and augmented reality.
- Discuss the virtual reality on the web

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Explain the concept of virtual reality.
- Discuss the various virtual reality development processes.
- State the side effects ofexposures to virtual reality environment.
- List the applications of virtual reality and augmented reality.
- Discuss the virtual reality on the web
- Discuss the virtual reality on the mobile

Course Contents:

UNIT I INTRODUCTION

The three I's of Virtual Reality(VR) – commercial VR technology and the five classic components of a VRsystem – input devices(trackers, navigation, and gesture interfaces): three-dimensionalposition trackers, navigation and manipulation,interfaces and gesture interfaces – output devices:graphics displays, sound displays and haptic feedback.

UNIT II VR DEVELOPMENT PROCESS

Geometric modelling – kinematics modelling – physical modelling – behaviour modelling – model management.

UNIT III CONTENT CREATION CONSIDERATIONS FOR VR

Methodology and terminology – user performance studies – VR health and safety issues – usability ofvirtual reality system – cyber sickness – side effects of exposures to virtual reality environment.

UNIT IV VR ON THE WEB AND VR ON THE MOBILE

JS – pros and cons – building blocks (WebVR, WebGL, three.js, device orientation events) – frameworks (A-frame, React VR) – Google VR for Android – scripts, mobile device configuration,building to android – cameras and interaction – teleporting – spatial audio – assessing humanparameters – device development and drivers – design haptics.

UNIT V APPLICATIONS

Medical applications – military applications – robotics applications – advanced real time tracking – other applications: games, movies, simulations, therapy.

Suggested Readings:

1. Grigore C. Burdea and Philippe Coiffet, *Virtual Reality Technology*, John Wiley & Sons, 2003.
2. Jason Jerald, *The VR Book: Human-Centered Design for Virtual Reality*, Morgan & Claypool, 2015.
3. Dieter Schmalstieg and Tobias Höllerer, *Augmented Reality: Principles and Practice*, Addison-Wesley Professional, 2016.
4. Steve Aukstakalnis, *Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR*, Addison-Wesley Professional, 2016.
5. Robert Scoble and Shel Israel, *The Fourth Transformation: How Augmented Reality and Artificial Intelligence Change Everything*, Patrick Brewster Press, 2016.
6. Tony Parisi, *Learning Virtual Reality: Developing Immersive Experiences and Applications for Desktop, Web, and Mobile*, O'Reilly Media Inc., 2015.
7. Tony Parisi, *Programming 3D Applications with HTML5 and WebGL: 3D Animation and Visualization for Web Pages*, O'Reilly Media Inc., 2014.
8. Jos Dirksen, *Learning Three.js – the JavaScript 3D Library for WebGL*, Packt Publishing Ltd., 2015.

18BEBMEOE03 ARTIFICIAL ORGANS AND IMPLANTS 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To have an overview of artificial organs and transplants.
- To impart knowledge on the principles of implant design with a case study.
- To understand the implant design parameters and solutions in use.
- To study about various blood interfacing implants.
- Explain the implant design parameters and solutions in use.
- Discuss the various blood interfacing implants.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Discuss about the artificial organs and transplants.
- Describe the principles of implant design with a case study.
- Explain the implant design parameters and solutions in use.
- Discuss the various blood interfacing implants.
- Explain implantable medical devices and organs
- Explain the gastrointestinal system

Course Contents:

UNIT I ARTIFICIAL ORGANS AND TRANSPLANTS

Artificial organs:Introduction, outlook for organ replacements, design consideration,evaluation process.

Transplants:Overview, immunological considerations, blood transfusions, individual organs – kidney, liver, heart and lung, bone marrow, cornea.

UNIT II PRINCIPLES OF IMPLANT DESIGN

Principles of implant design, clinical problems requiring implants for solution, permanent versusabsorbable devices, the missing organ and its replacement, tissue engineering, scaffolds, cellsand regulators criteria for materials selection, case study of organ regeneration.

UNIT III IMPLANT DESIGN PARAMETERS AND ITS SOLUTION

Biocompatibility, local and systemic effects of implants, design specifications for tissue bondingand modulus matching, degradation of devices, natural and synthetic polymers, corrosion, wearand tear, implants for bone, devices for nerve regeneration.

UNIT IV BLOOD INTERFACING IMPLANTS

Neural and neuromuscular implants, heart valve implants, heart and lung assist devices, artificialheart, cardiac pacemakers, artificial kidney - dialysis membrane and artificial blood.

UNIT V IMPLANTABLE MEDICAL DEVICES AND ORGANS

Gastrointestinal system, dentistry, maxillofacial and craniofacial replacement, soft tissue repair,replacement and augmentation, recent advancement and future directions.

Suggested Readings:

1. Kolff W. J., *Artificial Organs*, John Wiley & Sons, 1976.
2. Joon Park, *Biomaterials Science and Engineering*, Springer US, 1984.
3. Joseph D. Bronzino, *Biomedical Engineering Handbook - Volume II*, CRC Press / IEEE Press, 2000.
4. Khandpur R. S., *Handbook of Biomedical Instrumentation*, McGraw-Hill Education, 2014.
5. Joon Park and Roderic S. Lakes, *Biomaterials: An Introduction*, Springer US, 1992.
6. Ioannis V. Yannas, *Tissue and Organ Regeneration in Adults: Extension of the Paradigm to Several Organs*, Springer, 2014.
7. Yadin David, Wolf W. von Maltzahn, Michael R. Neuman and Joseph D. Bronzino, *Clinical Engineering*, CRC Press, 2003.
8. Myer Kutz, *Standard Handbook of Biomedical Engineering & Design*, McGraw-Hill, 2003.

18BTBTOE01	BIOREACTOR DESIGN	3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To impart basic knowledge in bioprocess engineering.
- To design the bioreactors for various operations.
- To understand the principle and working of heat transfer equipments.
- To extendtheknowledge in principle of heat transfer inside a bioreactor.
- To construct the equipments used in mass transfer operations.
- To learn the equipments used in the separation process.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Summarise the basic concepts in biotechnology
- Summarise the basic concepts in bioprocess engineering.
- Design the bioreactors for various operations.
- Develop the heat transfer equipments for bioprocess engineering.
- Construct the equipments used in mass transfer operations.
- Categorise the equipments used in separation process.

Course Contents:

UNIT I INTRODUCTION TO BIOPROCESS ENGINEERING

Introduction – biotechnology and bioprocess engineering – biologists and engineers differ in their approach to research – how biologists and engineers work together – bioprocesses: regulatory constraints.

UNIT II REACTOR DESIGN

Design of airlift fermentor, bubble column reactor and continuous stirred tank reactor.

UNIT III HEAT TRANSFER EQUIPMENTS

Design of shell and tube heat exchanger, double pipe heat exchanger, long tube vertical evaporator and forced circulation evaporator.

UNIT IV MASS TRANSFER EQUIPMENTS

Design of Bollmann extractor, fractionating column, packed tower and spray tray absorber.

UNIT V SEPARATION EQUIPMENTS

Design of plate and frame filter press, leaf filter, rotary drum filter, disc bowl centrifuge, rotary drum drier and Swenson Walker crystallizer.

Suggested Readings:

1. James Edwin Bailey and David F. Ollis, *Biochemical Engineering Fundamentals*, McGraw-Hill Education (India), 2015.
2. Don W. Green and Robert H.Perry, *Perry's Chemical Engineers' Handbook*, McGraw-Hill, 2008.
3. Pauline. M. Doran, *Bioprocess Engineering Principles*, Academic Press, 2015.

18BTBTOE02 FOOD PROCESSING AND PRESERVATION 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To learn the scope and importance of food processing.
- To impart basic knowledge in different food processing methods carried out in the food tech companies.
- To extend the brief knowledge in food conservation operations.
- To study the methods of food preservation by cooling.
- To familiarise the students on the concepts of preservation methods for fruits.
- To create a deeper understanding of preservation methods for vegetables.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Describe the scope and importance of food processing.
- Outline the various processing methods for foods.
- Extend the knowledge in food conservation operations.
- Describe the methods of food preservation by cooling.
- Summarise the preservation methods for fruits.
- Demonstrate the preservation methods for vegetables.

Course Contents:

UNIT I SCOPE AND IMPORTANCE OF FOOD PROCESSING

Propertiesoffood –physical, thermal, mechanical, sensory. Raw material preparation –cleaning, sorting, grading, peeling.

UNIT II PROCESSING METHODS

Heating–blanching and pasteurization. Freezing – dehydration – canning – additives –fermentation – extrusion cooking – hydrostatic pressure cooking – dielectric heating – microwave processing and aseptic processing – infrared radiation processing – concepts and equipment used.

UNIT III FOOD CONVERSION OPERATIONS

Sizereduction – fibrous foods, dry foodsand liquid theory and foods – equipments – membrane separation – filtration – equipment and application.

UNIT IV FOOD PRESERVATION BY COOLING

Refrigeration, freezing–theory, freezing time calculation, methods of freezing, freezing equipments, freeze drying, freeze concentration, thawing, effect of low temperatureon food. Water activity,methodsto control water activity.

UNIT V PRESERVATION METHODS FOR FRUITS AND VEGETABLES

Pre-processing operations – preservation by reduction of water content: drying/dehydration and concentration – chemical preservation – preservation of vegetables by acidification, preservation with sugar –heat preservation– food irradiation – combined preservation techniques.

Suggested Readings:

1. R. Paul Singh and Dennis R. Heldman, *Introduction to Food Engineering*, Academic Press, 2014.
2. P.Fellows, *Food Processing Technology Principles and Practice*, Woodhead Publishing Ltd., 2017.
3. Mircea Enachescu Dauthy, *Food and Vegetable Processing*, FAO Agricultural Services Bulletin, 1995.
4. M.A.Rao,SyedS.H.Rizvi and Ashim K. Datta, *Engineering Properties of Foods*, CRC Press, 2014.
5. B. Sivasankar, *Food Processing and Preservation*, PHI Learning Pvt. Ltd., 2002.

18BTBTOE03 BASIC BIOINFORMATICS 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To understand the available tools and databases for performing research in bioinformatics.
- To expose students to sequence alignment tool in bioinformatics.
- To construct the phylogenetic trees for evolution.
- To get familiar with the 3D structure of protein and classification.
- To acquire basic knowledge in protein secondary structure prediction.
- To extend the brief knowledge in microarray data analysis.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Summarise the basic concepts and importance of bioinformatics in various sectors.
- Demonstrate the sequence alignment tool in bioinformatics.
- Construct the phylogenetic trees for evolution.
- Analyse the three-dimensional protein structure and classification using various tools.
- Illustrate the protein secondary structure prediction by comparative modelling.
- Extend the knowledge in microarray technology and applications of bioinformatics in various sectors.

Course Contents:

UNIT I OVERVIEW OF BIOINFORMATICS

The scope of bioinformatics; bioinformatics and the internet; useful bioinformatics sites. Data acquisition: sequencing DNA, RNA and proteins; determination of protein structure; gene and protein expression data; protein interaction data. Databases – contents, structure and annotation; file formats; annotated sequence databases; miscellaneous databases.

UNIT II RETRIEVAL OF BIOLOGICAL DATA

Data retrieval with Entrez and DBGET/LinkDB; data retrieval with SRS (sequence retrieval system).Searching sequence databases by sequence similarity criteria: sequence similarity searches; amino acid substitution matrices; database searches, FASTA and BLAST; sequence filters; iterative database searches and PSI-BLAST. Multiple-sequence alignment, gene and protein families: multiple-sequence alignment and family relationships; protein families and pattern databases; protein domain families.

UNIT III PHYLOGENETICS

Phylogenetics, cladistics and ontology; building phylogenetic trees; evolution of macromolecular sequences. Sequence annotation: principles of genome annotation; annotation tools and resources.

UNIT IV STRUCTURAL BIOINFORMATICS

Conceptual models of protein structure; the relationship of protein three-dimensional structure to protein function; the evolution of protein structure and function; obtaining, viewing andanalysing structural data; structural alignment; classification of proteins of known three-dimensional structure: CATH and SCOP; introduction to protein structure prediction; structure prediction by comparative modelling; secondary structure prediction; advanced protein structure prediction and prediction strategies.

UNIT V MICROARRAY DATA ANALYSIS

Microarray data, analysis methods; microarray data, tools and resources; sequence sampling and SAGE. Bioinformatics in pharmaceutical industry: informatics and drug discovery; pharma informatics resources. Basic principles of computing in bioinformatics: running computer software; computer operating systems; software downloading and installation; database management.

Suggested Readings:

1. Dan E Krane and Michael L Raymer, *Fundamental Concepts of Bioinformatics*, Pearson Education, 2004.
2. Andreas D Baxevanis and B.F. Franchis Ouellette, *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins*, Wiley-Interscience, 2004.
3. David W. Mount, *Bioinformatics: Sequence and Genome Analysis*, Cold Spring Harbor Laboratory Press, 2004.
4. Jonathan Pevsner, *Bioinformatics and Functional Genomics*, Wiley-Blackwell, 2015.
5. Michael J Koernberg, *Microarray Data Analysis: Methods and Applications*, Humana Press, 2016.

18BTBTOE04 FUNDAMENTALS OF NANOBIOTECHNOLOGY 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To impart the skills in the field of nanobiotechnology and its applications.
- To acquire knowledge in the nanoparticles and its significance in various fields.
- To extend the knowledge in types and application of nanoparticles in sensors.
- To define the concepts of biomaterials through the molecular self assembly.
- To equip students with clinical applications of nanodevices.
- To describe a deeper understanding of the socio-economic issues in nanobiotechnology.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Develop skills in the field of nanobiotechnology and its applications.
- Summarise the nanoparticles and its significance in various fields.
- Extend the knowledge in types and application of nanoparticles in sensors.
- Define the concepts of biomaterials through the molecular self assembly.
- Outline the clinical applications of nanodevices.
- Describe the socio-economic issues in nanobiotechnology.

Course Contents:

UNIT I INTRODUCTION

Introduction, scope and overview, length scales, importance of nanoscale and technology, history of nanotechnology, future of nanotechnology: nanotechnology revolution, silicon based technology, benefits and challenges in molecular manufacturing: the molecular assembler concept, controversies and confusions, understanding advanced capabilities, nanotechnology in differentfields: nanobiotechnology, materials, medicine, dental care.

UNIT II NANOPARTICLES

Introduction, types of nanoparticles, techniques to synthesise nanoparticles, characterization of nanoparticles, applications, toxic effects of nanomaterials, significance of nanoparticles nanofabrications– MEMS/NEMS, atomic force microscopy, self assembled monolayers/dip-pen nanolithography, soft lithography, PDMS molding, nanoparticles, nanowires and nanotubes.

UNIT III MEDICAL NANOTECHNOLOGY

Nanomedicine, nanobiosensor and nanofluidics. nanocrystals in biological detection, electrochemical DNA sensors and integrated nanoliter systems. Nano-biodevices and systems. Fabrication of novel biomaterials through molecular self assembly – small scale systems for in vivo drug delivery – future nanomachine.

UNIT IV NANOBIOTECHNOLOGY

Clinical applications of nanodevices. Artificial neurons. Real-time nanosensors –applications in cancer biology. Nanomedicine.Synthetic retinyl chips based on bacteriorhodopsins. High throughput DNA sequencing with nano carbontubules.Nanosurgical devices.

UNIT V ETHICAL ISSUES IN NANOTECHNOLOGY

Introduction, socioeconomic challenges, ethical issues in nanotechnology: with especial reference to nanomedicine, nanomedicine applied in nonmedical contexts, social issues relating to nanomedicine. Social and ethical issues, economic impacts, other issues, nanotechnology and future socio-economic challenges.

Suggested Readings:

1. Niemeyer, C.M. and Mirkin, C.A., *Nanobiotechnology: Concepts, Applications and Perspectives*, Wiley-VCH, 2005.
2. Goodsell, D.S., *Bionanotechnology*, John Wiley and Sons, Inc., 2004.
3. Shoseyov, O. and Levy, I., *Nanobiotechnology: Bioinspired Devices and Materials of the Future*, Humana Press, 2008.
4. Bhushan, B., *Springer Handbook of Nanotechnology*, Springer-Verlag Berlin Heidelberg, 2017.
5. Robert A. Freitas Jr., *Nanomedicine*, Landes Biosciences, 2006.
6. Kohler, M. and Fritzsche, W., *Nanotechnology: An Introduction to Nanostructuring Techniques*, Wiley-VCH, 2008.

18BTCEOE01 ENERGY MANAGEMENT IN CHEMICALINDUSTRIES 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To teachthe basic concepts and fundamental aspects of industrial and domestic thermal systems' design.
- To prepare the students for the positions of energy management in energy intensive industries.
- Examine the relationship between energy systems and society.
- Use optimization techniques for conservation of energy in chemical industries.
- Understand economic balance in energy
- Evaluate the production rate and analyze the cost from economic balance for energy consumption.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Plan to optimize energy using systems and procedures to meet energy demand.
- Describe the movement of substances in the entire globe.
- Examine the relationship between energy systems and society.
- Use optimization techniques for conservation of energy in chemical industries.
- Understand economic balance in energy
- Evaluate the production rate and analyze the cost from economic balance for energy consumption.

Course Contents:

UNIT I PLANNING FOR ENERGY NEEDS

Forecasting techniques; energy demand; magnitude and pattern; input and output analysis; energy modelling and optimal mix of energy sources.

UNIT II ENERGY AND ENVIRONMENT

Energy; various forms; energy storage; structural properties of environment; bio-geo-chemical cycles; society, environmentpopulation and technology.

UNIT III ENERGY AND SOCIETY

Energy and evolution; growth and change; patterns of consumption in developing and advanced countries; commercial generationof power requirements and benefit.

UNIT IV MANAGEMENT OF ENERGY CONSERVATION IN CHEMICAL INDUSTRIES

Chemical industries; classification; conservation in unit operations such as separation; cooling tower; drying; conservation applied o refineries, petrochemical, fertilisers, cement, pulp and paper, food and chlor-alkali industries; conservation using optimizationtechniques.

UNIT V ECONOMIC BALANCE IN ENERGY CONSUMPTION

Cost analysis; capacity; production rate; system rate; system cost analysis; corporate models; production analysis and productionusing fuel inventories; input-output analysis; economics; tariffs.

Suggested Readings:

1. Jerrold H Kertz, *Energy Conservation and Utilization*, Allyn and Bacur Inc., 1976.
2. Gemand M Gramlay, *Energy*, Macmillion Publishing Co., New York, 1975.
3. Krentz J. H., *Energy Conservation and Utilization*, Allyn and Bacur Inc., 1976.
4. Gramlay G. M., *Energy*, Macmillan Publishing Co., New York, 1975.
5. Rused C. K., *Elements of Energy Conservation*, McGraw-Hill Book Co., 1985.

18BTCEOE02 FERTILIZER TECHNOLOGY 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To enable the students to learn the fertilizer manufacturing including new or modified fertilizer products and new techniques.
- Develop the flow chart for manufacture of nitrogenous fertilizers.
- Analyze the various processes and develop the flow chart for the manufacture of phosphatic fertilizers.
- Develop the flow chart for the manufacture of potassic fertilizer and analyze the unit operations involved in the process.
- Understand the fertilizers impacts and standards
- Illustrate the quality and pollution standards permissible in fertilizer industry.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Illustrate chemical, organic fertilizers and nutrients.
- Develop the flow chart for manufacture of nitrogenous fertilizers.
- Analyze the various processes and develop the flow chart for the manufacture of phosphatic fertilizers.
- Develop the flow chart for the manufacture of potassic fertilizer and analyze the unit operations involved in the process.
- Understand the fertilizers impacts and standards
- Illustrate the quality and pollution standards permissible in fertilizer industry.

Course Contents:

UNIT I INTRODUCTION

Chemical fertilizers and organic manures – types of chemical fertilizers. Secondary nutrients, micro nutrients.

UNIT II NITROGEN FERTILIZERS

Nitrogenous fertilizers – methods of production of ammonia and urea. Nitric acid, ammonium sulphate, ammonium nitrate,calcium ammonium nitrate, ammonium chloride – their methods of production, characteristics, storage and handlingspecifications.

UNIT III PHOSPHATIC FERTILIZERS

Raw materials, phosphate rock, sulphur pyrites – process for the production of sulphuric and phosphoric acids. Ground phosphaterock, bone meal. Single super phosphate, triple super phosphate – methods of production, characteristics and specifications.

UNIT IV POTASSIC FERTILIZERS

Potassium chloride, potassium sulphate, potassium schoenite – methods of production, specification, characteristics. Complex fertilizers, NPK fertilizers, mono ammonium phosphate, diammonium phosphate, nitro phosphate methods of production.

UNIT V FERTILIZERS IMPACTS AND STANDARDS

Fluid fertilizers. Controlled release of fertilizers. solid, liquid and gaseous pollution from ammonia urea and NPK fertilizerindustries and standards laid down for them. Fertilizer production in India.

Suggested Readings:

1. Gopala Rao M. and Marshall Sittig, *Dryden's Outlines of Chemical Technology*, WEP East-West Press, NewDelhi, 2010.
2. George T. Austin, *Shreve's Chemical Process Industries*, McGraw Hill Professional, 2012.
3. Vincent Sauchelli, *The Chemistry and Technology of Fertilizers*, Reinhold Pub. Corp., 1960.
4. Editorial Committee, *FAI Seminar on Fertilizer in India in the Seventies (Proceedings)*, The Fertilizer Association of India, New Delhi, 1973.
5. Editorial Committee, *Seminar on Recent Advances in Fertilizer Technology*, The Fertilizer Association of India, New Delhi, 1972.
6. Sauchelli V., *Manual on Fertilizer Manufacture*, Industry Publication Inc., New Jersey, 1963.
7. Chari, K.S., *CHEMTECH - II - Chapter on Fertilizers*, Chemical Engineering Education Development Centre, IIT Madras, 1977.
8. Menon M.G., *Fertilizer Industry - Introductory Survey*, Higginbothams, Madras, 1973.

18BTCEOE03 INDUSTRIAL WASTEWATER TREATMENT 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To introduce students to the principles of wastewater and solid waste treatment and management.
- To impart knowledge on fundamental concepts in water and wastewater treatment technologies, hazardous solid waste disposal and management issues related to sludge treatment and disposal.
- Separate the contaminants from the effluent for treatability.
- Determine the biomass yield and substrate utilization rate for biological treatment process and design of activated sludge process.
- Develop a flow sheet for the waste water treatment from dairy, sugar, pulp and paper, textile and pharmaceutical industries.
- Apply wastewater reclamation technologies

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Examine the constituents of waste water and its effects.
- Separate the contaminants from the effluent for treatability.
- Determine the biomass yield and substrate utilization rate for biological treatment process and design of activated sludge process.
- Develop a flow sheet for the waste water treatment from dairy, sugar, pulp and paper, textile and pharmaceutical industries.
- Apply wastewater reclamation technologies
- Develop process flow diagram for water reuse and sludge disposal.

Course Contents:

UNIT I INTRODUCTION TO WASTE WATER ENGINEERING

Waste water engineering –overview, inorganic non-metallic constituents and metallic constituents, physical and biologicalcharacteristics.

UNIT II UNIT OPERATIONS AND UNIT PROCESS

Screening, flow equalization, mixing, flocculation, grit removal, sedimentation, coagulation, precipitation, oxidation andneutralization.

UNIT III FUNDAMENTALS OF BIOLOGICAL TREATMENT

Introduction, microbial growth kinetics, types of biological process for wastewater treatment – aerobic and anaerobic oxidation,biological nitrification and de-nitrification, biological phosphorous removal, activated sludge process (with designconsiderations), trickling filters and lagoons.

UNIT IV WASTE WATER TREATMENT IN SPECIFIC INDUSTRIES

Dairy, sugar, pulp and paper, textile and pharmaceutical industries.

UNIT V WATER REUSE

Wastewater reclamation technologies and reuse, solid processing flow diagrams, sludge and scum pumping, grinding, screening,degritting, blending, anaerobic digestion, composting, conditioning, dewatering and incineration.

Suggested Readings:

1. Metcalf Eddy, *Wastewater Engineering - Treatment and Reuse*, Tata McGraw Hill, New Delhi, 2002.
2. Mark J. Hammer, *Water and Wastewater Technology*, Prentice Hall of India Pvt. Ltd., New Delhi, 2012.
3. James M. Montgomery, *Water Treatment Principles and Design*, A Wiley Interscience Publication, New York, 1985.

18BTCEOE04 SOLID AND HAZARDOUS WASTE MANAGEMENT 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To provide an understanding of solid and hazardous waste engineering principles and management issues.
- To provide students with the necessary background and knowledge pertaining to the engineering design of solid and hazardous waste facilities.
- Deduce the source reduction, recycling and reuse techniques of solid waste.
- Analyze the collection systems and method of transfer of solid waste.
- Describe the processing techniques for solid and hazardous waste.
- Select the suitable methods for disposal of solid and hazardous waste.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Outline the salient features of solid waste management and handling.
- Deduce the source reduction, recycling and reuse techniques of solid waste.
- Analyze the collection systems and method of transfer of solid waste.
- Describe the processing techniques for solid and hazardous waste.
- Select the suitable methods for disposal of solid and hazardous waste.
- Interpret the legislation for management, handling and disposal of solid and hazardous waste.

Course Contents:

UNIT I CHARACTERISTICS AND SOURCE REDUCTION OF SOLID WASTE

Definition, sources, and types of solid waste –composition, physical, chemical and biological properties of solid wastes –percapita generation rates –sampling and characterization of solid waste –source reduction of wastes – waste exchange –recyclingand reuses –salient features of Indian legislations on management and handling of municipal solid wastes.

UNIT II COLLECTION AND TRANSPORT OF SOLID WASTE

Estimation of solid waste and factors affecting generation rates – on-site handling, storage, and processing – collection services:municipal and commercial – industrial services –collection systems: Hauled-Container System (HCS) and Stationary ContainerSystem (SCS) –vehicle and labour assessment –assessment of collection route – transfer and transport –transfer stationlocation – means and methods of transfer.

UNIT III PROCESSING AND DISPOSAL OF SOLID WASTE

Objective of processing – material separation and processing technologies – biological, chemical and thermal conversiontechnologies – disposal in landfills: site selection methods and operations, leachate and gas generations and movement andcontrol of gas and leachate techniques – composting: aerobic and anaerobic – resource and energy recovery schemes.

UNIT IV HAZARDOUS WASTE CHARACTERIZATION AND MANAGEMENT

Definitions and identifications of hazardous waste – origin and characterization of hazardous solid waste – typical hazardouswastes in MSW – hazardous waste management: minimization, collection, storage, handling, transport, and disposal – design ofhazardous waste landfills – TCLP tests – national and international legislation for hazardous waste management – AtomicEnergy Regulatory Board – International Atomic Energy Agency – Department of Atomic Energy – Nuclear Power Corporation – nuclear power plants in India.

UNIT V NUCLEAR WASTE AND e-WASTE

Sources – classification – effects of nuclear waste – initial treatment of nuclear waste – vitrification, ion exchange, synroc – longterm management – above ground disposal, geological disposal, ocean dumping, transmutation, space disposal – reuse ofwaste – nuclear safety and waste regulation – case study on nuclear disaster – source of e-waste – material composition ofe-waste – recycling and recovery – integrated approaches to e-waste recycling – socio economic factors – treatment option – disposal option – e-waste legislation.

Suggested Readings:

1. Tchobanoglous, G., *Integrated Solid Waste Management*, McGraw-Hill Publication, New York, 1993.
2. Ronald E. Hester and Roy M. Harrison,*Electronic Waste Management*, Royal Society of Chemistry, 2009.
3. Peavy, S.H., Rowe, R.D. and Tchobanoglous, G., *Environmental Engineering*, McGraw-Hill Inter Edition, 1985.
4. 2. Charles, A.W., *Hazardous Waste Management*, McGraw-Hill Publication, 2002.

18BECEOE01 HOUSING, PLAN AND MANAGEMENT 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To examine the role and tasks of basic housing policies and building bye-laws.
- To understand the process of integrated service delivery in the context of economic, social, environmental and institutional factors.
- To analyse the innovative construction methods and materials.
- To analyse city management strategies and strengthen the urban governance through a problem solving approach.
- Use housing programmes and schemes.
- Plan and design housing projects.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Explain the importance of basic housing policies and building bye-laws.
- Use housing programmes and schemes.
- Plan and design housing projects.
- Examine innovative construction methods
- Examine innovative construction materials.
- Describe housing finance and loan approval procedures.

Course Contents:

UNIT I INTRODUCTION TO HOUSING

Definition of basic terms – house, home, household, apartments, multi-storeyed buildings, special buildings, objectives and strategies of national housing policies, principle of sustainable housing, housing laws at state level, bye-laws at urban and rural local bodies – levels – development control regulations, institutions for housing at national, state and local levels.

UNIT II HOUSING PROGRAMMES

Basic concepts, contents and standards for housing programmes – sites and services, neighbourhoods, open development plots, apartments, rental housing, co-operative housing, slum housing programmes, role of public, private and non-government organizations.

UNIT III PLANNING AND DESIGN OF HOUSING PROJECTS

Formulation of housing projects – site analysis, layout design, design of housing units (design problems)

UNIT IV CONSTRUCTION TECHNIQUES AND COST-EFFECTIVE MATERIALS

New constructions techniques – cost effective modern construction materials, building centers – concept, functions and performance evaluation.

UNIT V HOUSING FINANCE AND PROJECT APPRAISAL

Appraisal of housing projects – housing finance, cost recovery – cash flow analysis, subsidy and cross subsidy, pricing of housing units, rents, recovery pattern (problems).

Suggested Readings:

1. Meera Mehta and Dinesh Mehta, *Metropolitan Housing Markets*, Sage Publications Pvt. Ltd., New Delhi, 2002.
2. Francis Cherunilam and Odeyar D Heggade, *Housing in India*, Himalaya Publishing House, Bombay, 2001.
3. *Development Control Rules for Chennai Metropolitan Area*, CMA, Chennai, 2002.
4. *National Experiences with Shelter Delivery for the Poorest Groups*, UNCHS (Habitat), Nairobi, 2000.

18BECEOE02	BUILDING SERVICES	3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To provide knowledge on machineries involved in building construction.
- To impart knowledge onelectrical systems in buildings.
- To understand theprinciples of illumination and design.
- To learn therefrigeration principles and its applications.
- To study the importance of fire safety and its installation techniques.
- Use the principles of illumination and design.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Explain the machineries involved in building construction.
- Discuss the electrical system and its selection criteria.
- Use the principles of illumination and design.
- Illustrate the principle of refrigeration.
- Explain the importance of fire safety and its installation techniques.
- Apply fire safety installation techniques.

Course Contents:

UNIT I MACHINERIES

Hot water boilers – lifts and escalators – special features required for physically handicapped and elderly – conveyors – vibrators – concrete mixers – DC/AC motors – generators – laboratory services – gas, water, air and electricity.

UNIT II ELECTRICAL SYSTEMS IN BUILDINGS

Basics of electricity – single/three phase supply – protective devices in electrical installations – earthing for safety – types of earthing – ISI specifications – types of wires, wiring systems and their choice – planning electrical wiring for building – main and distribution boards – transformers and switch gears – layout of substations.

UNIT III PRINCIPLES OF ILLUMINATION AND DESIGN

Visual tasks – factors affecting visual tasks – modern theory of light and colour – synthesis of light – additive and subtractive synthesis of colour – luminous flux – candela – solid angle illumination – utilization factor – depreciation factor – MSCP – MHCP –classification of lighting – artificial light sources – spectral energy distribution – luminous efficiency – colour temperature – colour rendering. Design of modern lighting – lighting for stores, offices, schools, hospitals and house lighting. Elementary idea of special features required and minimum level of illumination required for physically handicapped and elderly in building types.

UNIT IV REFRIGERATION PRINCIPLES AND APPLICATIONS

Thermodynamics – heat – temperature, measurement transfer – change of state – sensible heat – latent heat of fusion, evaporation, sublimation – saturation temperature – superheated vapour – subcooled liquid – pressure temperature relationship for liquids – refrigerants – vapour compression cycle – compressors – evaporators – refrigerant control devices – electric motors – starters – air handling units – cooling towers – window type and packaged air-conditioners – chilled water plant – fan coil systems – water piping – cooling load – air conditioning systems for different types of buildings – protection against fire to be caused by AC systems.

UNIT V FIRE SAFETY INSTALLATION

Causes of fire in buildings – safety regulations – NBC – planning considerations in buildings like non-combustible materials, construction, staircases and lift lobbies, fire escapes and AC systems. Special features required for physically handicapped and elderly in building types – heat and smoke detectors – fire alarm system, snorkel ladder – fire lighting pump and water storage – dry and wet risers – automatic sprinklers.

Suggested Readings:

1. E.R.Ambrose, *Heat Pumps and Electric Heating*, John and Wiley and Sons Inc., New York, 2002.
2. *Handbook for Building Engineers in Metric Systems*, NBC, New Delhi, 2005.
3. Derek Phillips, *Lighting in Architectural Design*, McGraw-Hill, New York, 2000.
4. A.F.C. Sherratt, *Air-Conditioning and Energy Conservation*, The Architectural Press, London, 2005.
5. National Building Code.

18BECEOE03 REPAIR AND REHABILITATION OF STRUCTURES 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To learn various distress and damages to concrete and masonry structures.
- To know the influence of corrosion in durability of structures.
- To understand the importance of maintenance of structures.
- To study the various types and properties of repair materials.
- To learn various techniques involved in demolition of structures.
- Describe the importance of maintenance of structures, types and properties of repair materials.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Explain the various distress and damages to concrete and masonry structures.
- Discuss the durability of structures and corrosion mechanism.
- Describe the importance of maintenance of structures, types and properties of repair materials.
- Assess the damage of structures.
- Apply various repair techniques
- Explain the modern techniques and equipment adopted for the demolition of structures.

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Course Contents:

UNIT I INTRODUCTION

Quality assurance for concrete construction as-built concrete properties strength, permeability, thermal properties and cracking. Effects due to climate, temperature, chemicals, wear and erosion, design and construction errors.

UNIT II DURABILITY OF STRUCTURES

Corrosion mechanism – diagnosis – causes and effects – cover thickness and cracking, measurements for corrosion – methods of corrosion protection, corrosion inhibitors, corrosion resistant steels, coatings, cathodic protection.

UNIT III MAINTENANCE AND REPAIR STRATEGIES

Definitions: maintenance, repair and rehabilitation, facets of maintenance, importance of maintenance, preventive measures on various aspects, inspection, assessment procedure for evaluating a damaged structure, causes of deterioration, testing techniques.

UNIT IV MATERIALS FOR REPAIR

Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, expansive cement, polymer concrete, sulphur infiltrated concrete, ferro cement, fibre reinforced

concrete, eliminators and polymers coating for rebars during repair, foamed concrete, mortar and dry pack, vacuum concrete.

UNIT V TECHNIQUES FOR REPAIR AND REPAIR OF STRUCTURES

Non-destructive testing techniques, corrosion protection techniques, gunite and shotcrete epoxy injection, mortar repair for cracks, shoring and underpinning. Repairs to overcome low member strength, deflection, cracking, chemical disruption, weathering wear, fire, leakage, marine exposure. Engineered demolition techniques for dilapidated structures – case studies.

Suggested Readings:

1. R.T.Allen and S.C.Edwards, *Repair of Concrete Structures*, Blakie and Sons, UK, 2011.
2. Dr. B.Vidivelli, *Rehabilitation of Concrete Structures*, Standard Publishers, Chennai, 2011.

18BECEOE04 COMPUTER-AIDED CIVIL ENGINEERING DRAWING 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To impart knowledge on parametric design and the conventions of formal engineering drawing.
- To produce and interpret 2D and 3D drawings.
- To communicate a design idea/concept graphically/visually.
- To provide knowledge onmasonry bonds.
- To understand perspective view of buildings.
- Illustrate a design idea/concept graphically/visually.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Explain the parametric design and the conventions of formal engineering drawing.
- Create and interpret 2D drawings.
- Create and interpret 3D drawings.
- Illustrate a design idea/concept graphically/visually.
- Discuss the various types of masonry bonds.
- Create perspective view of a building.

Course Contents:

UNIT I INTRODUCTION

Introduction to concept of drawings, interpretation of typical drawings, planning drawings to show information concisely and comprehensively; optimal layout of drawings and scales; introduction to computer aided drawing, co-ordinate systems, reference planes. Commands: initial settings, drawing aids, drawing basic entities, modify commands, layers, text and dimensioning, blocks. Drawing presentation norms and standards.

UNIT II SYMBOLS AND SIGN CONVENTIONS

Materials, architectural, structural, electrical and plumbing symbols. Rebar drawings and structural steel fabrication and connections drawing symbols, welding symbols; dimensioning standards.

UNIT III MASONRY BONDS

English bond and Flemish bond – corner wall and cross walls –one brick wall and one and half brick wall.

UNIT IV BUILDING DRAWING

Terms, elements of planning building drawing, methods of making line drawing and detailed drawing. Site plan, floor plan, elevation and section drawing of small residential buildings. Foundation plan. Roof drainage plans. Depicting joinery, standard fittings and fixtures, finishes. Use of notes to improve clarity.

UNIT V PICTORIAL VIEW

Principles of isometrics and perspective drawing. Perspective view of building.

List of Drawing Experiments:

1. Buildings with load bearing walls including details of doors and windows.
2. Single storey RCC building.
3. Multi-storey RCC building.

Suggested Readings:

1. Subhash C Sharma and Gurucharan Singh, *Civil Engineering Drawing*, Standard Publishers, 2005.
2. Ajeet Singh, *Working with AutoCAD 2000 with Updates on AutoCAD 2000i*, Tata McGraw-Hill Company Ltd., New Delhi, 2002.
3. Sham Tickoo, *AutoCAD 2009 for Engineers and Designers*, Pearson Education, 2009.
4. Venugopal K, *Engineering Drawing and Graphics + AutoCAD*, New Age International Pvt. Ltd., 2007.
5. Balagopal T.S. Prabhu, *Building Drawing and Detailing*, Spades Publishing, Calicut, 1987.

18BECSOE01	INTERNET PROGRAMMING	3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To introduce the Java programming language and explore its current strengths and weaknesses.
- To study the way that object-oriented concepts are implemented in the Java programming language.
- To write working Java code to demonstrate the use of applets for client side programming.
- Discuss the way that exceptions are detected and handled in the Java programming language.
- Create Java code that demonstrates multiple threads of execution.
- Describe internet telephony

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Explain the basic and advanced concepts and techniques of Java.
- Design an application based upon the concepts of Java and advance Java.
- Discuss the way that exceptions are detected and handled in the Java programming language.
- Create Java code that demonstrates multiple threads of execution.
- Describe internet telephony
- Explain multimedia applications

Course Contents:

UNIT I INTRODUCTION

Introduction –network of networks, intranet, extranet and internet. World wide web – domain and subdomain, address resolution, DNS, telnet, FTP, HTTP. TCP/IP –features, segment, three-way handshaking, flow control, error control, congestion control, IP datagram, IPv4 and IPv6. IP subnetting and addressing – classful and classless addressing, subnetting.

UNIT II HTML

Introduction, editors, elements, attributes, heading, paragraph. Formatting, link, head, table, list, block, layout, CSS. Form, iframe, colors, colorname, colorvalue. Image maps– map, area, attributes of image area– Extensible Markup Language (XML)–introduction, tree, syntax, elements, attributes, validation, viewing. XHTML in brief. CGI scripts – introduction – environment variable, GET and POST methods.

UNIT III PERL

Introduction, variable, condition, loop, array, implementing data structure, hash, string, regular expression, file handling, I/O handling –JavaScript – basics, statements, comments, variable, comparison, condition, switch, loop, break. Object – string, array, boolean, regex. Function, errors,

validation. Cookies–definition of cookies, create and store a cookie with example. Java applets – container class, components, applet life cycle, update method, applications.

UNIT IV CLIENT-SERVER PROGRAMMING

Client-server programming in Java – Java socket, Java RMI. Threats –malicious code – viruses, Trojan horses, worms; eavesdropping, spoofing, modification, denial of service attacks–network security techniques – password and authentication– VPN, IP security, security in electronic transaction, Secure Socket Layer (SSL), Secure Shell (SSH). Firewall–introduction, packet filtering, stateful, application layer, proxy.

UNIT V INTERNET TELEPHONY

Introduction, VoIP–multimedia applications – multimedia over IP: RSVP, RTP, RTCP and RTSP–streaming media, codec and plugins, IPTV–search engine and web crawler – definition, metadata, web crawler, indexing, page rank, overview of SEO.

Suggested Readings:

1. Paul Deitel, Harvey Deitel and Abby Deitel, *Internet and World Wide Web: How to Program*, Pearson, 2011.
2. N.P. Gopalan and J. Akilandeswari, *Web Technology: A Developer's Perspective*, PHI Learning, Delhi, 2013.
3. Rahul Banerjee, *Internetworking Technologies: An Engineering Perspective*, PHI Learning, Delhi, 2011.
4. Robert W. Sebesta, *Programming the World Wide Web*, Pearson Education, 2016.

18BECSOE02 MULTIMEDIA AND ANIMATION 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To study the graphics techniques and algorithms.
- To study the multimedia concepts and various I/O technologies.
- Explain the various latest interactive multimedia devices, the basic concepts about images and image formats.
- Explain the data compression techniques, image compression techniques like JPEG
- Explain the video compression techniques like MPEG, and the basic concepts about animation
- Create an interactive multimedia presentation by using multimedia devices

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Discuss the fundamental concepts of computer animation and multimedia.
- Explain the various latest interactive multimedia devices, the basic concepts about images and image formats.
- Explain the data compression techniques, image compression techniques like JPEG
- Explain the video compression techniques like MPEG, and the basic concepts about animation
- Create an interactive multimedia presentation by using multimedia devices
- Identify theoretical and practical aspects in designing multimedia applications surrounding the emergence of multimedia technology.

Course Contents:

UNIT I INTRODUCTION

What is mean by animation – why we need animation – history of animation– uses of animation – types of animation – principles of animation – some techniques of animation – animation on the web – 3D animation – special effects – creating animation.

UNIT II CREATING ANIMATION IN FLASH

Introduction to flash animation – introduction to flash – working with the timeline and frame-based animation – working with the timeline and tween-based animation – understanding layers – action script.

UNIT III 3D ANIMATION AND ITS CONCEPTS

Types of 3D animation– skeleton and kinetic 3D animation– texturing and lighting of 3Danimation – 3D camera tracking – applications and software of 3D animation.

UNIT IV MOTION CAPTION

Formats – methods – usages – expression – motion capture softwares – script animation usage– different language of script animation among the software.

UNIT V CONCEPT DEVELOPMENT

Story developing – audio and video – colour model – device independent colour model – gamma and gamma correction – production budgets – 3D animated movies.

Suggested Readings:

1. Malay K. Pakhira, *Computer Graphics, Multimedia and Animation*,PHI Learning Pvt. Ltd., 2010.
2. Ranjan Parekh, *Principles of Multimedia*, Tata McGraw-Hill, 2007.
3. Ashok Banerji and Ananda Mohan Ghosh, *Multimedia Technologies*, McGraw-Hill Publication, 2009.
4. Pankaj Dhaka, *Encyclopedia of Multimedia and Animations*, Anmol Publications, 2011.

18BECSOE03 PC HARDWARE AND TROUBLE SHOOTING 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To assemble/setup and upgrade personal computer systems.
- To perform installation, configuration, and upgrading of microcomputer hardware and software.
- To install/connect associated peripherals.
- Define the terms that are directly related to processors such ascaching, multi-threading, dual-core technology, multi-processing, and pipelining.
- Explain the PC memories such as RAM and ROM devices.
- Discuss about motherboards and the various technologies connected to mainboards such as chipsets, buses, and various BIOS types.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Identify the main components of the PC.
- Use the skills to troubleshoot various power-related problems.
- Define the terms that are directly related to processors such ascaching, multi-threading, dual-core technology, multi-processing, and pipelining.
- Explain the PC memories such as RAM and ROM devices.
- Discuss about motherboards and the various technologies connected to mainboards such as chipsets, buses, and various BIOS types.
- Prepare a HDD for storing data; installWindows OS and various programs.

Course Contents:

UNIT I INTRODUCTION

Introduction –computer organization – number systems and codes – memory – ALU – CU – instruction prefetch – interrupts – I/O techniques – device controllers – error detection techniques– microprocessor – personal computer concepts – advanced system concepts – microcomputer concepts – OS – multitasking and multiprogramming – virtual memory – cache memory – modern PC and user.

UNIT II PERIPHERAL DEVICES

Introduction – keyboard – CRT display monitor – printer – magnetic storage devices – FDD – HDD – special types of disk drives – mouse and trackball – modem – faxmodem – CD ROM drive – scanner – digital camera – DVD – special peripherals.

UNIT III PC HARDWARE OVERVIEW

Introduction – hardware BIOS DOS interaction – the pc family – pc hardware – inside the system box – motherboard logic – memory space – peripheral interfaces and controllers – keyboard interface – CRT display interface – FDC – HDC.

UNIT IV INSTALLATION AND PREVENTIVE MAINTENANCE

Introduction – system configuration – pre-installation planning – installation practice – routine checks – PC assembling and integration – BIOS setup – engineering versions and compatibility – preventive maintenance – DOS – virus – data recovery.

UNIT V TROUBLESHOOTING

Introduction – computer faults – nature of faults – types of faults – diagnostic programs and tools – microprocessor and firmware – programmable LSI's – bus faults – faults elimination process – systematic troubleshooting – symptoms observation and analysis – fault diagnosis – fault rectification – troubleshooting levels – FDD, HDD, CD-ROM problems.

Suggested Readings:

1. B. Govindarajalu, *IBM PC Clones Hardware, Troubleshooting and Maintenance*, Tata McGraw-Hill, 2002.
2. Peter Abel and Niyaz Nizamuddin, *IBM PC Assembly Language and Programming*, Pearson Education, 2007.
3. Scott Mueller, *Upgrading and Repairing PCs*, Pearson Education, 2016.

18BECSOE04	JAVA PROGRAMMING	3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To understand the fundamentals of programming such as variables, conditional and iterative execution, methods, etc.
- To understand the fundamentals of object-oriented programming in Java, including defining classes, invoking methods, using class libraries, etc.
- Demonstrate the concepts of polymorphism and inheritance.
- List the important topics and explain the principles of software development.
- Create a computer program to solve specified problems.
- Use the Java SDK environment to create, debug and run simple Java programs.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Identify classes, objects, members of a class and relationships among them needed for a specific problem.
- Demonstrate the concepts of polymorphism and inheritance.
- List the important topics and explain the principles of software development.
- Create a computer program to solve specified problems.
- Use the Java SDK environment to create, debug and run simple Java programs.
- Describe the basics of event handling

Course Contents:

UNIT I INTRODUCTION TO JAVA

Object oriented programming concepts – objects – classes – methods and messages –abstraction and encapsulation – inheritance – abstract classes – polymorphism –objects and classes in Java – defining classes – methods – access specifiers – static members –constructors – finalise method.

UNIT II PACKAGES

Arrays – strings – packages – Javadoc comments – inheritance – class hierarchy –polymorphism – dynamic binding – final keyword – abstract classes.

UNIT III I/O STREAMS

The object class – reflection – interfaces – object cloning – inner classes – proxies – I/O streams – graphics programming – frame – components – working with 2D shapes.

UNIT IV EXCEPTION HANDLING

Basics of event handling – event handlers – adapter classes – actions – mouse events – AWT event hierarchy – introduction to swing – model-view-controller design pattern –buttons – layout management – swing components – exception handling – exception hierarchy – throwing and catching exceptions.

UNIT V MOTIVATION FOR GENERIC PROGRAMMING

Motivation for generic programming – generic classes – generic methods – generic code and virtual machine – inheritance and generics – reflection and generics –multi-threaded programming – interrupting threads – thread states – thread properties – thread synchronization – executors – synchronizers.

Suggested Readings:

1. Cay S. Horstmann and Gary Cornell, *Core Java: Volume I - Fundamentals*, Sun Microsystems Press, 2008.
2. K. Arnold and J. Gosling, *The Java Programming Language*, Pearson Education, 2009.
3. Timothy Budd, *Understanding Object-Oriented Programming with Java*, Pearson Education 2002.
4. C. Thomas Wu, *An introduction to Object-Oriented Programming with Java*, Tata McGraw-Hill Publishing Company Ltd., 2008.

18BECSOE05	MACHINE LEARNING	3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To introduce the basic concepts and techniques of machine learning.
- To have a complete understanding of the supervised and unsupervised learning techniques.
- To study the various probability based learning techniques.
- To learn dimensionality reduction techniques.
- To understand evolutionary models and graphical models of machine learning algorithms.
- Employ supervised, unsupervised or semi-supervised learning algorithms for any given problem.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Distinguish betweensupervised, unsupervised and semi-supervised learning.
- Apply the appropriate machine learning strategy for any given problem.
- Employ supervised, unsupervised or semi-supervised learning algorithms for any given problem.
- Design systems that use the appropriate graph models of machine learning.
- Propose new machine learning algorithms to improve classification accuracy/efficiency.
- Apply Markov models and Bayesian networks

Course Contents:

UNIT I INTRODUCTION

Foundations: linear algebra – probability – vectorizationlearning – types of machine learning – supervised learning – preliminaries – testing machine learning algorithms – data into probabilities – basic statistics – the brain and the neuron – design a learning system – perspectives and issues in machine learning – concept learning task – concept learning as search – finding a maximally specific hypothesis – version spaces and the candidate elimination algorithm – linear discriminants – perceptron – linear separability – linear regression – logistic regression.

UNIT II LINEAR MODELS AND TREE

Multi-layer perceptron – going forwards – going backwards: back propagation error – multi-layer perceptron in practice – examples of using the MLP – overview – deriving back-propagation – radial basis functions and splines – concepts – RBF networks – curse of dimensionality – interpolations and basis functions – support vector machines – introduction to deep learning.

UNIT III PROBABILISTIC MODELS

Decision trees – constructing decision trees – classification and regression trees –feature selection-ensemble learning – boosting – bagging – different ways to combine classifiers – probability and learning –Gaussian mixture models – nearest neighbor methods – unsupervised learning – K-means and K-medoids algorithms – vector quantization – self organizing feature map.

Case study 1: Analysis of feature selection algorithms for real-world problems.

Case study 2: Evaluation of neural network model, decision trees and support vector machines for real-world problems.

Case study 3: Evaluation of clustering algorithms such as K-means and K-medoids for real-world problems.

Case study 4: Modify supervised and unsupervised learning algorithms to improve the learning performance.

UNIT IV DIMENSIONALITY REDUCTION, EVOLUTIONARY MODELS

Dimensionality reduction – linear discriminant analysis – principal component analysis – factor analysis – independent component analysis – locally linear embedding – isomap – least squares optimization – evolutionary learning – genetic algorithms – genetic offspring – genetic operators – using genetic algorithms – reinforcement learning – overview – getting lost example – Markov decision process.

UNIT V GRAPHICAL MODELS

Markov Chain Monte Carlo methods – sampling – proposal distribution – Markov Chain MonteCarlo – graphical models – Bayesian networks – Markov random fields – hidden Markov models – tracking methods.

Case study 5: Working with dimensionality reduction algorithms for real-world problems.

Case study 6: Demonstrating the use of evolutionary algorithms to improve the efficiency of the algorithm / to optimization problem for real-world scenarios.

Case study 7: Working with Markov models and Bayesian networks to forecast future for real-world scenarios.

Suggested Readings:

1. Stephen Marsland, *Machine Learning: An Algorithmic Perspective*, Chapman and Hall/CRC, 2014.
2. Jason Bell, *Machine Learning: Hands-On for Developers and Technical Professionals*, John Wiley & Sons, 2014.
3. Michael Bowles, *Machine Learning in Python: Essential Techniques for Predictive Analysis*, John Wiley & Sons, 2015.
4. Ethem Alpaydin, *Introduction to Machine Learning*, The MIT Press, 2014.
5. Peter Flach, *Machine Learning: The Art and Science of Algorithms that Make Sense of Data*, Cambridge University Press, 2012.
6. Thomas Mitchell, *Machine Learning*, McGraw-Hill Education, 2013.

18BEEEOE01	ELECTRIC HYBRID VEHICLE	3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To understand the basic concepts of an electric hybrid vehicle.
- To gain knowledge about the electric propulsion unit.
- To understand and gain knowledge about various energy storage devices.
- Evaluate the different energy management strategies.
- Describe the concept of different energy storage devices.
- Analyse the different motor drives used in hybrid electric vehicles.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Explain the concept of hybrid electric vehicles.
- Discuss the concept of hybrid electric drive-trains.
- Evaluate the different energy management strategies.
- Describe the concept of different energy storage devices.
- Analyse the different motor drives used in hybrid electric vehicles.
- Discuss the fuel cell based energy storage and its analysis

Course Contents:

UNIT I INTRODUCTION

History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

UNIT II HYBRID ELECTRIC DRIVE-TRAINS

Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

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, configuration and control of permanent magnet motor drives, configuration and control of switch reluctance motor drives, drive system efficiency.

UNIT IV 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, super capacitor based energy storage and its analysis, flywheel based energy storage and its analysis, hybridization of different energy storage devices.

UNIT V ENERGY MANAGEMENT STRATEGIES

Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.

Suggested Readings:

1. Iqbal Hussein, *Electric and Hybrid Vehicles: Design Fundamentals*, CRC Press, 2010.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay and Ali Emadi, *Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design*, Standardsmedia, 2009.
3. James Larminie and John Lowry, *Electric Vehicle Technology Explained*, Wiley, 2012.

18BEEEOE02 ENERGY MANAGEMENT AND ENERGY AUDITING 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To gain knowledge about energy management.
- To understand the basic concepts in economic analysis in energy management.
- To understand the basic principles of an energy audit.
- Discuss the basic concept of energy audit and types.
- Analyse the different energy efficient motors.
- Describe the concept of energy conservation.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Explain the concept of energy management.
- Analyse the different methods for economic analysis.
- Discuss the basic concept of energy audit and types.
- Analyse the different energy efficient motors.
- Describe the concept of energy conservation.
- Analyse the different methods to improve power factor.

Course Contents:

UNIT I ENERGY MANAGEMENT

Principles of energy management, organizing energy management program, initiating, planning, controlling, promoting, monitoring, reporting –energy auditor and energy manager – eligibility, qualification and functions – questionnaire and checklist for top management.

UNIT II ECONOMIC ASPECTS AND ANALYSIS

Economics analysis – depreciation methods, time value of money, rate of return, present worth method, replacement analysis, life cycle costing analysis – calculation of simple payback method, net present worth method.

UNIT III BASIC PRINCIPLES OF ENERGY AUDIT

Energy audit – definition, concept, type of audit, energy index, cost index, pie charts, Sankey diagrams, load profiles, energy conservation schemes – energy audit of industries – energy saving potential, energy audit of process industry, thermal power station, building energy audit.

UNIT IV ENERGY EFFICIENT MOTORS

Electric motors: factors affecting efficiency – energy efficient motors – constructional details, characteristics – voltage variation –over motoring – motor energy audit.

Energy conservation: importance – energy saving measures in DG set – fans and blowers pumps – air conditioning system – energy efficient transformers.

UNIT V POWER FACTOR IMPROVEMENT, LIGHTING AND ENERGY INSTRUMENTS

Power factor – methods of improvement, location of capacitors, p.f. with nonlinear loads, effect of harmonics on p.f. – p.f.motor controllers –energy efficient lighting system design and practice – lighting control– measuring instruments – wattmeter, data loggers, thermocouples, pyrometers, lux meters, tong testers, application of PLCs.

Suggested Readings:

1. Murphy W.R. and G. Mckay, *Energy Management*, Butterworth-Heinemann, 2007.
2. John C. Andreas, *Energy Efficient Electric Motors*, Marcel Dekker Inc. Ltd., 2005.
3. Wayne C. Turner and Steve Doty, *Energy Management Handbook Volume II*, Lulu Enterprises Inc., 2013.

18BEEEOE03 PROGRAMMABLE LOGIC CONTROLLER 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To understand the basic principles of PLC systems.
- To gain knowledge about data handling functions.
- To understand the principles of PID.
- Interpret relay ladder diagrams.
- Examine the issues related to using PLCs for batch processes and sequential control.
- Describe programmable controller networking and supervisory control.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Examine the typical PLC hardware structure.
- Interpret relay ladder diagrams.
- Examine the issues related to using PLCs for batch processes and sequential control.
- Describe programmable controller networking and supervisory control.
- Design logic circuits to perform industrial control functions of medium complexity.
- Demonstrate the correct operation of logic circuits by programming them into the programmable logic controller.

Course Contents:

UNIT I INTRODUCTION

PLC Basics: PLC system, I/O modules and interfacing, CPU processor, programming equipment, programming formats, construction of PLC ladder diagrams, devices connected to I/O modules.

UNIT II PLCPROGRAMMING

PLC Programming: Input instructions, outputs, operational procedures, programming examples using contacts and coils. Drill-press operation. Digital logic gates programming in the Boolean algebra system, conversion examples. Ladder diagrams for process control: Ladder diagrams and sequence listings, ladder diagram construction and flow chart for spray process system.

UNIT III REGISTERS AND PLC FUNCTIONS

PLC Registers: Characteristics of registers, module addressing, holding registers, input registers, output registers. PLC Functions: Timer functions and industrial applications, counters, counter function, industrial applications, architecture functions, number comparison functions, number conversion functions.

UNIT IV DATA HANDLING FUNCTIONS

Data Handling Functions: SKIP, master control, relay, jump, move, FIFO, FAL, ONS, CLR and sweep functions and their applications. Bit Pattern and changing a bit shift register, sequence functions and applications, controlling of twoaxes and threeaxis robots with PLC, matrix functions.

UNIT V PID PRINCIPLES

Analog PLC Operation: Analog modules and systems, analog signal processing, multi-bit data processing, analog outputapplicationexamples, PID principles, position indicator with PID control, PID modules, PID tuning, PID functions.

Suggested Readings:

1. John R. Hackworth and Frederick D. Hackworth, Jr., *Programmable Logic Controllers: Programming Method and Applications*, Pearson, 2006.
2. John W. Webb and Ronald A. Reis, *Programmable Logic Controllers: Principle and Applications*, Pearson, 2003.
3. W. Bolton, *Programmable Logic Controller*, Elsevier Newnes Publications, 2009.

18BEEEOE04 RENEWABLE ENERGY RESOURCES 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To gain knowledge about environmental aspects of energy utilization.
- To understand the basic principles of wind energy conversion, solar cells, photovoltaic conversion.
- To understand the basic principles of the fuel cell and geothermal power plants.
- To gain knowledge about the hydro energy.
- Explain the need of wind energy and the various components used in energy generation.
- Discuss the need of hydro energy and the various types of hydro energy.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Explain the need of renewable energy resources, historical and latest developments.
- Describe the use of solar energy and the various components used in the energy production with respect to applications.
- Explain the need of wind energy and the various components used in energy generation.
- Discuss the need of hydro energy and the various types of hydro energy.
- Analyse the different energy sources for energy production.
- Explain the need of ocean thermal power plants

Course Contents:

UNIT I INTRODUCTION

Energy scenario –different types of renewable energy sources – environmental aspects of energy utilization – energy conservation and energy efficiency – needs and advantages, Energy Conservation Act, 2003.

UNIT II SOLAR ENERGY

Introduction to solar energy: Solar radiation, availability, measurement and estimation– solar thermal conversion devices and storage – solar cells and photovoltaic conversion – PV systems – MPPT. Applications of PV Systems – solar energy collectors and storage.

UNIT III WIND ENERGY

Introduction – basic principles of wind energy conversion – components of wind energy conversion system – site selection consideration – basictypes of wind machines. Schemes for electric generation – generator control, load control, energy storage – applications of wind energy – interconnected systems.

UNIT IV HYDRO ENERGY

Hydropower, classification of hydropower, turbine selection, ocean energy resources, ocean energy routes. Principles of ocean thermal energy conversion systems, ocean thermal power plants. Principles of ocean wave energy conversion and tidal energy conversion.

UNIT V OTHER SOURCES

Bioenergy and types – fuel cell, geothermal power plants; Magneto-Hydro-Dynamic (MHD) energy conversion.

Suggested Readings:

1. G.D. Rai, *Non-conventional Energy Sources*, Khanna Publishers, 2011.
2. B H Khan, *Non-Conventional Energy Resources*, Tata McGraw-Hill Education, 2009.
3. S. Rao and B.B. Parulekar, *Energy Technology: Non Conventional, Renewable and Conventional*, Khanna Publishers, 2013.
4. Godfrey Boyl, *Renewable Energy: Power for a Sustainable Future*, Oxford University Press, 2012.
5. John W. Twidell and Anthony D. Weir, *Renewable Energy Resources*, Taylor and Francis, 2015.

18BEECOE01 REAL TIME EMBEDDED SYSTEMS 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To introduce the embedded systems, its hardware and software.
- To introduce devices and buses used for embedded networking.
- To study about task management.
- To learn about semaphore management and message passing.
- To study about memory management.
- Discuss about task management.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Discuss about embedded systems architecture.
- Explain embedded system, its hardware and software.
- Discuss about task management.
- Express semaphore management and message passing.
- Describe about memory management.
- Implement the multitasking

Course Contents:

UNIT I INTRODUCTION TO EMBEDDED SYSTEM

Introduction –embedded systems description, definition, design considerations and requirements – overview of embedded system architecture (CISC and RISC) – categories of embedded systems – embedded processor selection and tradeoffs – embedded design life cycle – product specifications – hardware/software partitioning – iterations and implementation – hardware software integration – product testing techniques–ARM7.

UNIT II OPERATING SYSTEM OVERVIEW

Introduction–advantageanddisadvantageofusingRTOS–multitasking–tasks – realtimekernels – scheduler – non-preemptive kernels – preemptive kernels – reentrancy – reentrantfunctions– round robin scheduling – task priorities – static priorities– mutual exclusion–deadlock – intertask communication–message mailboxes–message queues – interrupts – taskmanagement–memory management – time management–clock ticks.

UNIT III TASK MANAGEMENT

Introduction – µ C/OS-II features – goals ofµ C/OS-II – hardware and software architecture– Kernelstructures: Tasks–task states–task scheduling–idle task–statistics task–interrupts underµC/OS-II–clock tick – µC/OS-II initialization. Task management: Creating tasks–task stacks–stackchecking–task'spriority–suspendingtask–resumingtask.Timemanagement: Delaying atask–resuming a delayed task–system time. Event control blocks – placing a task in the ECB wait list–removing a task from an ECB wait list.

UNIT IV SEMAPHORE MANAGEMENT AND MESSAGE PASSING

Semaphore management: Semaphore management overview– signalling a semaphore. Message mailbox management: Creating a mailbox –deleting mailbox–waiting for a message box–sending message to a mailbox – status of mailbox. Message queue management: Creating message queue– deleting a message queue–waiting for a message queue–sending message to a queue– flushing a queue.

UNIT V MEMORY MANAGEMENT

Memory management: Memory control blocks–creating partition – obtaining a memory block– returning a memory block. Getting started withμ C/OS-II–installingμC/OS-II–Portingμ C/OS-II:Development tools–directories and files– testing a port – IAR workbench withμC/OS-II – μC/OS-II porting on a 8051CPU– implementation of multitasking – implementation of scheduling andrescheduling –analyse the multichannel ADC with help ofμ C/OS-II.

Suggested Readings:

1. JeanJ. Labrosse, *Micro C/OS–II The Real Time Kernel*, CMPBooks, 2009.
2. David Seal, *ARM Architecture Reference Manual*, Addison-Wesley, 2008.
3. Steve Furbe, *ARM System-on-Chip Architecture*, Addison-Wesley Professional, California, 2000.
4. K. V. K. K. Prasad, *Embedded / Real-Time Systems: Concepts, Design & Programming Black Book*, Dreamtech Press, 2005.
5. Sriram V Iyer and Pankaj Gupta, *Embedded Realtime Systems Programming*, Tata McGraw-Hill, 2004.

18BEECOE02 CONSUMER ELECTRONICS 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To study about various speakers and microphone.
- To learn the fundamental of television systems and standards.
- To learn the process of audio recording and reproduction.
- To study the various telephone networks.
- To discuss about the working of home appliances.
- Demonstrate the working of various optical recording systems.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Explainthe working of various types of loud speakers.
- Describe various types of picture tubes.
- Demonstrate the working of various optical recording systems.
- Distinguish various standards for colour TV system.
- Discuss various telecommunication networks.
- Demonstrate the working of various home appliances.

Course Contents:

UNIT I LOUDSPEAKERS AND MICROPHONES

Dynamic loudspeaker, electrostatic loudspeaker, permanent magnet loudspeaker, woofers and tweeters – microphone characteristics, carbon microphones, dynamic microphones and wireless microphones.

UNIT II TELEVISION STANDARDS AND SYSTEMS

Components of a TV system–interlacing–composite video signal. Colour TV – luminance and chrominance signal; monochrome and colour picture tubes –colourTV systems–NTSC, PAL, SECAM– components of a remote control.

UNIT III OPTICAL RECORDING AND REPRODUCTION

Audio disc– processing of the audio signal–readout from the disc –reconstruction of the audio signal–video disc–video disc formats – recording systems–playback systems.

UNIT IV TELECOMMUNICATION SYSTEMS

Telephone services – telephone networks–switching system principles–PAPX switching–circuit, packet and message switching, LAN, MAN and WAN, integrated services digital network. Wireless local loop. VHF/UHF radio systems, limited range cordless phones; cellular modems.

UNIT V HOME APPLIANCES

Basic principle and block diagram of microwave oven; washing machine hardware and software;components of air conditioning and refrigeration systems.

Suggested Readings:

1. S.P. Bali, *Consumer Electronics*, Pearson Education, 2005.
2. J. S. Chitode, *Consumer Electronics*, Technical Publications, 2007.
3. Philip Hoff, *Consumer Electronics for Engineers*, Cambridge University Press, 1998.

18BEECOE03 NEURAL NETWORKS AND ITS APPLICATIONS 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To introduce the basic concepts of neural networks and their applications in various domain.
- To educate how to use soft computing to solve real-world problems.
- To have a solid understanding of the basic neural network.
- Apply perception concept in design.
- Design using ART phenomena.
- Describe SOM concepts.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Explain the basic concepts of neural networks and its applications in various domains.
- Discuss about learning process in neural networks.
- Apply perception concept in design.
- Design using ART phenomena.
- Describe SOM concepts.
- Use soft computing to solve real-world problems.

Course Contents:

UNIT I INTRODUCTIONTO NEURALNETWORKS

Introduction – biological neurons and their artificial models – learning, adaptation and neural network's learning rules – types of neural networks – single layer, multiple layer – feed forward, feedback networks.

UNIT II LEARNING PROCESS

Error– correction learning– memory based learning –Hebbian learning – competitive learning – Boltzmann learning – supervised and unsupervised learning – adaptation – statistical learning theory.

UNIT III PERCEPTION

Single layer perception – adaptive filtering – unconstrained optimization – least-mean square algorithm – leaning curve – annealing technique – perception convergence theorem – relationship between perception and Baye's classifier – back propagation algorithm.

UNIT IV ATTRACT OR NEURAL NETWORK AND ART

Hopfield model – BAM model– BAM stability – adaptive BAM – Lyapunov function – effect of gain – Hopfield design – application to TSP problem – ART – layer 1 – layer 2 – orienting subsystem – ART algorithm – ARTMAP.

UNIT V SELF ORGANIZATION

Self-organizing map – SOM algorithm – properties of the feature map – LVQ – hierarchical vector quantization. Applications of self-organizing maps: The neural phonetic type writer learning ballistic arm movements.

Suggested Readings:

1. Simon Haykin and Simon S. Haykin, *Neural Networks and Learning Machines*, Prentice Hall, 2009.
2. Satish Kumar, *Neural Networks: A Classroom Approach*, McGraw-Hill Education, 2012.
3. Rajasekaran S. and Vijayalakshmi PaiG. A., *Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications*, PHI Learning Pvt. Ltd. 2003.
4. Laurene V. Fausett, *Fundamentals of Neural Networks: Architectures, Algorithms and Applications*, Pearson, 1994.
5. Philip D. Wasserman, *Neural Computing: Theory and Practice*, Van Nostrand Reinhold, 1989.
6. James A. Freeman and David M. Skapura, *Neural Networks: Algorithms, Applications, and Programming Techniques*, Addison-Wesley, 2005.

18BEECOE04 FUZZY LOGIC AND ITS APPLICATIONS 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To introduce the basic concepts of fuzzy logic and their applications in various domain.
- To educate how to use fuzzy computation to solve real-world problems.
- To have a solid understanding of basic fuzzy models.
- Describe the theory of reasoning.
- Develop fuzzy controllers.
- Discuss the concepts of adaptive fuzzy control.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Explain the basic concepts of fuzzy logic and its applications in various domains.
- Describe the theory of reasoning.
- Develop fuzzy controllers.
- Discuss the concepts of adaptive fuzzy control.
- Use fuzzy computation to solve real-world problems.
- Design fuzzy based model for any application.

Course Contents:

UNIT I BASICS OF FUZZY LOGIC

Fuzzy sets, properties of fuzzy sets, operation in fuzzy sets, fuzzy relations, the extension principle.

UNIT II THEORY OF APPROXIMATE REASONING

Linguistic variables, fuzzy proportions, fuzzy if-then statements, inference rules, compositional rule of inference – fuzzy models.

UNIT III FUZZY KNOWLEDGE BASED CONTROLLERS

Basic concept structure of FKBC, choice of membership functions, scaling factors, rules, fuzzyfiction and de fuzzyfiction procedures–design of fuzzy logic controller.

UNIT IV ADAPTIVE FUZZY CONTROL

Process performance monitoring, adaption mechanisms, membership functions, tuning using gradient descent and performance criteria. Set organizing controller model based controller.

UNIT V FUZZY BASED SYSTEMS

Simple applications of FKBC – washing machines – traffic regulations – lift control – fuzzy in medical applications – introduction to ANFIS.

Suggested Readings:

1. Dimiter Driankov, Hans Hellendoorn and Michael Reinfrank, *An Introduction to Fuzzy Control*, Springer-Verlag Berlin Heidelberg, 1996.
2. George J. Klir and Tina A. Folger, *Fuzzy Sets, Uncertainty and Information*, Prentice Hall, 1988.
3. Timothy J. Ross, *Fuzzy Logic with Engineering Applications*, John Wiley & Sons, 2010.
4. George J. Klir and Bo Yuan, *Fuzzy Sets and Fuzzy Logic: Theory and Applications*, Prentice Hall, 1995.

18BEECOE05	PRINCIPLES OF MODERN COMMUNICATION SYSTEM	3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To provide students with an overview of communication systems.
- To provide an overview on mobile communication.
- To make students to have a better understanding on satellite and radar communication.
- Explain the working of mobile cellular communication.
- Describe various standards in use for wireless communication and its application.
- Demonstrate some basic application of GPS.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Discuss the past, present and future trends in mobile communication.
- Explain the working of mobile cellular communication.
- Describe various standards in use for wireless communication and its application.
- Demonstrate some basic application of GPS.
- Explain the working of radar and its applications.
- Describethe modern navigation systems

Course Contents:

UNIT I THE EVOLUTION OF ELECTRONIC COMMUNICATION

From smoke signals to smart phones – history of communications: theoretical foundations, development and applications – frequencies for communication – frequency regulations – overview of communication transmitter and receiver.

UNIT II MOBILE CELLULAR COMMUNICATIONS

Evolution to cellular networks – cellular systems generations and standards: 1G, 2G, 3G, 4G – cellular network components – components of a mobile phone – setting up a call process – making a call process – receiving a call process – spectrum allocation: policies and strategies, role of TRAI.

UNIT III WIRELESS COMMUNICATION

Introduction –Bluetooth– infrared communication – IEEE wireless LANs (Wi-Fi) – IEEE 802.16 (WiMaX) –future mobile and wireless networks: introduction to 5G – device to device communication – IoT.

UNIT IV SATELLITE COMMUNICATION

History of satellite communication, basics of satellites, types of satellites, capacity allocation – launch vehicles and orbits: introduction to launching vehicles, important orbits, working of rocket, three pioneers of rocketry – basics of Global Positioning System (GPS) –applications of GPS.

UNIT V RADAR AND NAVIGATION

Introduction, radar block diagram and operation, radar frequencies, applications of radar. Navigation systems: introduction and methods of navigation, instrument landing system, microwave landing system – modern navigation systems.

Suggested Readings:

1. Simon Haykin and Michael Moher, *Communication Systems*, John Wiley & Sons, 2009.
2. B.P. Lathi, Zhi Ding and Hari Mohan Gupta, *Modern Digital and Analog Communication Systems*, Oxford University Press, 2017.
3. Theodore S. Rappaport, *Wireless Communications: Principles and Practice*, Prentice Hall, 2002.
4. Vijay K. Garg, *Wireless Communications and Networking*, Morgan Kaufmann, 2007.
5. Timothy Pratt, Charles W. Bostian and Jeremy E. Allnutt, *Satellite Communications*, John Wiley & Sons, 2002.
6. Merrill I Skolnik, *Introduction to Radar Systems*, Tata McGraw-Hill, 2001.
7. Myron Kayton and Walter R. Fried, *Avionics Navigation Systems*, John Wiley & Sons, 1997.

18BTFTOE01 PROCESSING OF FOOD MATERIALS 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To explain the milling, extraction and manufacture of tremendous products from cereals, pulses and oil seeds.
- To summarise the production and processing methods of fruits and vegetables.
- To discuss the chemical composition, processing, production, spoilage and quality of milk and milk products.
- To outline the overall processes involved in the production of meat, poultry and fish products.
- To review the production and processing methods of plantation and spice products.
- Illustrate the techniques involved in the processing of dairy products.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Discuss the various processing technologies involved in cereal, pulses and oilseed technology.
- Demonstrate the major operations applied in fruits and vegetable processing.
- Illustrate the techniques involved in the processing of dairy products.
- Infer the production of different types of milk.
- List the overall processing of meat, poultry and fish processing.
- Outline the processing of spices and plantation products.

Course Contents:

UNIT I CEREAL, PULSES AND OIL SEEDS TECHNOLOGY

Rice milling, pulse milling, wheat milling – oil extraction – methods of manufacture of bread – different processes of manufacture – types of breads – buns, biscuits, cakes and cookies – pasta products – tortilla – method of manufacture.

UNIT II FRUITS AND VEGETABLE PROCESSING

Production of fruits and vegetables in India, cause for heavy losses, preservation treatments – basics of canning, minimal processing and hurdle technology as applied to vegetable and fruit processing, processing of fruit juices, dehydration, aseptic processing.

UNIT III DAIRY PROCESSING

Basic dairy terminology, composition, general tests at reception, dairy processing – method of manufacture of standardized, toned and double toned milk, milk powder – equipments – pasteurizers, homogenizers and pumps – method of manufacture of dairy products – ice-cream, cheese, paneer, yoghurt – pasteurization and microorganisms involved in spoilage of milk.

UNIT IV MEAT, POULTRY AND FISH PROCESSING

Meat composition from different sources, definitions and measurements, carcass processing, meat products, processing of poultry products, fish and other marine products processing.

UNIT V PLANTATION PRODUCT TECHNOLOGY

Processing of tea, coffee and cocoa – outline of the methods of manufacture of green tea, black tea, instant tea, instant coffee, cocoa and chocolate. Outline of the methods of processing of pepper, cardamom, ginger, vanilla and turmeric.

Suggested Readings:

1. Srivastava R.P. and Kumar S., *Fruit and Vegetable Preservation: Principles and Practices*, International Book Distributing Co., Lucknow, 2010.
2. Chakraverty A., Mujumdar A.S., Raghavan G.S.V. and Ramaswamy H.S., *Postharvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices*, Marcel Dekker Press, USA, 2003.
3. Sukumar De, *Outlines of Dairy Technology*, Oxford University Press, New Delhi, 2016.

18BTFTOE02 NUTRITION AND DIETETICS 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To explain the basic concepts of food and nutrition.
- To define the overall classification, function, and source of carbohydrates, lipids and proteins.
- To discuss the overall aspects of vitamins.
- To outline the role of health and nutritional importance of micro and macro minerals.
- To summarise the recent trends in nutrition.
- List the various attributes of fat and water soluble vitamins.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Discuss the basics in the area of nutritional assessment in health and disease.
- Categorise the recommended dietary allowances for different age groups.
- Express the classifications, functions and sources of carbohydrates, lipids and proteins.
- List the various attributes of fat and water soluble vitamins.
- Report the role, bioavailability, sources and deficiency diseases of macro and micro minerals.
- Recognise the diets and concepts of foods suggested for nutrional, chronic and acute disorders.

Course Contents:

UNIT I HUMAN NUTRITION

Historical perspective of nutrient requirements – assessment of nutritional status – recommended dietary allowances of macronutrients for all age groups – assessment of protein quality – malnutrition and related disorders– balanced diet. Factors influencing dietary intake: Food habits, food fads and fallacies, their influence on health and wellbeing.

UNIT II BIOMOLECULES

Carbohydrates –definition, classification, functions, sources of carbohydrates, deficiency. Lipids – definition, classification, function, sources, refined and hydrogenated fats process. Proteins – definitions, classification, function, amino acids, sources of proteins.

UNIT III VITAMINS

Physiological role, bio-availability, requirements, sources and deficiency of fat soluble vitamins: Vitamin A, D, E and K. Water soluble vitamins: Vitamin C, thiamine, riboflavin, niacin, pantothenic acid, biotin, folic acid, vitamin B12, vitaminB6.

UNIT IV MINERALS

Physiological role, bio-availability, requirements, sources and deficiency of macro minerals: Calcium, phosphorus magnesium, sodium, potassium chloride. Micro minerals: Iron, zinc, copper, selenium, chromium, iodine, manganese, molybdenum and fluoride.

UNIT V RECENT TRENDS IN NUTRITION

Principles of dietary management in gout, rheumatism, AIDS/HIV –cancer – risk factors, symptoms, dietary management, role of food in prevention of cancer. Role of functional foods, health foods and novel foods, organically grown foods, recent concepts in human nutrition like nutrigenomics, nutraceuticals, etc.

Suggested Readings:

1. Gordon M. Wardlaw, *Perspectives in Nutrition*, WCB McGraw-Hill Publishers, Boston, 2013.
2. Shubhangini A. Joshi, *Nutrition and Dietetics*, Tata McGraw- Hill Publishing Company Ltd., New Delhi, 2016.
3. Srilakshmi. B., *Nutrition Science*, New Age International Pvt. Ltd., Publishers, 2017.
4. Ronald Ross Watson, *Functional Foods and Nutraceuticals in Cancer Prevention*, Wiley-Blackwell, 2003.
5. Sunetra Roday, *Food Science and Nutrition*, Oxford Higher Education/Oxford University Press, 2018.

18BTFTOE03 READY TO EAT FOODS 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To outline the current status of snack food industry.
- To describe the production, processing and marketing trends of potato and tortilla chips.
- To outline the overall processing of popcorn.
- To explain the production and processing of fruits involved in snack food preparation.
- To summarise the sensory analysis methods and packaging techniques of snack foods.
- Demonstrate the various unit operations involved in the production of potato and tortilla chips.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Review the overall aspects of snack food industry.
- Develop ready to eat foods from potato and maize flour.
- Demonstrate the various unit operations involved in the production of potato and tortilla chips.
- Illustrate the overall aspects of popcorn production.
- List the production, processing and manufacturing of fruit based snacks.
- Recognise the sensory analysis and packaging methods of snack foods.

Course Contents:

UNIT I SNACK FOOD INDUSTRY

Introduction – history – past innovations – outline of snack food industry – nutrition – total quality management of technology – domestic snack food market – global market – snack food association future considerations.

UNIT II POTATO AND TORTILLA CHIPS PROCESSING

Potato production – potato snack ingredients – potato analysis and composition – potato chip manufacturing process – unit operations – other value added products from potato.

Tortilla chips –raw materials – processing steps – equipment involved – reconstitution of dry maize flour – unit operations.

UNIT III POPCORN PROCESSING

Introduction –raw popcorn selection and preparation – popping methods – home preparation of popcorn – equipments – industrial manufacturing process – flavouringsand applicators – popcorn packaging – relative nutrition – marketing.

UNIT IV FRUIT BASED SNACKS

Introduction – production and processing of fruit crops – fruit purees – fruit powders – canned fruit snacks – alcoholic preservation of fruit snacks – fruit candies – fruit bars – exotic fruits.

UNIT V SENSORY EVALUATION AND PACKAGING

Introduction – analytical methods – sensory methods – sensory aspect of processing – quality properties of snack foods and packaging materials – automated bag – pouch packaging – cartoning case packing – current issues in snack foods packaging.

Suggested Readings:

1. Lusas, E. W. and Rooney, L. W., *Snack Foods Processing*, CRC Press, 2001.
2. Panda, H., *The Complete Technology Book on Snack Foods*, National Institute of Industrial Research, Delhi, 2013.
3. Sergio O. Serna-Saldivar, *Industrial Manufacture of Snack Foods*, Kennedys Books Ltd., 2008.

18BTFTOE04	AGRICULTURAL WASTE AND BYPRODUCTS UTILIZATION	3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To categorise the types of agricultural wastes.
- To outline the production and utilization of biomass.
- To explain the various parameters considered to be important in the designing of biogas units.
- To review the various methods employed in the production of alcohol from the by-products of agricultural wastes.
- To summarise the overall aspects involved in the production of paperboards and particleboards from agricultural wastes.
- Assess the various parameters considered to be important in the designing of biogas units.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- List and group the types of agricultural wastes.
- Develop a number of value added products from agriculture wastes.
- Discuss the techniques and production involved in the utilization of biomass.
- Assess the various parameters considered to be important in the designing of biogas units.
- Illustrate the various methods employed in the production of alcohol from the by-products of agricultural wastes.
- Choose the appropriate materials to produce paperboards and particle boards from agricultural wastes.

Course Contents:

UNIT I TYPES OF AGRICULTURAL WASTES

Introduction and background, agricultural waste, crop waste, agricultural residues (annual crops), technical terms, rice by-products utilization-rice bran and germ, rice bran oil, economic products from agriculture waste/by-products.

UNIT II BIOMASS PRODUCTION AND UTILIZATION

Biomass gasifier, technology used for the utilization of agricultural wastes: biomass gasifier, Nimbkar Agricultural Research Institute (NARI) gasifier, rice-husk based gasifier, heat and steam from sugarcane leaf and bagasse.

UNIT III BIOGAS DESIGN AND PRODUCTION

Biogas: Definition, composition, history of biogas, production of biogas, types of biogas plant (floating drum type and fixed dome type) and their components (inlet, outlet, stirrer, slanting pipe, digester, gas holder and gas outer pipe), selection and design of biogas plant.

UNIT IV PRODUCTION OF ALCOHOL FROM WASTE MATERIALS

Production of alcohol from waste materials: Introduction, production methods, cellulolysis (biological approach): Pretreatment, cellulolytic processes (chemical and enzymatic hydrolysis), microbial fermentation, gasification process (thermochemical approach).

UNIT V PRODUCTION OF PAPERBOARDS AND PARTICLEBOARDS FROM AGRICULTURAL WASTE

Production and testing of paperboards and particleboards from agricultural waste: Introduction, history, terminology and classification, raw materials, production steps- pulping, classifications of pulp, bleaching, plies, coating, grades.

Suggested Readings:

1. K M Sahay and K K Singh, *Unit Operations of Agricultural Processing*, Vikas Publishing House Pvt. Ltd., Noida, 2013.
2. Beggs C., *Energy Management and Conservation*, Butterworth-Heinemann, 2009.
3. Chaturvedi P., *Energy Management: Challenges for the Next Millennium*, Concept Publishing Co., 2001.
4. Fardo S W, Patrick D R, Richardson R E and Fardo B W, *Energy Conservation Guidebook*, The Fairmont Press, 2014.
5. Wulfinghoff D R, *Energy Efficiency Manual*, Energy Institute Press, 2000.

18BEMEOE01	COMPUTER AIDED DESIGN	3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To provide an overview of how computers are being used in mechanical component design.
- To study the various computer graphics concepts.
- To get basic knowledge of geometric modelling.
- To study the basics of parametric design and object representation.
- To get basic knowledge in product design and development.
- Explain the process involved in graphic transformations.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Give an overview of the CAD systems and its importance.
- Explain the ideas and principles behind the computer graphics.
- Explain the process involved in graphic transformations.
- Understand the operations involved in geometric modelling.
- Describe the concepts of parametric design.
- Understand the basics of product design and development.

Course Contents:

UNIT I OVERVIEW OF CAD SYSTEMS

Conventional and computer aided design processes–advantages and disadvantages. Subsystems of CAD – CAD hardware and software, analytical and graphics packages, CAD workstations. Networking of CAD systems.

UNIT II INTERACTIVE COMPUTER GRAPHICS AND GRAPHICS TRANSFORMATIONS

Generative, cognitive and image processing graphics. Static and dynamic data graphics. Transport of graphics data. Graphic standards. Generation of graphic primitives – display transformation in Two- and Three-dimensional graphics concepts, graphical input technique, geometric transformations, visual realism, computer animation, customizing graphics software.

UNIT III GEOMETRIC MODELLING

Wireframe, surface, NURBS and solid modelling –applications and advantages. Creating primitive solids, sweeping solids, Boolean operations. Extracting entities from a solid. Filleting of edges of solids. Boundary representation (B-rep) Constructive Solid Geometry(CSG) and Analytical Solid Modelling(ASM)

UNIT IV PARAMETRIC DESIGN AND OBJECT REPRESENTATION

Types of coordinate systems. Parametric design – definition and advantages. Parametric representation of analytic and synthetic curves. Parametric representation of surfaces and solids – manipulations.

UNIT V PRODUCT DESIGN AND DEVELOPMENT

Automated 2D drafting – basics, mechanical assembly – bill of materials generation. Mass property calculations.

Suggested Readings:

1. Vera B Anand, *Computer Graphics and Geometric Modeling for Engineers*, John Wiley & Sons, New York, 2000.
2. Radhakrishnan P and Subramanyan S, *CAD/CAM/CIM*, New Age International Pvt. Ltd., 2008.
3. Ibrahim Zeid, *CAD/CAM Theory and Practice*, McGraw-Hill Inc., New York, 2009.
4. Barry Hawhes, *The CAD/CAM Process*, Pitman Publishing, London, 2007.
5. William M Newman and Robert Sproul, *Principles of Interactive Computer Graphics*, McGraw-Hill Inc., New York, 2001.
6. Sadhu Singh, *Computer-Aided Design and Manufacturing*, Khanna Publishers, New Delhi, 1998.

18BEMEOE02 INDUSTRIAL SAFETY AND ENVIRONMENT 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To provide in-depth knowledge on industrial safety.
- Understand the various safety techniques involved in the industrial sector.
- Record and investigate the accident zone and prepare reports related to it.
- Conduct basic safety inspections using strategies that they have developed.
- Identify and demonstrate the working of safety monitoring.
- Train about education and training based on safety.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Understand the need and awareness of safety concepts.
- Understand the various safety techniques involved in the industrial sector.
- Record and investigate the accident zone and prepare reports related to it.
- Conduct basic safety inspections using strategies that they have developed.
- Identify and demonstrate the working of safety monitoring.
- Train about education and training based on safety.

Course Contents:

UNIT I CONCEPTS

Evolution of modern safety concept –safety policy – safety organization – line and staff functions for safety – safety committee – budgeting for safety.

UNIT II TECHNIQUES

Incident Recall Technique (IRT), disaster control, Job Safety Analysis (JSA), safety survey, safety inspection, safety sampling, safety audit.

UNIT III ACCIDENT INVESTIGATION AND REPORTING

Concept of an accident, reportable and non-reportable accidents, unsafe act and condition – principles of accident prevention, supervisory role – role of safety committee – accident causation models – cost of accident. Overall accident investigation process –response to accidents, India reporting requirement, planning document, planning matrix, investigators kit, functions of investigator, four types of evidence, records of accidents, accident reports.

UNIT IV SAFETY PERFORMANCE MONITORING

Reactive and proactive monitoring techniques –permanent total disabilities, permanent partial disabilities, temporary total disabilities – calculation of accident indices, frequency rate, severity rate, frequency severity incidence, incident rate, accident rate, safety “t” score, safety activity rate – problems.

UNIT V SAFETY EDUCATION AND TRAINING

Importance of training – identification of training needs – training methods – programme, seminars, conferences, competitions – method of promoting safe practice – motivation – communication – role of government agencies and private consulting agencies in safety training – creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign – domestic safety and training.

Suggested Readings:

1. *Accident Prevention Manual for Industrial Operations*, N.S.C. Chicago, 2010.
2. Heinrich H.W., *Industrial Accident Prevention*, Tata McGraw-Hill Company, New York, 1941.
3. Krishnan N.V, *Safety Management in Industry*, Jaico Publishing House, Bombay, 1997.
4. John R Ridley, *Safety at Work*, Elsevier, 2014.
5. Roland P. Blake, *Industrial Safety*, Prentice Hall, New Jersey, 1973.
6. L M Deshmukh, *Industrial Safety Management*,Tata McGraw-Hill, 2005.

18BEMEOE03	TRANSPORT PHENOMENA	3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To provide the basics of transport phenomena and its applications.
- To provide the knowledge over the properties of the systems and unit systems used.
- To understand the basics and mathematics involved in momentum transport.
- To provide the basics and applications of energy transport.
- To give basics and principles involved in the mass transport phenomena.
- Understand the basic concepts involved in momentum transport.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Understand the basic concepts of transport phenomena.
- Understand the essentiality of properties of a system and unit systems used.
- Understand the basic concepts involved in momentum transport.
- Apply the mathematics involved in fluid flow problems.
- Explain the various energy transport phenomena.
- Understand the basics of mass transport phenomena.

Course Contents:

UNIT I INTRODUCTION AND BASIC CONCEPTS

General overview of transport phenomena including various applications, transport of momentum, heat and mass, transport mechanism, level of transport, driving forces, molecular transport (diffusion), convective transport (microscopic).

UNIT II PROPERTIES, UNITS AND OTHER PHYSICAL PARAMETERS

Unit systems, temperature, mole, concentration, pressure, gas laws, laws of conservation, energy and heat units.

UNIT III MOMENTUM TRANSPORT

Basic concepts in fluid mechanics, force, unit and dimensions, pressure in fluid, head of fluid, molecular transport for momentum, heat and mass transfer, viscosity of fluids, Newton's law, momentum transfer, Newtonian and non-Newtonian fluids, fluid flow and Reynolds number, overall mass balance, control volume and continuity equation, overall energy balance, Bernoulli's equation, overall momentum balance, drag coefficient, Stokes law, flow in packed beds, flow in fluidized bed.

UNIT IV ENERGY TRANSPORT

Basic concepts in heat transfer, heat transfer mechanisms, Fourier's law of heat conduction, thermal conductivity, convective heat transfer coefficient, conduction heat transfer through flat slab/wall and through hollow cylinder, conduction through solids in series, forced convection heat transfer

inside pipes, heat transfer outside various geometrics in forced convection, general discussion on natural convection heat transfer, heat exchangers, general discussion on radiation heat transfer.

UNIT V MASS TRANSPORT

Basic concepts in mass transport, some application examples, modes of mass transfer, molecular diffusion– Fick's law, analogy between mass, heat and momentum transfer, dispersion, hydraulic or Darcy's flow in porous media, chemical kinetics and activation energy, film theory, convective mass transfer, liquid-solid mass transfer, liquid-liquid mass transport, gas-liquid mass transfer, aeration and oxygen transport, air stripping.

Suggested Readings:

1. Geankoplis, C. J., *Transport Processes and Separation Processes Principles*, Prentice Hall, 2013.
2. R. Byron Bird, Warren E. Stewart and Edwin N. Lightfoot, *Transport Phenomena*, John Wiley & Sons, 2007.
3. Edwin N. Lightfoot, *Transport Phenomena and Living Systems: Biomedical Aspects of Momentum and Mass Transport*, Wiley, 2007.

18BEMEOE04 INTRODUCTION TO BIOMECHANICS 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- Biomechanics provides key information on the most effective and safest movement patterns, equipment, and relevant exercises to improve human movement.
- Present the nine fundamentals of biomechanics and its need.
- Explain the nine principles used for the application of biomechanics.
- Describe the human anatomy.
- Explain the need for biomechanics in muscle actions.
- Understand the basics of the mechanics involved in the musculoskeletal system.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Understand the basics and importance of biomechanics.
- Present the nine fundamentals of biomechanics and its need.
- Explain the nine principles used for the application of biomechanics.
- Describe the human anatomy.
- Explain the need for biomechanics in muscle actions.
- Understand the basics of the mechanics involved in the musculoskeletal system.

Course Contents:

UNIT I INTRODUCTION

Biomechanics –improving performance – applications – preventing and treating injury – qualitative and quantitative analysis – scholarly societies – computer searches – biomechanical knowledge versus information – kinds of sources – evaluating sources.

UNIT II KEY MECHANICAL CONCEPTS

Mechanics –basic units – nine fundamentals of biomechanics – principles and laws – nine principles for application of biomechanics.

UNIT III HUMAN ANATOMY AND SOME BASIC TERMINOLOGY

Gross (whole-body) modelling – position and direction terminology – terminology for common movements – skeletal anatomy – major joints – major muscle groups – anthropometric data.

UNIT IV ANATOMICAL DESCRIPTION

Key anatomical concepts – directional terms – joint motions – muscle actions – active and passive tension of muscle – limitations of functional anatomical analysis – mechanical method of muscle action analysis – the need for biomechanics to understand muscle actions – sports medicine and rehabilitation applications.

UNIT V MECHANICS OF THE MUSCULOSKELETAL SYSTEM

Tissue loads – response of tissues to forces – biomechanics of the passive muscle-tendon unit – biomechanics of bone – biomechanics of ligaments – three mechanical characteristics of muscle– Stretch-Shortening Cycle (SSC) –force-time principle – neuromuscular control.

Suggested Readings:

1. Duane Knudson, *Fundamentals of Biomechanics*, Springer US, 2013.
2. C. Ross Ethier and Craig A. Simmons, *Introductory Biomechanics: From Cells to Organisms*, Cambridge University Press, 2008.

18BESHOE01 SOLID WASTE MANAGEMENT 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To make the students conversant with the basics of solid wastes and its classification.
- To make the student acquire sound knowledge of different treatments of solid wastes.
- To acquaint the student with concepts of waste disposals.
- To develop an understanding of the basic concepts of hazardous waste management.
- To acquaint the students with the basics of energy generation from waste materials.
- Identify the methods of wastes disposals.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Outline the basic principles of solid waste and separation of wastes.
- Identify the concepts of treatment of solid wastes.
- Identify the methods of wastes disposals.
- Examine the level of hazardousness and its management.
- Examine the possible of energy production using waste materials.
- Integrate the chemical principles in the projects undertaken in the field of engineering and technology.

Course Contents:

UNIT I SOLID WASTE

Definitions – sources, types, compositions, properties of solid waste – municipal solid waste – physical, chemical and biological property – collection – transfer stations – waste minimization and recycling of municipal waste.

UNIT II WASTE TREATMENT

Size reduction – aerobic composting – incineration – batch type and continuous flow type, medical/pharmaceutical waste incineration – environmental impacts – measures of mitigate environmental effects due to Incineration.

UNIT III WASTE DISPOSAL

Sanitary landfill method of solid waste disposal – landfill classification, types, methods and siting consideration – layout and preliminary design of landfills – composition, characteristics generation, movement and control of landfill leachate and gases – environmental monitoring system for landfill gases, waste landfill remediation.

UNIT IV HAZARDOUS WASTE MANAGEMENT

Definition andidentification of hazardous waste – sources and nature of hazardous waste – impact on environment – hazardous waste control – minimization and recycling – assessment of hazardous

waste sites – disposal of hazardous waste, underground storage tanks construction, installation and closure, remediation, risk assessment.

UNIT V ENERGY GENERATION FROM WASTE

Thermal conversion technologies – pyrolysis systems, combustion systems, gasification systems, environment control systems, energy recovery systems. Biological andchemical conversion technologies – aerobic composting, low solids. Anaerobic digestion, high solids anaerobic digestion, energy production from biological conversion products, other biological transformation processes. Chemical transformation processes.

Suggested Readings:

1. DaraS.S. and MishraD.D., *A Textbook of Environmental Chemistry and Pollution Control*, S.Chand and Company Ltd., New Delhi, 2011.
2. Naomi B. Klinghoffer and Marco J. Castaldi, *Waste to Energy Conversion Technology*, Woodhead Publishing Ltd., Cambridge, UK, 2013.
3. Frank Kreith and George Tchobanoglous, *Handbook of Solid Waste Management*, McGraw-Hill Publishing Ltd., New York, 2002.
4. Kanti L. Shah, *Basics of Solid and Hazardous Waste Management Technology*, Prentice Hall (P) Ltd., New Delhi, 1999.

18BESHOE02	GREEN CHEMISTRY	3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To make the students conversant about green chemistry.
- To make the student acquire sound knowledge of the atom efficient process and synthesis elaborately.
- To acquaint the student with concepts of green technology.
- To develop an understanding of the basic concepts of renewable energy resources.
- To acquaint the students with the basics information on catalysis.
- Apply the concepts combustion of green technology.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Outline the basic principles of green chemistry.
- Examine the different atom efficient process and synthesis elaborately.
- Apply the concepts combustion of green technology.
- Identify and apply the concepts of renewable energy.
- Apply the concepts of green catalysts in the synthesis.
- Integrate the chemical principles in the projects undertaken in the field of engineering and technology.

Course Contents:

UNIT I INTRODUCTION TO GREEN CHEMICAL PRINCIPLES

Definition, tools, and twelve principles of green chemistry, solvent-less reactions and reactions in water, microwaves and fluorous solvents, green resolution of racemic mixtures, materials for a sustainable economy, chemistry of longer wear, agrochemicals: problems and green alternate solutions.

UNIT II ATOM EFFICIENT PROCESSES

Atom efficient processes, evaluating chemical reagents according to their yield and atom efficiency, examples of efficient stoichiometric and catalytic processes, atom economy and homogeneous catalysis, halide-free synthesis and alternatives to Strecker synthesis.

UNIT III BIOTECHNOLOGY AND GREEN CHEMISTRY

Biotechnology and its applications in environmental protection – bio informatics – bio remediation, biological purification of contaminated air.Green chemistry for clean technology –significance of green chemistry – basic components of green chemistry, industrial applications of green chemistry, green fuels–e-green propellants and biocatalysts.

UNIT IV RENEWABLE RESOURCES

Use of renewable materials, evaluating feedstock and starting materials and their origins, toxicity, sustainability and the downstream implications of the choice of feedstock, commodity chemicals from glucose and biomass conversion.

UNIT V CATALYSIS IN GREEN CHEMISTRY

Catalysis, energy requirements and usage, optimization of the reaction by minimizing the energy requirements, examples of efficient catalytic reactions including the use of heterogeneous catalysis, zeolites, oxidation using molecular oxygen.

Suggested Readings:

1. Sanjay K. Sharma and Ackmez Mudhoo, *Green Chemistry for Environmental Sustainability*, CRC Press, London, 2010.
2. Ahluwalia V. K. and M.Kidwai, *New Trends in Green Chemistry*, Anamaya Publishers, New Delhi, 2007.
3. Sunita Rattan, *A Textbook of Engineering Chemistry*, S.K. Kataria and Sons, New Delhi, 2012.
4. Mukesh Doble, Ken Rollinsand Anil Kumar, *Green Chemistry and Engineering*, Academic Press, Elsevier, New Delhi, 2007.
5. Desai K. R., *Green Chemistry*, Himalaya Publishing House, Mumbai, 2005.
6. Matlack A. S., *Introduction to Green Chemistry*, Marcel Dekker, New York, 2001.

18BESHOE03 APPLIED ELECTROCHEMISTRY 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To make the students conversant with the information on electrochemical material.
- To make the student acquire sound knowledge of conducting polymers.
- To acquaint the student with concepts of energy storage devices.
- To develop energy storage devices.
- Apply the concepts of electrochemistry in storage devices.
- Identify the concepts of storage devices and their applications.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Outline the basic principles of chemistry in electrochemical material.
- Examine the properties of conducting polymers.
- Apply the concepts of electrochemistry in storage devices.
- Identify the concepts of storage devices and their applications.
- Apply suitable materials for the manufacturing of storage devices.
- Integrate the chemical principles in the projects undertaken in the field of engineering and technology.

Course Contents:

UNIT I METAL FINISHING

Fundamental principles, surface preparation – electroplating of copper, nickel, chromium, zinc and precious metals (gold and silver) – electroplating for electronic industry – alloy plating, brass plating – electroless plating of nickel – anodizing – electroforming – electrowinning.

UNIT II CONDUCTING POLYMERS AND ELECTROCHEMICALS

Electropolymerisation – anodic and cathodic polymerization – effect of reaction parameters on the course of the reaction – electrochemical preparation of conducting polymers – poly acetylene – electrolytic production of perchlorates and manganese dioxide – electro organic chemicals – constant current electrolysis.

UNIT III BATTERIES AND POWER SOURCES - I

Principles of energy conservation – electrochemical energy conservation – thermodynamic reversibility, Gibbs equation. EMF – battery terminology, energy and power density – properties of anodes, cathodes, electrolytes and separators – types of electrolytes.

UNIT IV BATTERIES AND POWER SOURCES - II

Primary batteries –dry Leclanche cells, alkaline primary batteries, lithium batteries – construction, characteristics, problems associated with system – secondary batteries – lead acid, nickel cadmium – fuel cells – introduction, types of fuel cells, advantages.

UNIT V ELECTROCHEMICAL MATERIAL SCIENCE

Solar cells – preparation of CdS/Cu_2S solar cells by screen printing techniques and their characteristics – amorphous silicon solar cells –PhotoElectrochemicalCells(PEC) for conversion of light energy to electrical energy – PEC cells based on Cd/Se and Ga/As characteristics.

Suggested Readings:

1. Cynthia G. Zoski, *Handbook of Electrochemistry*, Academic Press, Elsevier, UK, 2007.
2. D.Pletcher and F.C.Walsh, *Industrial Electrochemistry*, Chapman and Hall, London, 1990.
3. M. Barak, *Electrochemical Power Sources*, Peter Peregrinius Ltd., Steverage, UK, 1997.
4. Bruno Scrosati, *Applications of Electroactive Polymers*, Chapman & Hall, London, 1993.
5. K.L. Chopra and I. Kaur, *Thin Film Devices and their Application*, Plenum Press, New York, 1983.
6. M.M.Baizer, *Organic Electrochemistry*, Dekker Inc., New York, 1983.

18BESHOE04 INDUSTRIAL CHEMISTRY 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To make the students conversant with cement and lime and its uses.
- To make the student acquire sound knowledge of abrasives and refractories.
- To acquaint the student with concepts of inorganic chemicals.
- To develop an understanding of the basic concepts of explosives.
- To acquaint the students with the basics of agriculture chemicals.
- Identify the usage of inorganic chemicals.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Outline the basic chemistry of cement and lime.
- Examine the uses of abrasives and refractories.
- Identify the usage of inorganic chemicals.
- Identify the concepts of explosives and smoke screens.
- Identify the usage of agriculture chemicals.
- Integrate the chemical principles in the projects undertaken in the field of engineering and technology.

Course Contents:

UNIT I CEMENT AND LIME

Manufacture of Portland cement – settling of hardening of Portland cement – regauging cement – effect of fineness on setting and hardening – freezing – high early strength cement – high alumina cement Lime – raw materials – manufacture – slaking – lime mortar – types of lime – high – calcium or fat lime – calcium lime or lean lime – magnesiam lime – dolomitic lime – hydraulic lime.

UNIT II ABRASIVES AND REFRACTORIES

Abrasives – hard abrasives – siliceous abrasives – soft abrasives– artificial abrasives – uses. Refractories – definition – classification – acid refractories – basic refractories – neutral refractories – properties – uses.

UNIT III INORGANIC CHEMICALS

Common salt and soda ash – manufacture – different grades – products – alkalis – Na_2CO_3, caustic soda and chlor-alkali industry – manufacture principles of electrolytic process – chlorine – storage. Hydrochloric acid – manufacture – absorption – uses, sulphur and sulphuric acid – extraction of sulphur – manufacture of H_2SO_4 – chamber – contact processes – industrial uses.

UNIT IV EXPLOSIVES

Explosives – uses – properties and tests – explosives for war – nitrocellulose – picric acid and TNT. – industrial explosives – nitro-glycerine and dynamites – black powder – smoke screens – incendiaries – gas mask.

UNIT V AGRICULTURE CHEMICALS

Fertilizers – organic and inorganic – ammoniated superphosphates, sodium nitrate, solid pellets – potassium salts – pesticides – fungicides – herbicides – their preparations and characteristics – environmental impacts.

Suggested Readings:

1. Harikrishan, *Industrial Chemistry*, Goel Publishing House, Meerut, 2014.
2. B.K. Sharma, *Industrial Chemistry*, Goel Publishing House, Meerut, 2000.
3. B.N.Chakrabarty, *Industrial Chemistry*, Oxford and IBH Publishing Co., New Delhi, 1998.
4. James A. Kent, *Handbook of Industrial Chemistry*, Van Nostrand Reinhold, New York, 1992.
5. R.N. Sherve, *Chemical Process Industries*, McGraw-Hill, Kugakuisha Ltd., Tokyo, 1984.
6. S.D. Shukla and G.N. Pandy, *A Textbook of Chemical Technology*, Vikas Publishing House (P) Ltd., New Delhi, 1979.

18BESHOE05	TECHNICAL WRITING	3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To develop abilities to write technically and expressively.
- To recognise writing as a constructive and meaningful process.
- To practice using reading strategies for effective writing.
- To design effective technical documents for both print and digital media.
- To identify the qualities of good technical writing.
- Identify the usage of inorganic chemicals.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Create simple sentences and correct common grammatical errors in written English.
- Use their reading ability for effective writing.
- Restate to minimize word, sentenceand paragraph length without sacrificing clarity or substance.
- Discuss the basic technical writing concepts and termssuch as audience analysis, jargon, format, visuals, and presentation.
- Demonstrate the basic components of definitions, descriptions, process explanations and other common forms of technical writing.
- Organize the structure of thesis and articles

Course Contents:

UNIT I BASICS OF WRITING

Introduction to technical writing – importance of writing – characteristics of writing – audience recognition/analysis – appropriateness of language –conciseness and flow– bias-free and plain writing – impersonal and formal language – techniques of technical writing– overcoming writer's block – prioritizing for effective writing– avoiding plagiarism.

UNIT II PARAGRAPHS AND ESSAYS

Expressing ideas – paragraph construction – cohesion and coherence – adequate development – kinds of paragraphs – writing drafts – paragraph length and pattern – types of essays – characteristics of essays – salient point of sentence constructions.

UNIT III LETTERS, MEMOS AND EMAIL

Formal written correspondence – types of messages – business letters – structure of letters – language in letters – tense in letters – cover letters – resumes – curriculum vitae – memos – emails – email etiquette – effectiveness and purpose.

UNIT IV THE ART OF CONDENSATION AND TECHNICAL PROPOSALS

Steps to effective précis writing – guidelines – technical proposals – types of proposals – characteristics – body of the proposals – style and appearance – evaluation of proposals – proof reading – book/film review – travelogue – dialogue writing.

UNIT V REPORTS AND RESEARCH ARTICLES

Discussion of newspaper articles – objectives of reports – characteristics of reports – structure of reports – types of reports – writing an article – writing research articles – essential features of dissertation – organizing the structure of thesis and articles – writing technical description.

Suggested Readings:

1. V.N. Arora and Lakshmi Chandra, *Improve Your Writing*, Oxford University Press, New Delhi, 2014.
2. David Morley, *The Cambridge Introduction to Creative Writing*, Cambridge University Press, New Delhi, 2010.
3. Graham King, *Collins Improve Your Writing Skills*, HarperCollins Publishers, UK, 2009.
4. Phyllis Creme and Mary R. Lea, *Writing at University: A Guide for Students*, Oxford University Press, New Delhi, 2003.

18BESHOE06	GEOPHYSICS	3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To inculcate the basics of the brief history of earth sciences.
- To divulge knowledge on the basics of the structure of earth and earth's gravitational field.
- To disseminate the fundamentals of the magnetic field and thermal distribution of earth.
- To introduce the concepts of seismology and seismic waves.
- To impart the basic knowledge of oceans.
- Discuss the concepts of the structure of earth and earth's gravitational field.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Explain basics of the history of earth sciences.
- Discuss the concepts of the structure of earth and earth's gravitational field.
- Describe the concepts of the magnetic field and thermal distribution of earth.
- Explain the basics of seismic waves.
- Discuss the basics of oceans and the properties of seawater.
- Apply the knowledge gained from this course to solve the relevant problems in the engineering stream.

Course Contents:

UNIT I ORIGIN OF EARTH

A brief history of the development of earth sciences. An overview of geophysical methods and their essential features, problems of inversion and non-uniqueness in geophysics, origin and evolution of solar system, earth and moon structure,Kepler's law of planetary motion, a review of the earth's structure and composition.

UNIT II STRUCTURE OF EARTH

Chemical composition of earth, rheological behaviour of crust and upper mantle, viscoelasticity and rock failure criteria, Geochronology: Radiometric dating and their advantages, meaning of radiometric ages, major features of the earth's gravitational field and relationship with tectonic processes in the crust and upper mantle, concept of isostasy, mathematical concept of Airy and Pratt hypotheses of isostasy.

UNIT III MAGNETIC FIELD AND THERMAL DISTRIBUTION OF EARTH

Origin of geomagnetic field, polar wandering, secular variations and westward drift, reversals of geomagnetic field, sunspot, solar flares, geomagnetic storms, sea-floor spreading, paleomagnetism and its uses, thermal history of the earth, sources of heat generation and temperature distribution inside the earth, convection in the mantle.

UNIT IV SEISMOLOGY

Earthquake seismology, earthquakes and its classifications, global seismicity and tectonics, earth's internal structure derived from seismology, earthquake mechanism and Anderson's theory of faulting, continental drift and plate tectonics: Itsessential features, present day plate motions, triple junctions, oceanic ridges, Benioff zones, arcs, hot spots, mantle plume, mountain building, origin of Himalaya, geodynamics of Indian subcontinent.

UNIT V OCEANS

Physical properties of seawater and methods of determination, distribution of salinity in the oceans, factors affecting salinity, water masses and water type, TS Diagram, circulation of currents in major ocean waves. Tides: Dynamical and equilibrium theory of tides. Marine pollution, steps to control marine pollution, laws of seas, coastal zone management.

Suggested Readings:

1. B.F. Howell, *Introduction to Geophysics*, McGraw-Hill, 2007.
2. W. Lowrie, *Fundamentals of Geophysics*, Cambridge University Press, 2007.
3. J.A. Jacobs and R.D. Russel, *Physics and Geology*, McGraw-Hill, 2002.

18BESHOE07 ENGINEERING ACOUSTICS 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To disseminate the fundamentals of acoustic waves.
- To inculcate the characteristics of radiation and reception of acoustic waves.
- To divulge knowledge on the basics of pipe resonators and filters.
- To introduce the features of architectural acoustics.
- To impart the basic knowledge of transducers and receivers.
- Explain the basic ideas of pipe resonators and filters.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Develop the idea of the fundamentals of acoustic waves.
- Apply the concepts of radiation and reception of acoustic waves.
- Explain the basic ideas of pipe resonators and filters.
- Illustrate the basics of architectural acoustics.
- Illustrate the transducers and receivers and its applications in various electronic devices.
- Apply the knowledge inputs of the course for engineering applications.

Course Contents:

UNIT I INTRODUCTION

Acoustics waves – linear wave equation – sound in fluids – harmonic plane waves – acoustics intensity – specific acoustic impedance – spherical waves – describer scales.Reflection and transmission:Transmission from one fluid to anothernormal and oblique incidence –method ofimages.

UNIT II RADIATION AND RECEPTION OF ACOUSTIC WAVES

Radiation from a pulsating sphere – acoustic reciprocity – continuous line sourceradiation impedance – fundamental properties of transducers.Absorption and attenuation of sound. Absorption from viscosity – complex sound speed and absorption – classical absorption coefficient.

UNIT III PIPES RESONATORS AND FILTERS

Resonance in pipes – standing wave pattern absorption of sound in pipes – long wavelength limit – Helmholtz resonator – acoustic impedance – reflection and transmission of waves in pipe – acoustic filters – low pass, high pass and band pass. Noise, signal detection, hearing and speech. Noise, spectrum level and band level – combing band levels and tones – detecting signals in noise – fundamental properties of hearing – loudness level and loudness – pitch and frequency – voice.

UNIT IV ARCHITECTURAL ACOUSTICS

Sound in enclosure – a simple model for the growth of sound in a room – reverberation time – Sabine, sound absorption materials – measurement of the acoustic output of sound sources in live rooms – acoustics factor in architectural design.

Environmental acoustics: Highway noise – noise induced hearing loss – noise and architectural design specification and measurement of some isolation design of portions.

UNIT V TRANSDUCTION

Transducer as an electives network – canonical equation for the two simple transducers transmitters – moving coil loudspeaker– horn loudspeaker, receivers – condenser – microphone – moving coil electrodynamics microphone piezoelectric microphone – calibration of receivers.

Suggested Readings:

1. Lawrence E. Kinsler, Austin R. Frey, Alan B. Coppens and James V. Sanders, *Fundamentals of Acoustics*, John Wiley & Sons, 1999.
2. F. Alton Everest and Ken C. Pohlmann, *Master Handbook of Acoustics*, McGraw-Hill Professional, 2014.

18BESHOE08	INDUSTRIAL MATHEMATICS - I	3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To develop analytical skills for solving engineering problems.
- To teach the students the basic concepts of LPP.
- To learn the techniques to solve transportation and assignment problems.
- To make the students study the integer programming and network analysis.
- To analyse the results and propose recommendations to the decision-making processes in management engineering.
- Formulate and solve transportation models and assignment models.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Define and formulate linear programming problems and appreciate their limitations.
- Solve linear programming problems using appropriate techniques and optimization solvers, interpret the results obtained and translate solutions into directives for action.
- Formulate and solve transportation models and assignment models.
- Construct linear integer programming models and discuss the solution techniques.
- Formulate and solve problems as networks and graphs.
- Apply PERT and CPM

Course Contents:

UNIT I LINEAR PROGRAMMING PROBLEM

Formulation of LPP –graphical method –simplex method – artificial variable technique and two-phase simplex method. Duality –dual and simplex method – dual simplex method.

UNIT II TRANSPORTATION PROBLEM

Transportation model, finding initial basic feasible solutions, moving towards optimality, degeneracy.

UNIT III ASSIGNMENT PROBLEM

Solution of an assignment problem, multiple solution, Hungarian algorithm, maximization in assignment model, impossible assignment.

UNIT IV INTEGER PROGRAMMING

Integer programming problem – Gromory's fractional cut method – branch bound method.

UNIT V NETWORK ANALYSIS

PERT and CPM – network diagram – probability of achieving completion date – crash time – cost analysis.

Suggested Readings:

1. Hamdy Taha. A., *Operations Research*, Prentice-Hall of India Pvt. Ltd., New Delhi, 2013.
2. Kanti Swarup, P. K. Gupta and Man Mohan, *Operations Research*, Sultan Chand & Sons, New Delhi, 2010.
3. Natarajan A.M., Balasubramani P. and Thamilarasi A, *Operations Researc*h, Pearson Education, New Delhi, 2005.
4. Srinivasan G, *Operations Research: Principles and Applications*, PHI Pvt. Ltd., New Delhi, 2007.
5. Wayne L. Winston, *Operations Research: Applications and Algorithms*, Cengage Learning India Pvt. Ltd., New Delhi, 2004.

18BESHOE09 INDUSTRIAL MATHEMATICS - II 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To kindle analytical skills for solving engineering problems.
- To impart the knowledge about inventory models.
- To learn replacement models and simulation models.
- To provide techniques for effective methods to solve nonlinear programming and decision making.
- To analyse the results and propose recommendations to the decision-making processes in management engineering.
- Discuss the characteristics of different types of decision-making environments and the appropriate decision making approaches and tools to be used in each type.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Solve simple models in inventory problems and replacement problems.
- Explain different queuing situations and find optimal solutions using models for different situations.
- Simulate different real-life probabilistic situations using Monte Carlo simulation technique.
- Discuss the characteristics of different types of decision-making environments and the appropriate decision making approaches and tools to be used in each type.
- Convert and solve practical situations into replacement models.
- Model and solve problems using non-integer programming.

Course Contents:

UNIT I INVENTORY MODELS

Economic order quantity models – techniques in inventory management – ABC analysis.

UNIT II NON-LINEAR PROGRAMMING

Khun-Tucker conditions with non-negative constraints –quadratic programming – Wolf's modified simplex method.

UNIT III SIMULATION MODELS

Elements of simulation model – Monte Carlo technique – applications. Queuing model: Problems involving (M\M\1): (∞\FIFO), (M\M\c): (∞\FIFO) models.

UNIT IV DECISION MODELS

Decision analysis – decision making environment – decisions under uncertainty – decision under risk – decision – tree analysis.

UNIT V REPLACEMENT MODELS

Models based on models that gradually deteriorate with time – whose maintenance cost increase with time – replacement of items that fail suddenly and completely.

Suggested Readings:

1. Hamdy Taha. A., *Operations Research*, Prentice-Hall of India Pvt. Ltd., New Delhi, 2013.
2. Kanti Swarup, P. K. Gupta and Man Mohan, *Operations Research*, Sultan Chand & Sons, New Delhi, 2010.
3. Natarajan A.M., Balasubramani P. and Thamilarasi A, *Operations Researc*h, Pearson Education, New Delhi, 2005.
4. Srinivasan G, *Operations Research: Principles and Applications*, PHI Pvt. Ltd., New Delhi, 2007.
5. Wayne L. Winston, *Operations Research: Applications and Algorithms*, Cengage Learning India Pvt. Ltd., New Delhi, 2004.

18BESHOE10	FUZZY MATHEMATICS	3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To understand basic knowledge of fuzzy sets and fuzzy logic.
- To apply the basic knowledge of fuzzy operations.
- To know the basic definitions of fuzzy relations.
- To apply basic fuzzy inference and approximate reasoning.
- To know the applications of fuzzy technology.
- Describe the methods of fuzzy logic.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Explain the main subject of fuzzy sets.
- Discuss the concept of fuzziness involved in various systems and fuzzy set theory.
- Describe the methods of fuzzy logic.
- Comprehend the concepts of fuzzy relations.
- Analyse the application of fuzzy logic control to real-time systems.
- Understand the fuzzy relational inference

Course Contents:

UNIT I FUZZY SETS

Basics – classical sets vs. fuzzy sets – need for fuzzy sets – definition and mathematical representations – level sets – fuzzy functions – Zadeh's extension principle.

UNIT II OPERATIONS ON FUZZY SETS

Operations on [0,1] – Fuzzy negation, triangular norms, t-conorms, fuzzy implications, aggregation operations, fuzzy functional equations.

UNIT III FUZZY RELATIONS

Fuzzy binary and n-ary relations – composition of fuzzy relations – fuzzy equivalence relations – fuzzy compatibility relations – fuzzy relational equations.

UNIT IV FUZZY MEASURES

Possibility theory – fuzzy measures – evidence theory – necessity and belief measures – probability measures vs. possibility measures.

UNIT V FUZZY INFERENCE

Approximate reasoning fuzzy decision making – fuzzy relational inference – compositional rule of inference – efficiency of inference – hierarchical.

Suggested Readings:

1. George J Klir and Bo Yuan, *Fuzzy Sets and Fuzzy Logic: Theory and Applications*, Prentice Hall of India, New Delhi, 2003.
2. Zimmermann H.J., *Fuzzy Set Theory and its Applications*, Kluwer Academic Publishers, USA, 2001.
3. Michał Baczyński and Balasubramaniam Jayaram, *Fuzzy Implications*, Springer-Verlag Publishers, Heidelberg, 2008.
4. Kevin M Passino and Stephen Yurkovich, *Fuzzy Control*, Addison Wesley Longman Publishers, USA, 1998.

18BESHOE11 MATHEMATICAL PHYSICS 3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To know the fundamentals of tensors.
- To know the series solutions to differential equations.
- To introduce the concepts of special functions.
- To study about calculus of variations and integral equations.
- To familiar with the main mathematical methods used in physics.
- Discuss the special type of matrices that are relevant in physics and tensors.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Demonstrate proficiency in mathematics and the mathematical concepts needed for a proper understanding of physics.
- Discuss the special type of matrices that are relevant in physics and tensors.
- Explain special functions like Bessel, Legendre, Hermite and Laguerre functions and their recurrence relations.
- Compare different ways of solving second order differential equations.
- Use calculus of variations and linear integral equations.
- Solution of Fredholm equations with separable kernels.

Course Contents:

UNIT I TENSORS

Definition of tensor –rank, symmetric tensors, contraction, quotient rule –tensors with zero components, tensor equations, metric tensors and their determinants –pseudo tensors.

UNIT II DIFFERENTIAL EQUATIONS-SERIES SOLUTIONS

Series solution: Classification of singularities of an ordinarydifferential equation –seriessolution – methodofFrobenius– indicial equation– examples.

UNIT III SPECIAL FUNCTIONS

Basic properties (Recurrence and Orthogonality relations, series expansion) of Bessel, Legendre,Hermite and Laguerre functions – Generating Function.

UNIT IV CALCULUS OF VARIATIONS

Concept of variation and its properties – Euler's equation – functional dependant on first and higher order derivatives – functional dependant on functions of several independent variables – variational problems with moving boundaries – isoperimetric problems – direct methods – Ritz and Kantorovich methods.

UNIT V LINEAR INTEGRAL EQUATIONS

Introduction – conversion of a linear differential equation to an integral equations and vice versa – conversion of boundary value problem to integral equations using Green's function – solution of integral equation – integral equations of the convolution type – Abel's integral equations –integro-differential equations – integral equations with separable kernels – solution of Fredholm equations with separable kernels.

Suggested Readings:

1. Grewal B.S., *Higher Engineering Mathematics*, Khanna Publishers, New Delhi, 2013.
2. Murray R Spiegel, Seymour Lipschutz and Dennis Spellman, *Vector Analysis*, Tata McGraw-Hill Education Pvt. Ltd., New Delhi, 2010
3. Stephenson, G.and Radmore, P.M., *Advanced Mathematical Methods for Engineering and Science Students*, Cambridge University Press India Pvt. Ltd., New Delhi, 1990.
4. Larry C. Andrews, *Special Functions of Mathematics for Engineers*, Oxford Science Publishers, New Delhi, 1997.

18BESHOE12	LINEAR ALGEBRA	3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To introduce the basic concepts of vector space.
- To know the fundamentals of linear algebra.
- To solve the system of linear equations.
- To study the linear transformations.
- To introduce the concepts of inner product spaces.
- Express linear transformations as a matrix form.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Explain the fundamental concepts of advanced algebra and their role in modern mathematics and applied contexts.
- Apply the fundamental concepts in their respective engineering fields.
- Express linear transformations as a matrix form.
- Explain the underlying theory of vector spaces over a field and inner product spaces over real or complex numbers.
- Discuss the importance of linear algebra
- Discuss the applications of linear algebra in branches of mathematics.

Course Contents:

UNIT I VECTOR SPACES

General vector spaces, real vector spaces, Euclidean n-space, subspaces, linear independence, basis and dimension, row space, column space and null space.

UNIT II EIGEN VALUES AND EIGEN VECTORS

Eigen values and Eigen vectors –diagonalization – power method – QR decomposition.

UNIT III SYSTEM OF LINEAR EQUATIONS

Direct methods, Gauss elimination method, Gauss-Jordan method, Crout's method, iterative methods, Gauss-Jacobi method, Gauss-Seidel method, convergence criteria.

UNIT IV LINEAR TRANSFORMATIONS

Linear transformations – the null space and range – isomorphisms – matrix representation of linear transformations – similarity–Eigen values and Eigenvectors–diagonalization.

UNIT V INNER PRODUCT SPACES

The dot product on R^n and inner product spaces – orthonormal bases – orthogonal complements – Application: Least squares approximation – diagonalization of symmetric M – Application: Quadratic forms.

Suggested Readings:

1. KreyszigE, *Advanced Engineering Mathematics*, John Wiley & Sons, New Delhi, 2014.
2. Shahnaz Bathul, *Special Functions and Complex Variables*, PHI Publications, New Delhi, 2009.
3. Anton and Rorres, *Elementary Linear Algebra: Applications*, Wiley India, New Delhi.2012.
4. Jim Defranza, Daniel Gagliardi, *Introduction to Linear Algebra with Application*, Tata McGraw-Hill, New Delhi, 2008.

18BEAEOE01	AUTOMOBILE ENGINEERING	3H-3C

Instruction Hours/Week: L:3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 hours

Course Objectives:

- To impart knowledge on the constructional details and principle of operation of various automobile components.
- To learn the function and working of various components in transmission and drive lines.
- To study the concept and working of steering and suspension systems in an automobile.
- To give knowledge on the wheels, tyres and brakes of automobiles.
- To provideinformation on thecurrent and future trends in automobiles.
- Explain the function and working of components in transmission and drive lines.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

- Demonstrate the operating principles and constructional details of various automobile components.
- Explain the function and working of components in transmission and drive lines.
- Identify and explain the types of steering system.
- Identify and explain the types of suspension system.
- Classify and describe the types of wheels, tyres and brakes of automobiles.
- Discuss the current and future trends in the automobiles.

Course Contents:

UNIT I ENGINE AND AUXILIARY SYSTEMS

Classification of engines – construction and working of four-stroke Spark Ignition (SI) engine and CompressionIgnition (CI) engine – construction and working of two-stroke SI and CI engine – firing order – carburettor – fuel injection systems – battery – dynamo – alternator – starting motor – lighting system – ignition system.

UNIT II TRANSMISSION SYSTEMS

Requirements of transmission system – flywheel – clutch –types of clutch – construction of single and multi-plate clutches – need, types and construction of transmission gearbox – universal joint – propeller shaft – need, types and construction of differential – four wheel drive.

UNIT III STEERING AND SUSPENSION SYSTEMS

Principle of steering – steering linkages – types of steering gearbox –power steering – suspension systems – need and types – independent suspension – coil spring, leaf spring, torsion bar and airsuspension – shock absorbers.

UNIT IV WHEELS AND BRAKES

Wheels and tyres –construction –types and specifications –tyre wear and causes – brakes – need – braking distance – types – mechanical,hydraulic and pneumatic brakes – power brake – parking brake – redundant braking system.

UNIT V CURRENT AND FUTURE TRENDS

Anti-lock Braking System (ABS) – brake assist – Electronic Brakeforce Distribution (EBD)– airbags – automatic high-beam control – backup cameras – defogger– electric vehicles – hybrid vehicles– autonomous vehicles – vehicle-to-vehicle communication –vehicle tracking – alternative fuels.

Suggested Readings:

1. Kirpal Singh, *Automobile Engineering Volume 1*, Standard Publishers, New Delhi, 2018.
2. Sethi H M, *Automobile Technology*, Tata McGraw-Hill, New Delhi, 2003.
3. William HCrouse and Donald LAnglin, *Automotive Mechanics*, Tata McGraw-Hill, New Delhi, 2006.
4. Srinivasan S, *Automotive Mechanics*, Tata McGraw-Hill, New Delhi, 2003.
5. Ganesan V, *Internal Combustion Engines*, McGraw-Hill Education, New Delhi, 2012.

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