FACULTY OF ENGINEERING

DEGREE OF BACHELOR OF TECHNOLOGY IN CHEMICAL ENGINEERING

DEPARTMENT OF CHEMICAL ENGINEERING

(REGULAR PROGRAMME)

CURRICULUM AND SYLLABI

(2018 – 2019)

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

KARPAGAM ACADEMY OF HIGHER EDUCATION

Faculty of Engineering

Department of Chemical Engineering

(Deemed University Established Under Section 3 of UGC Act 1856)

Pollachi Main Road, Eachanari Post, Coimbatore- 641 021, India.

Semester-I

18BTCE101	**Mathematics-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:

1. Understanding the concept of elementary, linear and orthogonal transformations. Reduction of a given matrix to echelon and normal forms. Defining rank of a matrix and solve system of linear equations by different methods.
2. Determining the eigen values and eigen vectors. Reduction to diagonal and quadratic form. Deduce reduction formulae and discuss tracing of curves and applications. Understanding the concept of scalar and vector point function, Determining vector identities.
3. Gradient, divergence and curl of a vector point function and related identities which plays an important role in the understanding of science, engineering, economics and computer science, among other disciplines.
4. To acquaint the student with mathematical tools needed in evaluating line, surface and volume integrals using Green's theorems and their verification.
5. To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems and also to acquaint the student with Fourier series techniques in solving heat flow problems used in various situations
6. To analyze engineering problems and evaluate

Course outcomes:

After successfully completing the course, the student will have a good understanding of the following topics and their applications:

1. In rank, consistency and its inverse in Engineering fields.
2. Eigen values and eigenvectors, diagonalization of a matrix, Symmetric matrices and the students will be able to use matrix algebra techniques for practical applications.
3. To recognize scalar and vector functions. Evaluate Gradient, Divergence and Curl of a point function depending upon its nature, identifying Solenoidal and Irrotational Vector fields and to use vector identities connecting these quantities in problem solving.
4. To Calculate and establish identities connecting line, surface and volume integrals in simple coordinate systems and to Use Greens theorem to simplify calculations of integrals and prove simple results.
5. To solve differential equations using Fourier series analysis which plays a vital role in engineering applications.
6. To analyse and evaluate the basic concepts of mathematics like matrix opreations, vectors, Fourier series etc in their specific fields

Unit I - Linear Algebra

Matrices, Vectors: Addition and Scalar Multiplication, Matrix Multiplication, Linear Systems of Equations, Gauss Elimination, Linear Independence. Rank of a Matrix. Vector Space, Solutions of Linear Systems: Existence, Uniqueness, Determinants, Cramer's Rule, Inverse of a
Matrix. Gauss-Jordan Elimination.Simple problems using Scilab.

Unit II - Linear Algebra

Eigenvalues, Eigenvectors, Applications of Eigenvalue Problems, Symmetric, Skew-Symmetric, and Orthogonal Matrices

Unit III - Vector Differential Calculus

Vectors in 2-Space and 3-Space, Inner Product (Dot Product), Vector Product (Cross Product), Vector and Scalar Functions and Fields, Derivatives, Curves, Arc Length. Curvature, Gradient of a Scalar Field, Directional Derivative, Divergence of a Vector Field, Curl of a Vector Field.

Unit IV - Vector Integral Calculus

Line Integrals, Path Independence of Line Integrals, Green's Theorem in the Plane, Surface Integrals.

Unit V - Fourier Series

Dirichlet's conditions, General Fourier series, Odd and even functions, Half range sine series, Half range cosine series, Parseval's identity, Harmonic Analysis.

SUGGESTED READINGS

1. N.P. Bali and Manish Goyal, (2008), A text book of Engineering Mathematics, Laxmi Publications.
2. B.S. Grewal, (2000), Higher Engineering ,Khanna Publishers.
3. Hemamalini. P.T.(2017)**,** Engineering Mathematics**,** McGraw Hill Education (India) Private Limited, New Delhi.
4. Veerarajan T**,** (2008), Engineering Mathematics for first year,Tata McGraw-Hill, New Delhi,.
5. Erwin kreyszig, (2006)**,** Advanced Engineering Mathematics, 9th Edition,John Wiley & Sons**,**.
6. Ramana B.V,(2010), Higher Engineering Mathematics, 11th Reprint, Tata McGraw Hill New Delhi.

Semester-I

18BTCE102	**Physics**	**7H-5C**
	(Theory & Lab.)	

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

End Semester Exam:3 Hours

(i) Theory Course Objective:

1. The aim of this course is to understand the basic concepts and also how to apply the concepts in practical life where which will be used.
2. To introduce basic concepts of optics, electricity, magnetism, quantum physics and its applications.
3. To prepare the students to understand the fundamental concepts of physics and also about its applications.
4. The students should develop the innovative concepts and research oriented
5. program.
6. To enhance the fundamental knowledge in basic physics and various branches of engineering and technology.

Course Outcomes

Upon completion of this course, the students will be able to

1. Knowledge of Bragg's Law, interference, diffraction and its applications.
2. Understand the principles of lasers, types of lasers and itsapplications and also gain the knowledge of fiber optics.
3. Remember the basic concepts of electromagnetism, maxwell equations polarization,etc.
4. Gain the knowledge of dielectrics & magnetic propertiesofmaterials.
5. Analyze about the some of the basic laws and concepts of quantum mechanics, uncertainty principle and scanning electron microscope.
6. Have adequate knowledge on the basic concepts of physics and its applications.

UNIT I –INTERFERENCE AND DIFFRACTION

Introduction to interference and example; Michelson interferometer- Applications, Airwedge - concept of diffraction, Fraunhofer and Fresnel diffraction, Fraunhofer diffraction at single slit, double slit, and multiple slits; diffraction grating, characteristics of diffraction grating and its applications.

UNIT II - LASER & FIBER OPTICS

Introduction to interaction of radiation with matter, Einstein coefficients - principles and working of laser: population inversion, pumping, various modes, threshold population inversion, types of laser: CO_2laser, semiconductor laser, application of lasers.

Introduction, optical fibre as a dielectric wave guide: total internal reflection, numerical aperture and various fiber parameters, losses associated with optical fibres, step and graded index fibers, application of optical fibers.

UNIT III - ELECTROMAGNETISM &POLARISATION

Laws of electrostatics (Coulomb's law, Gauss law – Applications), electric current and the continuity equation, laws of magnetism (Biotsavarts law, Ampere's ciruital Applications), Faraday's laws, Maxwell's equations.

Introduction, polarisation by reflection, polarisation by double refraction, scattering of light, circular and elliptical polarisation, optical activity.

UNIT IV - DIELECTRICS & MAGNETIC PROPERTIES OF MATERIALS

Permittivity and dielectric constant, polar and non-polar dielectrics, internal fields in a solid, Clausius-Mossotti equation, applications of dielectrics.Magnetisation, permeability and susceptibility, classification of magnetic materials, ferromagnetism, magnetic domains, domain theory and hysteresis, applications.

UNIT V - QUANTUM MECHANICS

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

SUGGESTED READINGS

1. Bhattacharya D.K. &Poonam T., (2015), Engineering Physics, Oxford University Press
2. Gaur R.K. and Gupta S.L, (2012), Engineering Physics, DhanpatRai Publications
3. Pandey .B.K. &Chaturvedi .S, (2012), Engineering Physics, Cengage Learning India.
4. Halliday.D.,Resnick R. & Walker. J, (2015), Principles of Physics, Wiley.
5. SerwayR.A and Jewett J.W., (2010), Physics for Scientists and Engineers with Modern Physics, Thomson Brooks/Cole Publishing Co.
6. Tipler P.A. and MoscaG.P,(2007)., Physics for Scientists and Engineers with Modern Physics, W.H.Freeman.

(ii) Laboratory

Course objective:

1. To learn the basic concepts in physics relevant to different branches of Engineering and Technology.
2. To study the concept of semiconductor and conductivity.
3. To learn the properties of materials.
4. To develop basic laboratory skills and demonstrating the application of physical principles.
5. To prepare for the lab experiment and perform individually a wide spectrum of experiments.
6. To present experimental data in various appropriate forms like tabulation, and plots.

Course Outcome:

1. Familiarize the properties of material and basic concepts in physics.
2. List the fundamentals of Bragg's Law, interference, diffraction and its applications.
3. Understand the principles of lasers, types of lasers and its applications and also gain the knowledge of fiber optics.
4. Integrate the basic concepts of electromagnetism, Maxwell equations Polarization, etc.
5. List the knowledge of dielectrics & magnetic properties of materials.
6. Analyze about the some of the basic laws and concepts of quantum mechanics, uncertainty principle and scanning electron microscope.

LIST OF EXPERIMENTS – PHYSICS

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 e.m.f of a thermocouple
6. Laser- Determination of the wave length 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 Band gap of a semiconductor.
11. Spectrometer- Determination of wavelength using grating.
12. Viscosity of liquids-Determination of co-efficient of viscosity of a liquid by Poiseuille's flow

Semester-I

18BTCE103 **English** **4H-3C**

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

End Semester Exam:3 Hours

Course Objectives

1. 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.
2. To help students acquire their ability to speak effectively in real life situations.
3. To inculcate the habit of reading and to develop their effective reading skills.
4. To ensure that students use dictionary to improve their active and passive vocabulary.
5. To enable students to improve their lexical, grammatical and communicative competence.
6. To help students to improve their active and passive vocabulary and enable them to write letters and reports effectively in formal and business situations

Course Outcomes

Students undergoing this course will be able to

1. Use English language for communication: verbal & non –verbal.
2. Enrich comprehension and acquisition of speaking & writing ability.
3. Gain confidence in using English language in real life situations.
4. Improve word power: lexical, grammatical and communication competence.
5. To guide the students to write business letters and other forms of technical writing.
6. To enable students to prepare for oral communication in formal contexts.

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 - Acquaintance, with 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 @ 2 periods per each unit.

SUGGESTED READINGS

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

18BTCE104Chemistry –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 Objective

1. To understand the terminologies of quantum theory of chemical systems.
2. To study about various chemical bonding
3. To understand the stereochemistry of molecules.
4. To understand the thermodynamic functions.
5. To comprehend the basic organic chemistry and to synthesis simple
6. To learn about properties, characteristics and applications of different molecules based upon chemical bonding and structure

Course Outcomes

1. Appreciate quantum theory of chemical systems.
2. Appreciate aliphatic chemistry
3. Describe the concepts of stereochemistry
4. Write simple mechanisms
5. To synthesis of organic molecules
6. Integrate the chemical principles in the projects undertaken in field of engineering and technology

UNIT I - Introduction to quantum theory for chemical systems:

Schrodinger equation, Applications to Hydrogen atom, Atomic orbitals, many electron atoms

UNIT II - Chemical bonding in molecules:

MO theory, Structure, bonding and energy levels of bonding and shapes of many atom molecules, Coordination Chemistry, Electronic spectra and magnetic properties of complexes with relevance to bio-inorganic chemistry, organometallic chemistry

UNIT III - Introduction to Stereochemistry:

Stereodescriptors – R, S, E, Z. Enantiomers and Diastereomers. Racemates and their resolution. Conformations of cyclic and acyclic systems.

UNIT IV - Reactivity of organic molecules:

Factors influencing acidity, basicity, and nucleophilicity of molecules, kinetic vs. thermodynamic control of reactions

UNIT V - Strategies for synthesis of organic compounds:

Reactive intermediates substitution, elimination, rearrangement, kinetic and thermodynamic aspects, role of solvents

SUGGESTED READINGS:

1. B. H. Mahan, (2010), University chemistry, Pearson Education,
2. K. P. C. Volhardt and N. E. Schore, 5th Edition, Organic Chemistry: Structure and Function, W.H. Freeman, (2014)
3. B. L. Tembe, (2009), Kamaluddin and M. S. Krishnan, Engineering Chemistry (NPTEL Web-book)
4. Robert Neilson Boyd, SaibalKanti Robert Thornton Morrison, Organic Chemistry,Pearson;7 edition
5. Michael B. Smith&JerryMarch,,(2006)Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, Wiely..
6. ArunBahl and BS Bahl**,(2014)**AdvancedOrganic Chemistry**, S Chand**.

18BTCE111 Engineering Graphics5H-3C

Instruction Hours/week: L:1 T:0 P:4 **Marks:** Internal**:40** External**:60** Total**:100**
End Semester Exam:3 Hours

Course objectives

1. To aid visualization of engineering objects and communicating the same to other professionals.
2. To design simple assemblies involving theory of constraints, generation of assembly views from part drawings, animation of assemblies.
3. Increase ability to communicate with people
4. Learn to sketch and take field dimensions.
5. Learn to take data and transform it into graphic drawings.
6. Learn basic Auto Cad skills.

Course Outcomes

1. Understand the concept of projection and acquire visualization skills, projection of points
2. Able to draw the basic views related to projections of Lines, Planes
3. To know and understand the conventions and the method of engineering drawing.
4. Interpret engineering drawings using fundamental technical mathematics
5. Construct basic and intermediate geometry.
6. To improve their visualization skills so that they can apply these skill in developing

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. 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 free hand sketching of multiple views from pictorial views of objects.

UNIT III - ISOMETRIC PROJECTIONS

Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple solids, truncated prisms, pyramids, cylinders and cones; Developing visualization skills through free hand sketching of Conversion of Orthographic Views to Isometric Views

UNIT IV - SECTION OF SOLIDS AND ASSEMBLY DRAWINGS

Sectioning of Prism, Cylinder, Pyramid, and Cone in simple vertical position by cutting planes inclined to one reference plane and perpendicular to the other – Obtaining true shape of section.

Making free hand sketches of typical subassemblies like flange coupling, stuffing box, journal bearings, rolling element bearings, keyed joints, cotter joints, C clamp.

UNIT V - COMPUTER GRAPHICS & ENGINEERING ANIMATION

Overview of Computer Graphics, listing the computer technologies that impact on graphical communication, demonstrating knowledge of the theory of CAD software, Introduction to 3D modeling packages

Engineering animation including motion curves, coordinating multiple moving parts under joint-constraints and the notion and impact of lighting and camera, compositing and physics engines (gravity, dynamics, fluid animation)

SUGGESTED READINGS

1. Venugopal K and Prabhu Raja V, (2010), Engineering Graphics, New Age International Publishers,
2. C M Agrawal and Basant Agrawal, (2012), Engineering Graphics, Tata McGraw Hill, New Delhi,
3. James D. Bethune, (2016),Engineering Graphics with AutoCAD (2015), Pearson Education,.
4. Narayana, K.L. & P Kannaiah, (2008), Text book on Engineering Drawing, Scitech Publishers,
5. Bureau of Indian Standards, (2003), Engineering Drawing Practices for Schools and Colleges SP 46, BIS, New Delhi,.
6. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education,
7. Bhatt N.D., Panchal V.M. & Ingle P.R, (2014), Engineering Drawing, Charotar Publishing House,.

Semester-II

18BTCE201 **Mathematics-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:

1. Some standard functions and some of the properties of the Fourier transform.
2. To evaluate first order differential equations including separable, homogeneous, exact and linear equations.
3. To evaluate second order differential equations including Euler Cauchy's, Non-homogeneous, and method of variation of parameters.
4. To solving differential equation of certain type and Power series solutions of Legendrepolynomials, Bessel functions of the first kind and their properties.
5. Study Partial Differential equations in gravitation, electromagnetism, perfect fluids, elasticity,heat transfer and quantum mechanics.
6. To nurture and nourish strong communication and interpersonal skills for working in a team with high moral and ethical values

Course Outcomes

1. To be able to solve equations using Laplace and Fourier transform.
2. To solve first order differential equations utilizing the standard techniques for separable, exact, linear, Bernoulli cases.
3. To evaluate second order ordinary differential equations in various methods.
4. To apply various techniques in solving differential equations and to understand the method of finding the series solution of Bessel's and Legendre's differential equations.
5. Better understanding in problems related to heat condition, communication systems, electro optics and electromagnetic theory using the techniques will be learnt in this course.
6. The Learners can equip themselves in the transform techniques and solve ODEs and PDEs.

Unit I - Transforms

Laplace Transforms: Transforms of elementary functions, Basic properties, Transforms ofderivatives and integrals, Initial and final value theorems. Inverse Laplace transforms, Convolution theorem.Fourier Transforms: Fourier integral theorem (Statement Only), Fourier transform pair, Sine and Cosine transforms, Properties, Transforms of simple functions, Convolution theorem, Parseval'sidentity .

Unit II - First-Order ODEs

Basic Concepts, Solutions of Separable ODEs, Exact ODEs, Linear ODEs, Solving ODEs by Laplace Transforms

Unit III - Second-Order Linear ODEs

Homogeneous Linear ODEs of Second Order, Euler-Cauchy Equations, Wronskian, Nonhomogeneous ODEs, Solution by Variation of Parameters

Unit IV - Series Solutions of ODEs, Special Functions

Power Series Method, Legendre's Equation, Legendre Polynomials, Bessel's Equation, Bessel Functions.

Unit V - Partial Differential Equations

Classification of second order quasi linear partial differential equations, Solutions of one dimensional wave equation, One dimensional heat equation, Steady state solution of two-dimensional heat equation (Insulated edges excluded), Fourier series solutions in Cartesian coordinates.

Suggested Readings:

1. B.S. Grewal, (2000), Higher Engineering Mathematics, 35rd Edition, Khanna Publishers.
2. N.P.Bali N., Goyal M. A ,(2008)Text Book Of Engineering Mathematics, Laxmi Publications
3. Hemamalini. P.T, (2014&2017) Engineering Mathematics, McGraw Hill Education (India) Private Limited, New Delhi.
4. VeerarajanT,(2008)**,** Engineering Mathematics for first year,Tata McGraw-Hill, New Delhi
5. Erwin kreyszig, (2006), Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons.
6. Ramana B.V, (2010)Higher Engineering Mathematics, Tata McGraw Hill

B.Tech Chemical Engineering

Semester-II

18BTCE202	**Chemistry-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 Objective

1. To understand the basic chemical reactions.
2. To understand the mechanism of chemical reactions.
3. To understand the mechanism of lubricants.
4. To study about the nature of oils and fat.
5. To understand about the dye pigments.
6. general familiarity with the following areas in chemistry: analytical, biochemistry, inorganic, organic and physical.

Course Outcomes

1. To apply the various unit process
2. Extend the principles of reaction mechanisms
3. To apply the knowledge on chemical reactions
4. To prepare soaps
5. To analyses the effect of pigments
6. Integrate the chemical principles in the projects undertaken in field of engineering and technology

UNIT I - UNIT PROCESSES

Nitration, Sulphonation, Halogenation, Esterification, Amination, Saponification and Hydrogenation – Role of the above unit processes in such industries as petroleum, drugs, pharmaceuticals and organic synthesis.

UNIT II - REACTION MECHANISMS

Free radical, substitutions, electrophilic, addition, aromatic electrophilic substitutions, nucleophilic additions, condensation reactions, nucleophilic substitutions in aliphatic and aromatic compounds, cyclo-additions, rearrangements-Beckmann and Fries rearrangement reactions.

UNIT III - OILS, FATS, SOAPS & LUBRICANTS

Chemical constitution, Chemical analysis of oils and fats – acid, saponification and iodine values, Definitions, determinations and significance. Definition, mechanism of lubrication, preparation of petrolubes, desirable characteristics – viscosity, viscosity index, carbon residue, oxidation stability, flash and fire points, cloud and pour points, aniline point. Semisolid lubricant – greases, preparation of sodium, lithium, calcium and axle greases and uses, consistency test and drop point test.Solid lubricants – graphite and molybdenum disulphide.

UNIT IV - CHEMICALS AND AUXILIARIES

Preparation, properties and uses of bleaching powder, sodium hypochlorite, hydrogen peroxide, chlorine dioxide. Estimation of available chlorine in hypochlorite bleach liquor. Determination of strength of hydrogen peroxide.

UNIT V - COLORANTS

Theory of color and constitution: chromophore and auxochrome, classification of dyes based on application. Chemistry and synthesis of azo dye (Methyl red, Methyl orange and Congo red).

SUGGESTED READINGS

1 Dhara S. S (2016), A Text Book of Engineering Chemistry, S. Chand & Co. Ltd., NewDelhi
2 Jain. P.C and Monica Jain (2012), Engineering Chemistry, DhanpetRai& Sons, New Delhi
3ShikhaAgarwal (2015), Engineering Chemistry-Fundamentals and Applications, CambridgeUniversity Press, Delhi
4W.L. McCabe, J.C. Smith and P. Harriot (2005), Unit Operations of Chemical Engineering,7Edition, McGraw Hill Education
5 B.K. Sharma(2011), Industrial chemistry, Krishna Prakashan Media (P) Ltd, Meerut
6 Shore J (2002), Colourants and Auxiliaries: Volume II Auxiliaries, Wood head Publishing Ltd
7 Shenai V. A(1995), Chemistry of Dyes and Principles of Dyeing, Sevak Publications, Mumbai
8 Trotman E. R(1994), Dyeing and Chemical Technology of Textile Fibres, B.I Publishing Pvt. Ltd, New Delhi

Semester-II

18BTCE203 **Electrical & Electronics Engineering (Theory & Lab.)** **6H-5C**

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

End Semester Exam:3 Hours

(i) Theory

Course Objectives

1. To impart the basic knowledge about the Electric circuits.
2. To understand the concept of Electro Mechanical Energy Conversion and Transformers.
3. To understand the working of Semiconductor devices and Measuring Instruments.
4. To impart the basic knowledge of Digital Circuits.
5. Develop the basic concepts of network analysis, which is the pre-requisite for all the electrical engineering subjects.
6. Solve different complex circuits using various network reduction techniques such as Source transformation, Network theorems etc.

Course Outcomes

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

1. To understand and analyze basic electric and magnetic circuits.
2. To study the working principles of transformer and Measuring Instruments.
3. To understand the basic concepts of Digital Circuits.
4. Investigate the methods to improve power factor in power system networks.
5. Design resonant circuits which are used in wireless transmission and communication networks.
6. Understand 3-phase ac circuits for designing and analysis of power system networks.

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 - Electro Mechanical Energy Conversion And Transformer

Energy in magnetic system –singly and multiply excited magnetic field systems-mmf of distributed windings – Winding Inductances-, magnetic fields in rotating machines –Field energy and co energy-force and torque equations.BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency.

UNIT IV- Semiconductor Devices And Two Port Networks

Bipolar Junction Transistor – Characteristics Introduction to operational Amplifier –Model– Applications.Two-Port Parameters: Relationship of Two-Port Variables, Short-Circuit Admittance parameters, The Open-circuit Impedance Parameters, Transmission parameters.

UNIT V- Measuring Instruments And Digital Electronics

Principle, construction, and operation of moving coil and moving iron meters-Measurement of Power. Number systems – binary codes - logic gates - Boolean algebra, laws & theorems

SUGGESTED READINGS

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

B.Tech Chemical Engineering **2018-2019**

Semester-II

18BTCE204 **Thermodynamics 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 Objective

1. To introduce basic concepts of thermodynamics and laws of thermodynamics.
2. To understand the principles and application of first and second law of thermodynamics.
3. This course aims to provide a good platform to mechanical engineering students to understand, model and appreciate concept of dynamics involved in thermal energy transformation.
4. To prepare them to carry out experimental investigation and analysis at later stages of graduation.
5. This course aims to provide a good platform to mechanical engineering students to understand, model.
6. To appreciate concept of dynamics involved in thermal energy transformation in power plants

Course Outcomes

On completion of the course the students are expected to

1. Understand the fundamental concepts of thermodynamics.
2. Apply mass and energy balances for open systems.
3. Evaluate the properties of non-ideal gases.
4. Solve problems involving liquefaction, refrigeration and different power cycles.
5. To apply the knowledge of mathematics, science and engineering fundamentals to the solution of mechanical power generation in thermal power plant using pure substance as working substance and low temperature applications.
6. To understand and hence to carryout gravimetric and volumetric analysis in order to find other thermodynamic properties of mixtures.

UNIT I - INTRODUCTION

Introduction- scope and Limitations of thermodynamics;Definitions and Fundamental Concepts; Dimensions and Units; Temperature, Pressure, Work, Energy, Force, Heat- Equilibrium state and the Phase Rule; Temperature and Zeroth Law of Thermodynamics; Heat Reservoirs and Heat Engines.

UNIT II - FIRST LAW AND OTHER BASIC CONCEPTS

Joule's experiment; Internal Energy; First Law; State functions; Equilibrium; Phase Rule, Reversible process; Constant P,V, T processes; Mass and Energy Balances for Open systems.

UNIT III - PVT BEHAVIOUR AND HEAT EFFECTS

PVT behavior; description of materials – Ideal gas law, van der Waals, virial and cubic equations of state; Reduced conditions & corresponding states theories; correlations in description of material properties and behavior- Heat effects-latent heat, sensible heat, standard heats of formation, reaction and combustion.

UNIT IV - SECOND LAW OF THERMODYNAMICS

Statements of the second law; Heat engines, Carnot's theorem; Thermodynamic Temperature Scales; Entropy; Entropy changes of an ideal gas; Mathematical statement of the second law; Entropy

balance for open systems; Calculation of ideal work; Lost work; Thermodynamic property of fluids, Maxwell relations; Two-phase systems; graphs and tables of thermodynamic properties.

UNIT V - APPLICATIONS OF THERMODYNAMICS

Flow processes; Refrigeration-Carnot cycle, Vapor-compression cycle, Absorption Refrigeration; Liquefaction processes; Steam-Power plant-Rankine cycle; Internal Combustion Engines-Otto cycle, Diesel cycle, Jet Engines.

SUGGESTED READINGS

1. M. Smith, H.C. Van Ness and M.M. Abbott ((2005)), Introduction to Chemical Engineering Thermodynamics, 7th edition, McGraw-Hill International Edition
2. Narayanan K.V, (2013), A Text Book of Chemical Engineering Thermodynamics, 2nd Edm Prentice Hall India
3. M J Moran, H N Shapiro, D DBoettner and M B Bailey(2015), Principles of Engineering Thermodynamics, 8th Edition, Wiley
4. Kyle, B.G.,(2006), Chemical and Process Thermodynamics III Edition, Prentice Hall India
5. Elliott J.R, Lira, C.T.(2012), Introductory chemical engineering thermodynamics, 2nd ed
6. Prentice Hall India(2012)
7. Pradeep Ahuja,(2009), Chemical Engineering Thermodynamics, PHI Learning Ltd
8. Gopinath Halder, (2009),Introduction to Chemical Engineering Thermodynamics, PHI Learning Ltd

B.Tech Chemical Engineering **2018-2019**

Semester-II

18BTCE205 **Programming for Problem Solving (Theory & Lab.)** **3H-5C**

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

End Semester Exam:3 Hours

Theory

Course Objectives

1. Identify and understand the working of key components of a computer program.
2. Identify and understand the various kinds of keywords and different data types of C programming
3. Understand, analyze and implement software development tools like algorithm,
4. Pseudo codes and programming structure
5. Study, analyze and understand logical structure of a computer program, and different construct to develop a program in "C" language
6. students to the field of programming using C language. The students will be able to enhance their analyzing and problem-solving skills and use the same for writing programs in C

Course Outcomes

The course will enable the students

1. To formulate simple algorithms for arithmetic and logical problems
2. To translate the algorithms to programs (in C language)
3. To test and execute the programs and correct syntax and logical errors
4. To implement conditional branching, iteration and recursion
5. To decompose a problem into functions and synthesize a complete program using divide and conquer approach
6. To use arrays, pointers and structures to formulate algorithms and programs

Unit I – Introduction to Programming, Arithmetic expressions and precedence

Introduction to Programming-Flowchart / pseudocode, compilation, Variables including data types, Arithmetic expressions and precedence.

Unit II – Conditional Branching and Loops

Conditional Branching – Loops Writingand evaluation of conditionals and consequent branching, Iteration and loops.

Unit III – Arrays and Basic Algorithms

Arrays1-D,2-D,CharacterarraysandStrings**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,(2017) Computing Fundamentals and C Programming, 5th Edition, TMH Education
2. E. Balaguruswamy (2017), Programming in ANSI C, 7th Edition, Tata McGraw-Hill,
3. Byron Gottfried (2017), Schaum's Outline of Programming with C, 3rd Edition, McGraw-Hill
4. Brian W. Kernighan and Dennis M. Ritchie,(2015) The C Programming Language, 2nd Edition, Prentice Hall of India

B.Tech Chemical Engineering

Semester-II

18BTCE211	**Chemistry Laboratory**	**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

1.To provide students with practical knowledge of quantitative analysis of materials by classical and instrumental methods for developing experimental skills in building technical competence.

2.The student will understand the importance of the Periodic Table of the Elements, how it came to be, and its role in organizing chemical information.

3.The student will understand the interdisciplinary nature of chemistry and to integrate knowledge of mathematics, physics and other disciplines to a wide variety of chemical problems.

4.The student will learn the laboratory skills needed to design, safely conduct and interpret chemical research.

5.The student will acquire a foundation of chemistry of sufficient breadth and depth to enable them to understand and critically interpret the primary chemical literature.

6.The student will develop the ability to effectively communicate scientific information and research results in written and oral formats

Course Outcomes:

1. List steps for identifying simple organic compounds
2. Use different analytical instruments
3. Identify reaction rate parameters
4. Analyze the need, design and perform a set of experiments.
5. Identify the structure of unknown/new compounds with the help of spectroscopy.
6. Differentiate hard and soft water, solve the related numerical problems on water purification and its significance in industry and daily life.

About 10 experiments to illustrate the concepts learnt in Chemistry-I, Chemistry-II (No. of lab.Hours 3 per experiment).

Suitable number of experiments from the following categories:

1. Identification of an organic compounds through group detection, physical constants (m.p and b.p)
2. Synthesis of organic compounds involving reactions such as hydrogenation, oxidation, esterification, etc.
3. Use of analytical instruments for characterization and identification of compounds
4. Measurements of kinetics of simple reactions

Semester-III

18BTCE301 HEAT POWER ENGINEERING 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

1. To apply the thermodynamic concepts into various thermal application like IC engines, Steam Turbines, Compressors and Refrigeration and Air conditioning systems
2. Describe sources of energy and types of power plants.
3. Analyze different types of steam cycles and estimate efficiencies in a steam power plant.
4. Define the performance characteristics and components of such power plants
5. Describe different types of fuels used in power plants and estimate their heating values
6. To integrate the concepts, laws and methodologies from the first course inthermodynamics into analysis of cyclic processes

Course Outcomes

On Completion of the course students will be able to

1. Determine the efficiency and output of a modern Rankine cycle steam power plant from given data, including superheat, reheat, regeneration, and irreversibility's
2. Calculate the heat rate, fan power consumption, flame temperature and combustion air requirements of conventional steam generators (boilers)
3. Calculate the performance of gas turbines with reheat and regeneration, and discuss the performance of combined cycle power plants
4. Calculate the performance of I.C Engine with different efficiency and discuss the all other performance parameters of I.C Engine
5. Analyse performance of various refrigeration cycles and air conditioning systems
6. Describe construction, working of various types of reciprocating and rotary Compressors with performance calculations of positive displacement compressor

UNIT I GAS POWER CYCLES AND IC ENGINE 9

Otto, Diesel, Dual, Brayton cycles – Calculation of mean effective pressure and air standard efficiency – actual and theoretical PV and TS diagrams of two stroke and four stroke engines–valve timing diagram and port timing diagram – calculation of engine performance, heat balance sheet, retardation – Morse test.

UNIT II BOILER AND STEAM POWER CYCLES 9

Generation of steam, Boiler–Classification, fire tube boiler, water tube boiler, comparison, boiler mountings and accessories, performance of steam boilers – dryness fraction, properties of steam, T– S diagram, Mollier diagram, steam tables, Rankine Cycle – incomplete evaporation – superheated steam –modified cycle.

UNIT III STEAM NOZZLES AND STEAM TURBINES 9

Steam nozzles – flow through steam nozzles, effect of friction, critical pressure ratio, and super saturated flow

– Steam turbines impulse and reaction turbine, compounding, velocity diagram, condition for maximum efficiency – multi stage turbines - governing of turbines.

UNIT IV AIR COMPRESSORS **9**

Classifications of compressors – Reciprocating air compressor – performance characteristics, effect of clearance volume, free air delivery and displacement, intercooler, after cooler – Rotary compressor – vane type, centrifugal and axial, flow performance characteristics.

UNIT VREFRIGERATION AND AIR CONDITIONING **9**

Fundamentals of refrigeration – COP – Vapour compression refrigeration system – cycle, p–h chart, Vapour absorption system – comparison, properties of refrigerants. Fundamentals of air conditioning system, cycle, controls, air handling and distribution, simple cooling and heat load estimation

TOTAL 45 PERIODS

(Permitted to use standard thermodynamic table, Mollier diagram, Psychometric chart and Refrigeration property table in the examination

SUGGESTED READINGS

1. Rajput.R.K ,Thermal Engineering,SisthEdition,LaxmiPublications,New Delhi,2010
2. Arora.C.P,Refrigeration and Air Conditioning,Tata McGraw – Hill , New Delhi,2010
3. Kothandaraman.C.P and Domkundwar A.V, A Course in thermal engineering ,Fifth Edition,Dhanpat Raj and sons,Delhi,2006
4. Ganesan.V ,Internal combustion Engines, Tata McGraw – Hill , New Delhi,2008
5. Yunus A Cengel, Thermodynamics an Engineering approach, Tata McGraw – Hill , New Delhi,2010

B.Tech Chemical Engineering **2018-2019**

Semester-III

18BTCE302 **FLUID MECHANICS** **3H-4C**

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

End Semester Exam:3 Hours

Course Objectives:

1. The objective of this course is to introduce the mechanics of fluids (fluid statics and fluid dynamics), relevant to Chemical Engineering operations.
2. The course will introduce students to forces on fluids, hydrostatic forces on submerged bodies, Eulerian and Lagrangian descriptions of flow, flow visualization, integral analysis involving mass and momentum balances, Bernoulli equation, flow through pipes and ducts, flow measurement and instruments, flow transportation - pumps, blowers and compressors, conservation of mass, linear and angular momentum in differential form, Navier-Stokes equation.
3. To introduce and explain fundamentals of Fluid Mechanics, which is used in the applications of Aerodynamics, Hydraulics, Marine Engineering, Gas dynamics etc.
4. To give fundamental knowledge of fluid, its properties and behavior under various conditions of internal and external flows.
5. To develop understanding about hydrostatic law, principle of buoyancy and stability of a floating body and application of mass, momentum and energy equation in fluid flow.
6. To imbibe basic laws and equations used for analysis of static and dynamic fluids

Course Outcome

1. Ability to apply the basic concepts of fluid mechanics and to solve dimensional analysis problems.
2. Ability to solve problems related to mass, momentum and energy balances in fluid flow.
3. Ability to demonstrate the applications of flow statics, fluid flow phenomena.
4. Ability to design fluid flow reactors and solve problems on fluid flow measurements.
5. Ability to estimate the pump efficiency, head developed and pressure drop.
6. State the Newton's law of viscosity and Explain the mechanics of fluids at rest and in motion by observing the fluid phenomena.

UNIT – IBASIC CONCEPTS (12)

Definition of a fluid – Shear stress in a moving fluid – difference between liquids and gases – Compressible and incompressible fluids – Newtonian and non Newtonian fluids - continuum concept of a fluid - properties of fluids - viscosity - compressibility - bulk modulus. Dimensional analysis and its applications in fluid flow. Statics of fluid systems-pressure - variation of pressure vertically in a fluid under gravity -General equation for the variation of pressure due to gravity in a static fluid - manometers: U-tube, differential and inclined manometers.

UNIT – II FLUID DYNAMICS (12)

Fluid flow - basic concepts - Reynolds experiment - laminar and turbulent flows - nature of turbulence.Basic concepts of Boundary layer.Equation of continuity and its applications - momentum equations - Euler's equation of motion -Bernoulli's theorem and its applications

UNIT – III INCOMPRESSIBLE FLUID FLOW (12)

Flow in conduits -Shear stress distribution in a cylindrical tube -Friction factor-Fanning's equation -Applications -Laminar flow in pipes -Hagen Poiseuille equation -Velocity distribution for laminar and turbulent flows -Losses due to sudden expansion and sudden contraction -Losses in pipe fittings.

UNIT – IV FLUIDISED AND PACKED BEDS (12)

Flow through packed beds - Ergun equation and Kozeny - Carman equation. Equation

for one dimensional motion - Fluidisation- Mechanism of fluidisation - Types of fluidization- Pressure drop in fluidized beds - Minimum fluidisation velocity.

UNIT – V HYDRAULIC PUMPS AND PIPE FITTINGS (12)

Pipes, Fittings and valves - Pumps, Fans, Compressors and Blowers - Positive displacement pumps - Centrifugal pumps - NPSH and cavitation - Pump calculations - Constant and variable head flow meters.

TOTAL: 60

SUGGESTED READINGS

1. McCabe. W.L.,Smith. J C., Harriot. P.,Unit operations of Chemical Engineering, McGraw Hill, Seventh Edition, 2014
2. Douglas.J.F.,Gasiorek. J.M., Swaffielf. J.A., FLUID MECHANICS, Sixth Edition, 2011.
3. Hughes. F., John A Brighton and Nicholas Winowich, Schaum's Outline of Fluid Dynamics, Third Edition 2009.
4. Ranald.V.Giles, Cheng Liu and Jack Evett, Schaum's outline of Fluid Mechanics and Hydraulics, Fourth Edition 2010.
5. Sulzer Pumps Ltd, Centrifugal pump Handbook, Third edition, Winterthur, Switzerland, 2010

Semester-III

18BTCE303 CHEMICAL PROCESS CALCULATIONS 3H-4C

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

End Semester Exam:3 Hours

Course Objective

The anticipated knowledge, skills and/or attitude to be developed by the student are:

1. Perform basic engineering calculations
2. Perform mass balance calculations on existing processes (involving single and multiple units).
3. Use basic, applied chemistry/ thermodynamics in material balance calculations.
4. The measurement of gaseous mixtures, solution and gas-liquid mixtures compositions of will be understood and applied in the process calculation of the chemical industry.
5. 3The physical properties and their behavior with the process conditions will be understood and their application in the process calculations will be learned.
6. To understand and apply the basics of calculations related to material and energy flow in the processes

Course Outcome

After completion of the course, students are able to

1. .Apply the principles of dimensional homogeneity to convert one form of unit to other equivalent forms in CGS, FPS. MKS and SI unit systems and apply fundamental gas laws to solve ideal gas problems.
2. Calculate the composition of a mixture in terms of mole fractions from a given composition expressed in terms of mass fractions or vice versa.
3. Compute the concentration, degree of saturation and dew point of vapor -gas mixture at the given temperature and pressure using humidity chart.
4. Formulate steady state material balance for the unit operations such as distillation, evaporation, mixing, extraction, drying and crystallization processes with recycle, by-pass and purge.
5. Practice the combined steady state material and Energy balance for simple processes like distillation, evaporation and combustion.
6. Students will be able to define, calculate, and estimate fluid density, flow rate, chemical composition variables (mass and mole fractions, concentrations), fluid pressure, and temperature.

UNIT – I MASS RELATIONS AND IDEAL GASES (12)

Units and dimensions: Basic and derived units - Different ways of expressing units and quantities, Conversion of units. Properties of pure substances - Ideal gas laws. Mole fractions and partial pressures - Application of Dalton's and Amagat's law.

UNIT – II HUMIDITY AND SATURATION (12)

Definition of dry, wet bulb temperature - relative and percentage saturation, Dew point - humid heat, adiabatic saturation curve - Humidity Charts. Solubility and Crystallization - Recovery of crystals from solutions by crystallization - Calculations based on material balance. Henry's laws.Concept of Vapour pressure, Raoult's law and its applications, vapour pressure plots and effect of temperature on vapour pressure.

UNIT – III MATERIAL BALANCE WITH CHEMICAL REACTIONS **(12)**

Concept oflimiting and excess reactants, Concepts oftieelements, recycle, by-pass and purge.Batch,stagewise and continuous operations.

UNIT – IV MATERIAL BALANCE WITHOUT CHEMICAL REACTIONS **(12)**

Material balance in systems without chemical reactions, Material balance in systems with Recycle, Byepass and Purge.

UNIT – V ENERGY BALANCE **(12)**

Definition of Heat capacity and Specific heat, Heat capacity of gases as a function of temperature, Mean heat capacity, heat capacity of mixture of gases. Heat capacities of solids and liquids - Kopp's rule and Trouton's rule. Standard heat of reaction, formation and combustion, Hess's law of heat summation and its application to determine heat of reaction, heat of neutralization, integral heat of solution, heat of mixing. Effect of pressure and temperature on heat of reaction.Theoretical and actual flame temperature in combustion calculations.

TOTAL : 60

SUGGESTED READINGS

1. Bhatt, B.I. and Vora, S.M., Stoichiometry, Fourth Edition, Tata-McGraw Hill, New Delhi, 2004.
2. Narayanan. K.V. and Lakshmikutty.B., Stoichiometry and Process Calculations, First Edition, Prentice-Hall of India, New Delhi, 2006.
3. David M. Himmelblau, Basic Principles and Calculations in Chemical Engineering, Eighth Edition, Prentice -Hall of India, New Delhi, 2012.
4. Hougen, O.A., Watson, R.M. and Ragatz, R.A., Chemical Process Principles - Part I, Second Edition, John Wiley (ISE), 1976.

Semester-III

18BTCE304 MECHANICAL OPERATIONS 3H-4C

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

End Semester Exam:3 Hours

Course Objective

1. To impart the basic concepts of mechanical operations
2. To develop an understanding of size analysis, size reduction, and solid handling
3. Understand mechanical separation methods such as filtration, sedimentation, transportation of solids etc and associated equipment used for achieving these methods
4. The students are exposed to basic theory, calculations, and machineryinvolved in various solid handling operations
5. Identify the important physical mechanisms occurring in processes involving particles
6. Discuss unit operation and its role in Chemical industries, characteristics of particulate solids, Principles of size reduction, particle dynamics and separation of particles• formulate and solve mathematical descriptions of such processes

COURSE OUTCOMES

1. Calculate the Particle size, shape and surface area by both differential, cumulative analysis and compute the power requirement for particle size reduction screen effectiveness by sieve analysis.
2. Compute the pressure due to storage of particles and formulate the method of transportation and fine particle recovery.
3. Estimate the power required by mixers using power number and Reynolds number
4. Determine the terminal settling velocity, settling time and calculate the thickener area
5. Calculate the pressure drop in filters, filter medium resistance and cake resistance
6. Classify and suggest different type of separation processes required for the feed material.

UNIT – I PROPERTIES OF PARTICULATE SOLID AND SIZE REDUCTION (12)

Forces employed for size reduction of solids. Types of crushers, grinders and disintegrators for coarse, intermediate, fine and ultrafine grinding. Cutting machines. Size reduction operation - Power requirements - Laws of comminution. Open and closed circuit grinding. Industrial applications of size reduction equipments. Shape factor of particulate solids. Standard sieves and sieve scales. Differential and cumulative analysis - Plotting of sieve analysis data. Specific surface area determination - Calculation of particle size from sieve analysis data. Industrial screening equipments. Screen effectiveness.

UNIT – II TRANSPORTATION, STORAGE AND RECOVERY OF FINE PARTICLE (12)

Mechanical and pneumatic conveying equipments.Storage of solids - Angle of repose and angle of internal friction.Pressures in bins - Janssen equation. Gas cleaning methods - Cyclone separators, Bag filters, Scrubbers and electrostatic precipitators. Dense Media Separation (DMS), Flotation process -Separation by Magnetic and Impingement methods.

UNIT – III MIXING AND AGITATION (12)

Types of Mixers and mixing equipments for liquids, pastes, rubber and plastic materials and for dry powders.Power consumption in mixers.Criteria for mixing of Solids - Mixing Index - Scale up of agitator design.

UNIT – IV SIZE SEPARATION BY SETTLING ANDSEDIMENTATIONMETHODS (12)

Drag on spherical and non-spherical particles, Terminal settling velocity under laminar and turbulent conditions (Stokes' law and Newton's law). Size separation by settling methods - Free settling and Hindered settling. Equipments - Settling chambers, classifiers, jigging and Tabling. Theory of Sedimentation. Types of Thickeners – Batch and Continuous. Applications of batch sedimentation tests for design of continuous thickeners.

UNIT – V FILTRATION AND CENTRIFUGAL SEPARATION (12)

Batch and continuous filtration equipments.Theories of filtration and washing.Compressibility of filter cakes. Filter media and Filter aids. Industrial filtration practice.Centrifugal filtration, Centrifugal settling, Centrifugal sedimentation and centrifugal clarification.

TOTAL : 60

SUGGESTED READINGS

1. McCabe. W.L., Smith. J. C., Harriot. P.,Unit Operations of Chemical Engineering, Seventh Edition, McGraw-Hill, New York, 1905.
2. Badger. W.L., Banchero. J.T., Introduction to Chemical Engineering, McGraw Hill (ISE), 1997.
3. Perry. R. H., Green. D. W., Perry's Chemical Engineer's Handbook, Eighth Edition, McGraw- Hill, New York, 1907.
4. Narayanan. C.M., Bhattacharyya. B.C., Mechanical Operation for Chemical Engineers (Incorporating Computer Aided Analysis), Khanna Publisher, Third Edition, 1905

Semester-III

18BTCE305	**THERMODYNAMICS -II**	**3H-4C**

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

End Semester Exam:3 Hours

Course Objectives

1. To introduce the concepts of fugacity, activity coefficient, vapour-liquid equilibrium and reaction equilibrium. Introduction to molecular thermodynamics.
2. Purpose of this course is that students gain the knowledge and ability to apply 1st and 2nd laws of thermodynamics to power, refrigeration and air conditioning cycles, and chemical reactions
3. To develop the student's ability to apply the principles of thermodynamics to the optimal design of the basic energy conversion systems: power generation, refrigeration, air-conditioning, and combustion
4. To develop the student's ability to use thermodynamic relations and the property tables and charts for the analysis of energy conversion systems in the course of their operation.
5. To develop the student's ability to apply the first and the second laws of thermodynamics to the optimization of the basic energy conversion systems.
6. To provide the students with some knowledge and analysis skills associated with the principles of operation and applications of the main energy conversion systems

Course outcomes

Students will able to

1. Ability to apply fundamental concepts of thermodynamics to engineering applications.
2. Ability of application of thermodynamics to phase equilibria and reaction equilibria.
3. Applies thermodynamics to conversion devices.
4. Applied to design the chemical engineering equipments in processes.
5. Capability to determine thermodynamic efficiency of various energy related processes.
6. Ability to estimate thermodynamic properties of substances in gas and liquid states

UNIT -I: REVIEW OF BASICS **(12)**

Review of first and second law of thermodynamics **-**Vapor-liquid equilibrium -phase rule - simple models for VLE -VLE by modified Raoult's law -VLE from K-value correlations -Flash calculations.

UNIT- II: SOLUTION THERMODYNAMICS **(12)**

Fundamental property relationships- free energy and chemical potential -partial properties- definition of fugacity and fugacity coefficient of pure species and species in solution- the ideal solution and excess properties.

UNIT – III : PROPERTIES OF SOLUTIONS **(12)**

Liquid phase properties from VLE, Models for excess Gibbs energy, heat effects and property change on mixing **,**UNIFAC and UNIQUAC models.

UNIT – IV : LIQUID-LIQUID EQUILIBRIA (12)

Vapor-Liquid-Liquid Equilibria; Solid-Liquid Equilibria; Solid-Gas Equilibria. Chemical reaction equilibria: equilibrium criterion, equilibrium constant, evaluation of equilibrium constant at different temperatures, equilibrium conversion of single reactions, multireaction equilibria.

UNIT – V: MOLECULAR THERMODYNAMICS (12)

Introduction to molecular/statistical thermodynamics

Total: **60 Hours**

SUGGESTED READINGS

1. J.M. Smith, H.C. Van Ness and M.M. Abbott, "Introduction to Chemical Engineering Thermodynamics", 7th edition, McGraw-Hill International Edition, 2005

2. S.Sandler, "Chemical, Biochemical and Engineering Thermodynamics", 4th edition, Wiley, India.

3. Y.V.C.Rao, "Chemical Engineering Thermodynamics", University Press, Hyderabad, 1997.

SEMESTER - III

18BTCE311 **ENGINEERING WORKSHOP** **4H-3C**

Instruction Hours/week: L:1 T:0 P:3 **Marks:** Internal**:40** External**:60** Total**:100**
End Semester Exam:3 Hours

Course Objective

1. To provide exposure to the students with hands on experience on various basic engineering practices in civil, Mechanical, Electrical and Electronics Engineering
2. The Engineering Workshop Practice for engineers is a training lab course spread over entire semester.
3. The modules include training on different trades like Fitting, Carpentry, Black smithy etc… which makes the students to learn how various joints are made using wood and other metal pieces.
4. To study the basics of workshop engineering practice
5. To identify the hand tools and instruments and acquire measuring skills.
6. To acquire practical skills by performing the experiments in different shops of workshop

Course Outcomes:

1 To provides the knowledge of core technical subjects for making and working of any type of project.

2 Students will be able to analyze the material on the basis of their properties and thus assigning different weight age to their use for technical purposes.

3 Understand modern manufacturing operations, including their capabilities, limitations, and how to design economically.

4 Gain insight into how designers influence manufacturing schedule and cost, and cost of different components.

5 Learn how to analyze products and be able to improve their manufacturability and make the cost effectively.

6 The students will be able to assess the working conditions of any machining process and thus calculating the actual forces involved

PART – A (CIVIL & MECHANICAL)

1. WELDING **6**
   i. Preparation of arc welding of butt joints, lap joints and tee joints.

2. BASIC MACHINING **6**
   i. Simple Turning and Taper turning
   ii. Drilling and Tapping

3. SHEET METAL WORK **6**
   i. Model making – Trays, funnels, etc.

4. DEMONSTRATION ON **4**
   i. Smithy operations
   ii. Foundry operations
   iii. Plumbing Works
   iv. Carpentary Works

PART –B (ELECTRICAL & ELECTRONICS)

5. ELECTRICAL ENGINEERING **10**

i. Study of electrical symbols and electrical equipments.
ii. Construct the wiring diagram for Stair case wiring and Fluorescent lamp wiring.
iii. Construct the wiring diagram for Residential house wiring using switches, fuse, indicator, lamp and energy meter.
iv. Measurement of electrical quantities – voltage, current, power & power factor in R load.
v. Measurement of energy using single phase energy meter.

6. ELECTRONICS ENGINEERING **13**

i. Study of Electronic components– Resistor (color coding), capacitors and inductors.
ii. Soldering practice – Components Devices and Circuits – Using general purpose PCB.
iii. Study of logic gates AND, OR, NOT, NOR and NAND.
iv. Study of HWR and FWR.

TOTAL **45**

\\

Semester-IV

18BTCE401 HEAT TRANSFER 3H-4C

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

End Semester Exam:3 Hours

Course Objectives

1 Basic Concepts of Heat Transfer
2 Design and Rating of Heat exchangers with and Without Phase Change
3 Design and Rating of Compact Heat Exchangers
4 Basic Principles of Heat Transfer
5 Fourier Law and First thermodynamic law o Heat transfer with conduction, convection and radiation.
6 Analytical solutions of Heat transfer problems ,Numerical solutions of Heat Transfer problems and Steady state and transient problems of Heat Transfer

Course Outcome

1 Understands the concepts of heat transfer.
2 Understands mechanisms of conduction, convection and radiation.
3 Able to understand heat transfer in parallel & counter current flow.
4 Analyzes the performance of heat exchange equipments& evaporators.
5 Able to understand effect of heat transfer in boiling and evaporators.
6 To study components subjected to thermal loading**.**

UNIT – I CONDUCTION(12) Importance of heat transfer in Chemical Engineering operations - Modes of heat

transfer - Fourier's law of heat conduction - one dimensional steady state heat conduction equation for flat plate, hollow cylinder, - Heat conduction through a series of resistances- effect of temperature on thermal conductivity; Combined Conduction- Convection Heat transfer, Critical radius of insulation, Heat transfer in extended surfaces

UNIT –II CONVECTION (12)

Concepts of heat transfer by convection - Natural and forced convection, Dimensional analysis in heat transfer, Correlations for the calculation of heat transfer coefficients, heat transfer coefficient for flow through a pipe, flow through a non circular conduit, Concepts of thermal boundary layer, Von karmaan Integral & energy Equation for flow past flat plate, Heat transfer by natural convection.

UNIT –III HEAT EXCHANGERS (12)

Parallel and counter flow heat exchangers - Log mean temperature difference - Single pass and multipass heat exchangers; plate heat exchangers; use of correction factor charts; heat exchangers effectiveness; number of transfer unit - Chart for different configurations - Fouling factors - Design of various types of heat exchangers and condensers.

UNIT – IV CONDENSATION AND BOILING (12)

Heat transfer to fluids with phase change - heat transfer from condensing vapours, drop wise and film wise condensation, Nusselt equation for vertical and horizontal tubes, condensation of superheated vapours, effect of non-condensable gases on rate of condensation. Heat transfer to boiling liquids - mechanism of boiling, nucleate boiling and film boiling.

UNIT – V EVAPORATION AND RADIATION (12)

Theory of evaporation - single effect and multiple effect evaporation - Types of Evaporators -Design calculation for single and multiple effect evaporation. Radiation heat transfer - Emissive power, Black body radiation, Emissivity, Stefen - Boltzman law, Planck's law, radiation between surfaces.

SUGGESTED READINGS

1. Binay K. Dutta., Heat Transfer: Principles and Applications, Fifth Printing, Prentice Hall of India Private Limited, 2006.
2. Holman, J. P., Heat Transfer, Eighth Edition, McGraw Hill, 1997.
3. McCabe W.L.,Smith J.C., Harriott. P.,Unit Operations of Chemical Engineering, Seventh Edition, McGraw Hill International Student Edition, 2005.
4. Kern, D.Q., Process Heat Transfer, McGraw-Hill, 1899.Coulson, J.M. and Richardson, J.F., Chemical Engineering, Vol-1, Fourth Edition, Asian Books Private Limited, India, 1998

Semester-IV

18BTCE402 **MASS TRANSFER - 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 Objective

1 The purpose of this course is to introduce the undergraduate students with the most important separation equipments in the process industry, and provide proper understanding of unit operations.
2 To learn basic knowledge of mass transfer operation and its application.
3 To learn basic knowledge of mass transfer equipments.
4 To design mass transfer equipments.
5 To understand the basic concepts of mass transfer.
6 this module is to bring in the concept of mass transfer, which is mass in transit as a result of species concentration difference in a mixture

Course Outcome

1 Students will able to learn about the diffusional mass transfer
2 Students will able to understand interphase and different analogies of mass transfer
3 Student will be able to understand the mechanism of crystallization and absorption.
4 Student will be able to understand operation of drying
5 Design and operation of the equipments can be understood.
6 To study recent developments in mass transfer operation.

UNIT – I DIFFUSION IN FLUIDS (12)

Molecular diffusion and eddy diffusion. Steady state molecular diffusion in fluids at rest and in laminar flow. Molecular diffusion in gases, steady state diffusion of gas A through non- diffusing gas B, steady state equivocal counter diffusion. Effective diffusivity, steady state diffusion in multicomponent mixtures. Measurement of diffusivity Molecular diffusion in liquids.

UNIT – II INTERPHASE MASS TRANSFER **(12)**

Mass transfer coefficients, F and K type mass transfer coefficients, Relation between mass transfer coefficients, Film theory, Penetration theory, Danckwerts surface renewal theory. Two film theory. Wetted wall towers.Equilibrium stage modelling: equilibrium curve and operating line .Analogy between momentum, heat and mass transfer.

UNIT – III ABSORPTION (12)

Equilibrium solubility of gases in liquids.Choice of solvents for absorption.Single component absorption.Operating and equilibrium lines for absorber and stripper.Minimum liquid - gas ratio for absorption. Countercurrent multistage operation, one component transferred continuous contact equipment, absorption of one component in packed tower, overall coefficients, Concept of NTU and HTU - graphical, analytical methods and overall height of transfer units. Hydrodynamic consideration. Tower packings and packed tower.

UNIT – IV DISTILLATION **(12)**

Vapour - Liquid - Equilibrium (VLE). Ideal solutions and Raoult's law, non-ideal solutions and Henry's law, relative volatility, azeotropes - minimum and maximum boiling. Flash distillation, differential distillation - Rayleigh's equation, steam distillation.

UNIT – V EQUIPMENT FOR CONTINUOUS DISTILLATION **(12)**

Plate columns, packed columns.Determination of number of theoretical plates using McCabe - Thiele and Ponchon - Savaritmethods.Location of feed plate. Reflux ratio - minimum reflux, optimum reflux, total reflux. Plate efficiency - overall and Murphree efficiencies. Azeotropic and extractive distillations.

TOTAL : 60

SUGGESTED READINGS

1. McCabe W.L., Smith J.C., HarriottP.,Unit Operations of Chemical Engineering, Seventh Edition, McGraw Hill International Student Edition, 2005.
2. Treybal R.E., Mass Transfer Operations, Third Edition, McGraw Hill International Student Edition, 1980.
3. Geankoplis C. J., Transport Processes and Unit Operations, Third Edition, Prentice Hall of India Private Limited, New Delhi, 2003.
4. E.L. Cussler, Mass transfer in fluid systems, 2nd edition, Cambridge university press, 1984
5. Binay K Dutta, Principles of Mass Transfer and Separation Processes, PHI learning Private Limited, New Delhi, 2009.

Semester-IV

18BTCE403 CHEMICAL PROCESS INDUSTRIES 3H-4C

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

End Semester Exam:3 Hours

Course Objective

1. To Study process technologies of various organic and inorganic process industries
2. Introduce the basic information and the systematic diagrams of Unit operations involved in chemical industries.
3. Familiarize the concepts of design, operation details and schematic of industrial equipment.
4. Ascertain the right separation technology for easy separation of chemical components
5. fundamental knowledge of all Unit operation and Unit Process required for synthesis of production process. It covers production process of various industries likeIndustrial gases, Industrial carbon, Marine Chemicals, Nuclear Industries, Chlor – alkali industries, Electrolytic and Electrochemical Industries, Fertilizers, Glass – Chemistry
6. the students of Chemical Engg for industrial point of view production processes

Course Outcome

After completion of the course, students are able to

1. Identifies the contemporary technologies in water treatment and label the process economics in salt and sulphur based industries.
2. Desing the production methodology of oil industries and analyse the efficiency of the products.
3. Analyze and formulate the chemical processes and economics involved in the carbohydrate industries.
4. Describe the flow sheets of manufacture process of pulp based, leather industries and engineering problems faced in the industries.
5. Evaluate the surface coating & cement industry processes to justify their appropriate production techniques and their handling processes.
6. Students to get knowledge on metallurgy learn the topics “The Fuel and Industrial Gases”enabled

UNIT – I NITROGEN, PHOSPHOROUS AND SULPHUR BASED INDUSTRIES (9)

Nitrogen, Ammonium nitrate, Ammonium sulphate and Urea. Phosphorus, Phosphoric acid, Ammonium phosphates, Sodium phosphates, Nitrophosphate& Phosphate esters. Mixed fertilizers (NPK Mixtures). Manufacture of Sulphur and Sulphuric acid. Materials for handling, storage and transportation.

UNIT – II OIL AND ALLIED INDUSTRIES (9)

Vegetable oil extraction methods.Refining of vegetable oils.Hydrogenation of Oils.Soaps and Candle.Detergents and Glycerine.Materials for handling, storage and transportation.

UNIT – III CARBOHYDRATES AND FERMENTATION INDUSTRIES (9)

Manufacture of Starch, Dextrin, Glucose and sucrose and manufacture of Ethyl alcohol,Acetic acid, Citric acid, Oxalic acid and Antibiotics (Penicillin). Materials for handling, storage andtransportation

UNIT – IV PULP AND LEATHER INDUSTRIES (9)

Production of Pulp. Conversion to paper. Production of Viscose, Acetate and

Cuprammoniumrayons and Cellulose acetate.Production of Dimethyl sulphite and Dimethyl sulphoxide from wood liquor. Manufacture of leather from hides and skins. Manufacture of Glue and Gelatin.Materials for handling, storage and transportation.

UNIT – V SURFACE COATING, CEMENT AND GLASS INDUSTRIES (9)

Constituents of paints & varnishes and their functions. Paint mixing process. Manufacture of pigments such as White lead, Zinc oxide and Titanium dioxide. Cements: Introduction, types of cements, properties and applications. Manufacture of Portland cement. Beneficiation & Production of Hydrated lime. Raw materials for Glass Industries.Production of glass by tank furnace - shaping and forming of articles from glass.

TOTAL :45

SUGGESTED READINGS

1. Gopala Rao, M. & Marshall Sittig.: Dryden's Outlines of Chemical Technology, (3rd Ed.), Affiliated East-West Press, New Delhi, (2004).
2. Austin, G.T.: Shreve's Chemical Process Industries, (5th Ed.), McGraw Hill (ISE), (1984).
3. Shukla, S.D. Pandey, G.N.: A Text Book of Chemical Technology, Vol. I, Vikas, New Delhi, (2009).
4. Venkateswaralu, D., Upadrashta, K.R. & Chandrasekaran, K.D. (Editors): CHEMTECH - I, S. Chand & Co., New Delhi, (2010).
5. Kent, A.J. : Riegel's Handbook of Industrial Chemistry, Van Nostrand - Reinhold, New York, ninth Edition (1974).
6. Stephenson, R.M. : Introduction to Chemical Process Industries, Van Nostrand, New Jersy,

SEMESTER -IV

18BTCE404 MATERIAL 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 Objective

1 To impart knowledge on the structure, properties, treatment, testing and applications of metals and non-metallic materials so as to identify and select suitable materials for various engineering applications.
2 Selecting their career in core and emerging areas of Materials Engineering and allied industries.
3 Make them achieve timely progress towards higher degree in Materials, Engineering and related fields.
4 To solve challenging industrial problems and serve effectively in globally competitive industrial environments with leadership skills.
5 To describe the different types of bonding in solids, and the physical ramifications of these differences.
6 To describe and demonstrate diffraction, including interpretation of basic x-ray data. Give an introduction to metals, ceramics, polymers, and electronic materials in the context of a molecular level understanding of bonding.

Course Outcomes

On completion of the course the students will be able to

1 Comprehend the criterion for selection of materials for chemical process industries.
2 Outline the properties and applications of smart materials and nano and bio materials
3 Apply the knowledge about various materials used in chemical process industries
4 Select materials for high temperature and Sour service and gain knowledge of modern engineering materials.
5 Be able to qualitatively derive a material's Young's modulus from a potential energy curve
6 Be able to describe a polymer's elastic behavior above and below the glass transition.

UNIT I NATURE OF MATERIALS 9

Selection process of engineering materials (General aspects), Chemical and physical properties of materials, chemical structure, Micro and macrostructure, corrosion resistance, chemical Reactivity. Mechanical properties, stress, strain, strength, hardness, malleability, ductility, elasticity,plasticity, toughness, thermal stability. Types of deformation: Plastic, viscous; plastic deformation of single crystal, poly crystalline metals, slip, twinning, dislocations, viscoelasticity, creeps in metals,amorphous materials.

UNIT II METALLURGY 9

Extractive Metallurgy: Hydro, pyro and electro metallurgy, refining of metals. Powder Metallurgy:methods of production of metal powder, mixing of metal powders, compaction of powders -applications. Extraction process of Iron: manufacture of pig iron, blast furnace operations, chemistry of reactions. Manufacture of cast iron, varieties of cast iron, effect of impurities.

Production of steel ,Bessemerprocess,open-hearth process ,L D methods. Classification of steel, effect of impurities.Heattreatment process: annealing, hardening, tempering, normalizing and gas carburizing. Fe-Carbon phase diagram.

UNIT III COMPOSITES AND ADHESIVES **9**

Polymer composites: Introduction, Types of composites, particle reinforced, fiber reinforced, structural composites, examples. Matrix materials, reinforcement materials-, Kevlar, Polyamides,Fibers, glass, carbon fibers, ceramics and metals. Technical applications.

UNIT IVBIOMATERIALS **9**

Classification of bio-materials (based on tissue response) ,Comparison of properties of some common biomaterials , Metallic implant materials (stainless steel, cobalt- based and titanium-based alloys) , Polymeric implant materials (Polyamides, polypropylene, Acrylic resins and Hydro gels) ,Tissue replacement implants , Soft and hard tissue replacements ,Skin implants, Tissue engineering, Biomaterials for organ replacement (Bone substitutes), Biosensor.

UNIT V MODERN ENGINEERING MATERIALS **9**

Smart materials , Shape memory alloys, Electrostatics, Irreversible Marten sites, Domain Walls, Nature of Shape Memory, Shape Memory Alloy Materials, Ferromagnetic Shape Memory Alloys, Relation to Shape Memory Alloys, Actuator and Sensor Materials Chromic materials (Thermo, Photo and Electro) ,Rheological fluids , Metallic glasses.

TOTAL:45

SUGGESTED READINGS

1. Thiruvadigal .J.D , Ponnusamy, Sudha.D and Krishnamohan.M ,Materials Sciences , II Edition ,Vibrant Publication,Chennai,2013
2. Rajendran.V, Materials Science, III Edition, Tata McGraw hill, New Delhi, 2011
3. Khanna.O.P, A textbook of material science and metallurgy, IV Edition, Danpat raj Publications, 1999
4. Rajput.R.K, a Textbook of Material Science and Engineering, III Edition, S.K.Kataria&Sons, Delhi, 2003
5. Agarwal.C.V, Chemistry of Engineering materials, IV Edition, Tata McCraw Hill, 1997
6. William F.Smith, Foundation of materials science and Engineering , II Edition ,Tata McCraw Hill,1998

Semester-IV

18BTCE405 Engineering Economics and Financial 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

1. At the end of this course the student will be able to analyse the financial management, stock exchanges.
2. To enable students to understand and interpret the basic financial statements, to comprehend the basics in managing finance and to know pricing mechanism
3. Acquire knowledge of economics to facilitate the process of economic decision making
4. Acquire knowledge on basic financial management aspects
5. Develop the skills to analyze financial statements
6. Acquire knowledge of economics to facilitate the process of economic decision making

Course Outcomes

1. To know the fundamentals of cost analysis and economics.
2. To learn about the basics of economics and cost analysis related to engineering so as to take economically sound decisions.
3. To make the students to understand capital market, break-even point analysis and depreciation
4. Understand the principles of Engineering Economics.
5. Able to prepare and interpret financial statements.perform Profit analysis.
6. Able to manage the working capital. Understand the logic behind the capital budgeting.

UNIT I FUNDAMENTALS OF ENGINEERING ECONOMICS 9

Introduction to Engineering Economics – Definition and Scope – Significance of Engineering Economics- Demand and supply analysis-Definition – Law of Demand – Elasticity of Demand – Demand Forecasting. Supply – Law of supply – Elasticity of Supply.

UNIT II FINANCIAL MANAGEMENT 9

Objectives and functions of financial management – financial statements, working capital management– factors influencing working capital requirements – estimation of working capital. Capital budgeting - Need for Capital Budgeting – Project Appraisal Methods - Payback Period – ARR – Time Value of Money.

UNIT IIICAPITAL MARKET 9

Stock Exchanges – Functions – Listing of Companies – Role of SEBI – Capital Market Reforms. Money and banking - Money – Functions –Inflation and deflation – Commercial Bank and its functions – Central bank and its functions.

UNIT IV NEW ECONOMIC ENVIRONMENT 9

National Income – concepts – methods of calculating national income - Economic systems, economic Liberalization –Privatization – Globalization. An overview of International Trade – World Trade Organization – Intellectual Property Rights.

UNIT V COST ANALYSIS AND BREAK EVEN ANALYSIS 9

Cost analysis - Basic cost concepts – FC, VC, TC, MC – Cost output in the short and long run. Depreciation - meaning – Causes – Methods of computing Depreciation (simple problems in Straight Line Method, Written Down Vale Method). Meaning – Break Even Analysis - Managerial uses of BEA.

SUGGESTED READINGS

1. Ramachandra Aryasri .A, and V. V.Ramana Murthy Tata McGraw Hill, ,New Delhi 2007
2. Varshney R. L., and K.L Maheshwari Managerial Economics Sultan Chand &
3. Sons, New Delhi 2001.
4. M.L.Jhingan Principles of Economics Konark Publications 2010.
5. Prasanna Chandra Fundamentals of Financial Management Tata McGraw Hill, New Delhi. 2007

Semester-IV

18BTCE406 **Environmental Sciences** **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

1 To give a comprehensive insight into natural resources.
2 To understand the concept of ecosystem and biodiversity.
3 To educate the ways and means of the environment.
4 To protect the environment from various types of pollution.
5 To impart some fundamental knowledge on human welfare measures.
6 To give students an understanding of how science and the scientific method work to address environmental problems

Course Outcome

1.Recognize the importance of natural resources
2. Associate themselves with the various ecosystems
3.Describe the importance of biodiversity
4.Identify and minimize the difference pollutions
5.Prioritize and analyses the social issues
6.Integrate the environmental principles in the projects undertaken in field of engineering and technology

UNIT I - Introduction To Environmental Studies And Natural Resources (9)

Definition, Scope and Importance – Need for public awareness –Forest resources: Use and over-exploitation, deforestation- Water resources-Use and over-utilization of surface and ground water, 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 (9)

Chemistry and Environment- Environmental segments, Composition and Structure of atmosphere Concept of an ecosystem- Structure, components and function of an ecosystem Energy flow in the ecosystem – Food chain, Food web and Ecological pyramids, Structure and function of Terrestrial ecosystem (Forest, Desert and Grassland ecosystem) and Aquatic ecosystem (Fresh water and Marine ecosystem).

UNIT III - Biodiversity (9)

Introduction to biodiversity, Definition- Geneticdiversity, Species diversity and Ecosystem diversity.

Bio geographical classification of India, Importance of biodiversity-Value of biodiversity -

Hot Spots 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 (9)

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 (9)

From Unsustainable to Sustainable development, Urban problems related to energy sources, Water conservation, Rain water harvesting and Watershed management, Resettlement and rehabilitation of people, its problems and concerns, Environmental ethics- Issues and possible solutions- Climate change- Green house 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-Population growth, Variation of population among nations-Population explosion.

SUGGESTED READINGS

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

SEMESTER - IV

18BTCE411 Numerical Methods in Chemical Engineering 2H-3C

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

End Semester Exam:3 Hours

Course Objectives

1 The objective of this course is to familiarize the students with statistical techniques.
2 It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling various problems in the discipline.
3 To introduce students to numerical methods used to solve engineering problems, in particular chemical engineering problems, using numerical methods and computer programming.
4 Fundamentals of numerical methods/algorithms to solve systems of different mathematical equations (e.g. linear/ non-linear algebraic equations, ordinary /partial differential equations), will be introduced.
5 The course would enable students to write their own computer programs using programming languages like C and commercial software like Matlab.
6 To develop skills in properly defining and setting up chemical engineering problems and learning numerical methods that can be used to solve these problems

Course Outcomes
The students will learn:

1. To solve chemical engineering problems involving Linear and non-linear equations.
2. Hands-on experience will be provided to apply these computer programs to solve problems in different areas of chemical engineering e.g. fluid flow, heat and mass transfer, chemical reaction engineering etc.
3. To acquire skills in handling situations involving linear/ non-linear algebraic equations, ordinary /partial differential equations
4. To solving actual chemical engineering problems through computer programming and coding.
5. To solve ordinary and partial differential equations using programming languages like C and software's like MATLAB.
6. Student will understand procedure oriented MATLAB concepts. Student will be capable ofwriting C and MATLAB programs efficiently.

UNIT-I INTRODUCTION **(9)**

Approximation and Concept of Error & Error Analysis .Linear Algebraic Equations: Methods like Gauss elimination, LU decomposition and matrix inversion, Gauss-Siedel method, Chemical engineering problems involving solution of linear algebraic equations . **UNIT-II ROOT FINDING METHODS FOR SOLUTION ON NON-LINEAR ALGEBRAIC EQUATIONS** **(9)**

Bisection, NewtonRaphson and Secant methods, Chemical engineering problems involving solution of non-linear equations . Interpolation and Approximation, Newton's polynomials and

Lagrange polynomials, spline interpolation, linear regression, polynomial regression, least square regression .

UNIT-III ORDINARY DIFFERENTIAL EQUATIONS (9)

Euler method, Runge-Kutta method, Adaptive Runge-Kutta method, Initial and boundary value problems, Chemical engineering problems involving single, and a system of ODEs.

UNIT-IV NUMERICAL INTEGRATION (9)

Trapezoidal rule, Simpson's rule, integration with unequal segments, quadrature methods, Chemical engineering problems involving numerical differentiation and integration. Introduction to Partial Differential Equations: Characterization of PDEs, Laplace equation, Heat conduction/diffusion equations, explicit, implicit, Crank-Nicholson method

Practical description [No. of turns (2 hrs)]

1. Introduction to use of computers for numerical calculations (1 practical turn)
2. Solution of linear algebraic equations using Gauss elimination, Gauss-Siedel etc. (2 practical turns)
3. Solution of a non-linear equations using bracketing and Newton-Raphson method (2 practical turns)
4. Interpolation and Approximation(2 practical turns)
5. Numerical integration(2 practical turns)
6. Euler method (1 practical turn)
7. Runge-Kutta methods for ODEs (2 practical turns)
8. Solution of system of ODEs using simple methods (1 practical turn)
9. Solution of simple PDEs (2 practical turns)

Total :45

Suggested Text Books

1. Gupta, S. K., "Numerical Methods for Engineers, New Academic Science, 1912.
2. S.C. Chapra& R.P. Canale, "Numerical Methods for Engineers with Personal Computer Applications", McGraw Hill Book Company, 1985.
3. R.L. Burden & J. D. Faires, "Numerical Analysis", 7th Ed., Brooks Coles, 2000.
4. Atkinson, K. E., "An Introduction to Numerical Analysis", John Wiley & Sons, 1978.
5. Press, W. H. et al., "Numerical Recipes in C: The Art of Scientific Computing, 3rd Edition, Cambridge University Press, 2007.

Semester-IV

18BTCE412 UNIT OPERATIONS LAB- I 4H-2C

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

End Semester Exam:3 Hours

Course Outcome

1. Ability to operate all the fluid flow measuring devices and able to calculate their coefficients.
2. Ability to operate different fluid flow machineries and able to test their performance characteristics.
3. Plan efficient laboratory experiments to collect relevant data while minimizing error
4. Design and conduct experiments in the laboratory
5. Compare experimentally measured results with literature data and quantify the sources of error that contribute to differences between measured data and literature data
6. Prepare high quality written reports and oral presentations to summarize a project in a professional and informative manner.

Course Objective

1. Apply the concepts of mechanical operations in physical separation processes.
2. Perform the size reduction process using various mechanical operation equipments.
3. Estimate the performance characteristic parameters for solid-fluid and solid-solid separationequipments.
4. Conduct experiments to solve complex engineering problems effectively as an individual or team work.
5. Perform as a leader with good ethical principles to meet societal needs in the field of chemical engineering.
6. Demonstrate skills in safe operation of laboratory equipment

EXPERIMENTS

[1] Venturimeter and Orifice Meter

[2] Helical Coil and Spiral Coil

[3] Pipe Friction and Expansion Losses

[4] Reciprocating Pump

[5] Globe Valve and Loses in Bends

[6] Centrifugal Pumps

[7] Open orifice and V notch

[8] Fluidized Bed

[9] Packed Bed

[10] Annular pipes

[11] Bernoulli's Theorem

[12] Drag on Sphere

[13] Pitot Tube

[14] Elutriator

[15] Ball Mill

[16] Roll Crusher

[17] Sedimentation

[18] Filtration

[19] Air Classifier

[20] Plate and Frame Filter Press

[21] Screen Effectiveness

[22] Hammer Mill

[23] Jaw Crusher

[24] Leaf filter

[25] Drag on Sphere

Semester-V

18BTCE501 CHEMICAL REACTION ENGINEERING - I 3H-4C

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

End Semester Exam:3 Hours

Course Objective

1. To impart knowledge on different types of chemical reactors, the design of chemical reactors under isothermal and non-isothermal conditions
2. To provide experience for students to solve open-ended reaction engineering problems in teams.
3. To provide practice with computer software and simulation relating to chemical reaction engineering
4. To provide practice at developing critical and creative thinking skills related to reaction engineering.
5. To provide experience for students to solve open-ended reaction engineering problems in teams.
6. To provide practice with computer software and simulation relating to chemical reaction engineering

Course Outcomes

On completion of the course the students will be able to

1. Gain knowledge on the selection of the reactor for the reaction and its design
2. Apply the principles of reaction kinetics and formulate rate equations and analyze the batch reactor data
3. Understand the ideal reactor concepts and to develop the performance equation to workout conversion and space time
4. Perform RTD analysis in non-ideal flow reactors and calculation of conversion
5. Analyze multiple reactions carried out both isothermally and non-isothermally in flow, batch and semi batch reactors to determine selectivity and yield.
6. Determine the reaction order and specific reaction rate from experimental data.

UNIT I RATE EQUATIONS **12**

Rate equation, elementary, non-elementary reactions, theories of reaction rate and Prediction; Designequation for constant and variable volume batch reactors, analysis of experimental kinetics data,integral and differential analysis

UNIT II DESIGN OF REACTORS **12**

Design of continuous reactors - stirred tank and tubular flow reactor, recycle reactors, combination of reactors, size comparison of reactors.

UNIT III DESIGN OF REACTORS FOR MULTIPLE REACTIONS **12**

Design of reactors for multiple reactions - consecutive, parallel and mixed reactions - factors affecting choice, optimum yield and conversion, selectivity, reactivity and yield

UNIT IV NON-ISOTHERMAL REACTOR SYSTEM **12**

Non-isothermal homogeneous reactor systems, adiabatic reactors, rates of heat exchanges for different reactors, design for constant rate input and constant heat transfer coefficient, operation of batch and continuous reactors, optimum temperature progression

UNIT V NON IDEAL FLOW REACTORS **12**

The residence time distribution as a factor of performance; residence time functions and relationship between them in reactor; basic models for non-ideal flow; conversion in non-ideal reactors

TOTAL: 60

SUGGESTED READINGS

1. LevenspielO ,Chemical Reaction Engineering,Wiley Eastern Ltd,II Edition, 2000
2. Smith,J.M , Chemical Engineering Kinetics,McGraw Hill , III Edition,1981
3. Fogler.H.S,Elements of Chemical Reaction Engineering,Prentice Hall of India Ltd,III Edition,2000
4. Froment.G.F&K.B.Bischoff,Chemical Reactor Analysis and design ,John Wiley and sons,1979
5. Smith.J.M,VanNess,H.C., & Abbot M.C , Introduction to Chemical Engineering Thermodynamics,McGrawHill,VII Edition,2004

Semester-V

18BTCE502 MASS TRANSFER - 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 Objective

1. To provide introduction to physical and thermodynamic principles of mass transfer with an emphasis on how these principles affect the design of equipment and result in specific requirements for quality and capacity
2. To impart the basic concepts of mass transfer in distillation, extraction, leaching operations;
3. To gives details about method of conducting mass transfer operation, concepts of driving force, operating line; designing of stages for operations like absorption, distillation, extraction, leaching. Also it helps in process design and study of equipment for above mentioned operations
4. To deploy students for hand-on experiments relevant to the principles studied in the Mass Transfer Operations theory;
5. To enable them to estimate diffusivity coefficients and mass transfer coefficients;
6. To make them well versed to find out the equilibrium data for various systems;

Course Outcome

1. Determine the number of stages and recovery efficiency for solid-liquid and liquid-liquid separation processes.
2. Calculate the quantity of adsorbent required for stage-wise operations and illustrate the types of adsorption, adsorption isotherms and ion-exchange process.
3. Determine the properties of air-water system using psychrometric chart and review the operational features of cooling towers.
4. Analyse the applications of dryers and calculate the time of drying from rate of drying curve
5. Compute the yield of crystals and select the crystallizer by revising the working features.
6. Execute proper material balance for different operations in chemical or pharmaceutical industry. Solve the engineering problems of drying, adsorption, evaporation, crystallization operations etc

UNIT – I EXTRACTION (12)

Application of liquid-liquid extraction, Liquid-liquid equilibria, general features of triangular co-ordinate systems, Choice of solvent for extraction, Number of stages, Minimum solvent rate, Solid-liquid extraction, Typical industrial applications, Factors affecting leaching – agitation, particle size, temperature and solvent properties, Leaching by percolation moving bed leaching and shank's system, Operation of stage wise and differential contact extractors.

UNIT – II ADSORPTION AND ION EXCHANGE (12)

Types of adsorption - physical adsorption and chemical adsorption, factors influencing adsorption, nature of adsorbents, Industrial adsorbents, Freundlich adsorption isotherm and its application, Adsorption operation - single stage, crosscurrent and countercurrent operations,Recovery of solvent vapours, Principles of ion exchange - techniques and applications - equilibria rate of ion exchange.

UNIT – III HUMIDIFICATION (12)

Humidification operation of air-water system, Psychometric chart, Methods of humidification and dehumidification, Lewis relation, Theory and principles of cooling towers, Types of cooling towers.

UNIT –IV DRYING **(12)**

Theory and mechanism of drying. Batch drying, drying tests, drying curve, time of drying. Mechanism of moisture movement, drying rate during constant rate period, unsaturated surface drying, drying with internal diffusion. Continuous drying operations and equipment. Classification of dryers. Application of dryers in process industries

UNIT –V CRYSTALLIZATION **(12)**

Factors governing nucleation and crystal growth, theory of crystallization.Batch and continuous crystallizers.Performance and applications of industrial crystallizers.

TOTAL : 60

SUGGESTED READINGS

- McCabeW.L.,Smith J.C., andHarriottP.,UnitOperationsofchemicalEngineering, seventh Edition, McGrawHill(ISE),2005.
- Treybal R.E., Mass Transfer Operations, Third Edition, McGraw Hill (ISE), 1980.
- Coulson J.M., Richardson J.F., Backhurst J.R Harker J.M., Coulson and Richardson's., Chemical Engineering, Vol II, 6th Edition,Butter Worth Heinemann, Oxford, 2002.
- Alan S. Foust, Leonard A Wenzel, CurlisW.Clump, Louis Maus, L.Bryce Andersen., Principles of Unit operations, second ed, John Wiley and Sons, 2008.

Semester-V

18BTCE504 Professional Ethics in 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

1. To enable the students to create an awareness on Engineering Ethics and Human Values,to instill Moral and Social Values and Loyalty and to appreciate the rights of others.
2. Instill the moral values that ought to guide their profession.
3. Resolve the moral issues in the profession.
4. Infer moral judgment concerning the profession.
5. Correlate the concepts in addressing the ethical dilemmas.
6. Judge a global issue by presenting an optimum solution.

Course Outcomes (COs)

Upon completion of the course, the student should be

1. Able to apply ethics in society, discuss the ethical issues related to engineering and realize the responsibilities and rights in the society.
2. Distinguish between ethical and non-ethical situations.
3. Practice moral judgment in conditions of dilemma.
4. Relate the code of ethics to social experimentation.
5. Develop concepts based on moral issues and enquiry.
6. Resolve moral responsibilities in complications

UNIT I HUMAN VALUES **10**

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 and meditation for professional excellence and stress management.

UNIT II ENGINEERING ETHICS **9**

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 ENGINEERING AS SOCIAL EXPERIMENTATION **9**

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.

UNIT IV SAFETY, RESPONSIBILITIES AND RIGHTS **9**

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

UNIT V GLOBAL ISSUES **8**

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility.

SUGGESTED READINGS:

1. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003.
2. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, NewDelhi, 2004.
3. Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, 2004.
4. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics – Concepts andCases", Cengage Learning, 2009.
5. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003
6. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers",Oxford University Press, Oxford, 2001.

Semester-V

18BTCE505 PROCESS MODELING AND SIMULATION 3H-3C

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

End Semester Exam:3 Hours

Course Objective

1. To make the students understand physical systems in chemical Engineering and to develop their mathematical models and solutions for these models.
2. The students will also learn to use the commercial process simulators
3. able to carry out and manage the key design, managerial and decision-making processes.
4. Management and design is inherently complex and a systematic, yet flexible, agile and interdisciplinary approach is required to manage and improve complex systems
5. the manufacturing system and factory level, based on global best-practice methodologies, industry lecturers, and incorporates case studies and projects, to apply these methodologies and become proficient at them
6. Present fundamental laws in developing model equations.

Course Outcome

After completion of the course, students are able to

1. Apply first principles and constitutive laws to develop ordinary or partial differential equations by incorporating valid assumptions for both macroscopic and microscopic systems.
2. Derive phenomenological models for simple and variable flow hydraulic tanks, enclosed mixing vessel with reaction, steam jacketed mixing vessel and Continuous flow boiling systems.
3. Develop the mathematical model for simple flow systems and Homogeneous and Heterogeneous reaction kinetics.
4. Formulate distributed parameter model for various stage operations like binary distillation, multi stage counter current extraction and distributed systems like heat exchanger, tubular reactors and membrane separation unit.
5. Apply numerical methods to solve modeled equations using simulation tool Matlab/simulink.
6. students will be able to: learnt the basic concepts of Simulation and mathematical models applicable in Chemical Engineering

UNIT – I INTRODUCTION **(12)**

Uses of Mathematical Models - Principles of formulation. Fundamental laws: Continuity equations, Energy equation, Equations of motion, Transport equations, Equations of State, Equilibrium and Chemical Kinetics. Simple Examples.

UNIT – II BASIC MODELING **(12)**

Simple Hydraulic Tank, Variable flow hydraulic tank, Enclosed tank, Adiabatic compression in gas space, Mixing vessel, Mixing with reaction, Reversible reaction, Steam jacketed vessel, Continuous - Flow boiling system.

UNIT – III FLUID FLOW AND REACTION KINETICS **(12)**

Gas flow systems - Example: Three-Volume gas flow system, Hydraulic transients - between two reservoirs, pumping system. Reaction Kinetics: General modelling scheme, Liquid phase CSTR - Radical kinetics - Elementary reduction of Radical Mechanism- Rate limiting steps, Heterogeneous kinetics - Example: Autoclave.

UNIT – IV STAGED OPERATIONS AND DISTRIBUTED SYSTEMS **(12)**

Staged Operations: Counter current extraction, Distillation columns - Binary distillation. Distributed systems: Counter current Heat Exchanger, Membrane Separation Process,and Tubular Reactor and Evaporators

UNIT – V SIMULATION **(12)**

MATLAB/Simulink - Introduction, Basic components, Operational Blocks, Simple Examples - Three CSTR's in series, Gravity flow tank, Batch Reactor, Digital Simulation: Numerical Methods - Newton Raphson, False Position methods of convergence, Numerical integration - Euler, Runge Kutta fourth-order methods. Simple Examples: Three CSTR's in series, Non isothermal CSTR, Binary distillation column, Batch reactor. **SUGGESTED READINGS**

1. Luyben, W.L.: Process Modeling, Simulation and Control for Chemical Engineers, McGraw Hill, International Student Edition, Second Edition, 1996.
2. Franks, R.G.E.: Modeling and Simulation in Chemical Engineering, Wiley-Interscience, New York, 1972.
3. Himmelblau, D.M. and Bischoff, K.B,: Process Analysis and Simulation, Wiley,1968.
4. Ramirez,W.F.: Computational methods for Process Simulation, Butterworths, NewYork, 2nd Edition, 1998

TOTAL: 60

Semester-V

18BTCE511 UNIT OPERATIONS LABORATORY- II 4H-2C

Instruction Hours/week: L:0 T:0 P:4 **Marks:** Internal**:40** External**:60** Total**:100**
End Semester Exam:3 Hours

Course Objective:

1. Understanding of the how these learning objectives are realized in the course through a variety of student assessments
2. To enable the students to develop a sound working knowledge on different types of heat transfer equipment
3. Define the fundamental concepts to students in the area of heat transfer and its applications.
4. Recognize the practical significance of various parameters those are involved in different modes of heat transfer.
5. To train the students to develop sound working knowledge on different types of mass transfer equipment
6. These experiments will demonstrate the operation and the design of unit operations that incorporate heat and mass transfer phenomena.

Course Outcome

1. After completion of the course, students are able to
2. To collect quality raw data from any heat transfer operation and to compare observed with predicted performance.
3. Toapply the concepts of heat transfer, fluid dynamics and thermodynamics to the design and operation of heat transfer experiments.
4. Todetermine the heat, transfer co-efficient and effectiveness of heat exchangers from experimentally observed data.
5. Conduct experiments to solve complex engineering problems effectively as an individual or team work.
6. Perform as a leader with good ethical principles to meet societal needs in the field of chemical engineering.

.

EXPERIMENTS

[1] Heat transfer studies in metal bar apparatus

[2] Heat transfer studies in Agitated vessel

[3] Heat transfer studies in Fluidized bed dryer

[4] Natural convection Heat transfer

[5] Heat transfer in pool boiling and Nucleate boiling

[6] Studies in plate fin Heat Exchanger

[7] Studies in shell and Tube Heat Exchanger

[8] Heat transfer studies in Stefan –Boltzmaanapparatus

[9] Studies in Spiral type Heat Exchanger

[10] Studies in Packed bed Heat Exchanger

[11] Film wise and dropwise condensation

[12] Measurement of Diffusion coefficient

[13] Determination of HETP in Randompacking

[14] Wetted wall column

[15] Ternary Liquid-liquid Equilibrium

[16] Counter current & crosscurrent leaching

[17] Extraction in packed and plate columns

[18] Steam distillation

[19] Simple distillation

[20] Vapour- Liquid Equilibrium

[21] Drying rate measurements

Semester-VI

18BTCE601 CHEMICAL REACTION ENGINEERING - II 3H-3C

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

End Semester Exam:3 Hours

Course Objective

1. To enable the students to learn the gas-solid catalytic and non-catalytic reactors and gas-liquid reactors
2. To understand the effect of non-ideal flow on reactor performance and to design reactors for heterogeneous reaction systems.
3. Reaction stoichiometry balancing equation, determining number of moles of reactants and products
4. Reaction rates Relative rates of reaction based on stoichiometry Reaction orders and rate constants, units of rate constants
5. Rates for reversible reactions, Definition of conversion, Mole balances for batch, CSTR and PFR (PBR) reactors
6. Balances for semi-batch reactors with and without product removal Combining mole balances, rate equations and stoichiometry Working in terms of concentrations, conversions or molar flow rates

Course Outcomes

On completion of the course the students will be able to

1. Ability to distinguish between various RTD curves and predict the conversion from a non - ideal reactor using tracer information
2. Develop rate laws for heterogeneous reactions
3. Design of tower for gas liquid operations with and without chemical reaction
4. Design of reactors for non-catalytic and catalytic reactions
5. Understand the ideal reactor concepts and heterogeneous reactors.
6. Understand the basics of catalysis and industrial catalytic reactors such as gas-solid reactors

UNIT I CATALYSTS **12**

Nature of catalysts, surface area and pore-volume distribution, catalyst preparation.

UNIT IIHETEROGENEOUS REACTORS **12**

Rate equations for heterogeneous reactions, adsorption isotherms, rates of adsorption and desorption, surface reaction analysis of rate equation and rate controlling steps.

UNIT IIIGAS-SOLID CATALYTIC REACTORS **12**

Diffusion within catalyst particle, effective thermal conductivity, mass and heat transfer within catalyst pellets, effectiveness factor, Thiele Modulus, fixed bed reactors.

UNIT IV GAS-SOLID NON-CATALYTIC REACTORS **12**

Modelsfor explaining kinetics; volume and surface models; controlling resistances and rate

Controlling steps; time for complete conversion for single and mixed sizes, fluidized and static Reactors.

UNIT V GAS-LIQUID REACTORS **12**

Absorption combined with chemical reactions; mass transfer coefficients and kinetic constants;Application of film, penetration and surface renewal theories; Hatta number and enhancement factor for first order reaction, tower reactor design.

TOTAL **60**

SUGGESTED READINGS

1. Levenspiel, O, Chemical Reaction Engineering,III Edition ,John
2. Fogler .H.S , Elements of Chemical Reaction Engineering , III Edition , Prentice Hall of India,1899
3. Smith .J.M. , Chemical Engineering Kinetics , III Edition , McGraw

   – Hill ,New York,1881
4. FromentG.F and K.B.Bischoff , Chemical Reaction Analysis and Design, John wiley and sons,1879

Semester-VI

18BTCE602 PROCESS ECONOMICS 3H-3C

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

End Semester Exam:3 Hours

Course Objective

1. Prepare engineering students to analyze cost/revenue data and carry out make economic analyses in the decision-making process to justify or reject alternatives/projects on an economic basis
2. To make fundamentally strong base for decision making skills by applying the concepts of economics.
3. Educate the students on how to systematically evaluate the various cost elements of a typical manufactured product, an engineering project or service, with a view to determining the price offer.
4. prepare engineering students to analyze profit/revenue data and carry out make economic analysis in the decision making process to justify or reject alternatives/projects.
5. Students will be able to identify and explain economic concepts and theories related to the behavior of economic agents, markets, industry and firm structures, legal institutions, social norms, and government policies.
6. Students will be able to integrate theoretical knowledge with quantitative and qualitative evidence in order to explain past economic events and to formulate predictions on future ones.

Course Outcome

After completion of the course, students are able to

1. Practice various depreciation methods and its uses in industries for the recovery of plant cost
2. Assess the various financial ratios by taking the real time data's of the industries and comment the stability of the financial statements
3. Specify the economic balance in batch, cyclic and continuous operations and study the optimum conditions of operating variables.
4. Outline the various management principles and organization types practiced in the organizations
5. Discuss the production planning control methods in industries and also role of control charts in production for the quality control.
6. fundamentals and innovation to solve the problems related to energy, food, environment, healthcare

UNIT – I INTEREST AND PLANT COST **(10)**

Time value of money - equivalence, Depreciation, Depletion, estimation of capital cost, Capital requirement for complete plant, cost indices, capital recovery and its real time problems.

UNIT – II PROJECT PROFITABILITY AND FINANCIAL RATIOS **(10)**

Estimation of project profitability, Investment alternatives, income statement and financial ratios, balance sheet preparation-case studies and problems.

UNIT – III ECONOMIC BALANCE IN EQUIPMENTS **(9)**

Essentials of economic balance, economic balance in batch operations, cyclic operations, economic balance for insulation, evaporation, heat transfer equipments and its applications.

UNIT – IV PRINCIPLES OF MANAGEMENT **(8)**

Principles of management, planning, organizing, staffing, coordinating, directing, controlling and communicating. Types of organizations, Management information systems(MIS).

UNIT – V PRODUCTION PLANNING CONTROL **(8)**

Work measurement techniques, motion study, principles of time study, elements of production control, forecasting, planning, routing, scheduling, dispatching, inventory andcontrol, role of control charts in production and quality control.

TOTAL : 45

SUGGESTED READINGS

1. Max Peters, Klaus Timmerhaus, Ronald West, plant design and economics for chemical Engineers, Fifth Edition, McGraw Hill (ISE), 2003.
2. Ahuja K.K, Industrial management, khannapublishsers, New Delhi, 2004.
3. H.E. Schwyer, Process Engineering Economics, McGraw Hill Book, New York, 1970
4. FC Jelen, JH Black, Cost and Optimization Engineering, Second Edition, McGraw-Hill., New York, 1990.
5. Robin Smith, Chemical Process Design and Integration, Second edition, John Wiley & Sons, United States, 2016.

Semester-VI

18BTCE603 PROCESS CONTROL 3H-3C

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

End Semester Exam: 3 Hours

Course Objective

1. To gain the knowledge of different process instruments
2. To understand dynamic modeling of a physical process using first principles,
3. To convert the model to a form amenable to solution and analysis,
4. To design various control schemes and to apply the control system in various Processes.
5. to the advanced control methods used in industries and research.
6. to take up such challenges in his profession

Course Outcome

After completion of the course, students are able to

1. Apply conservation principles in order to model the dynamics of simple process systems to develop first, second and multi capacity transfer functions.
2. Analyze closed loop stability systems by applying transient responses and also to test the stability of the control system by Root Locus methods. Draw the bode diagram for the stability of process for the frequency response processes.
3. Discuss P, PI, PD, PID controller actions and its transfer functions. practice block diagram development for closed loop systems by applying transient responses to find the process error.
4. Devise a control strategies for the control of mass and heat transfer equipment using advanced controllers.
5. Discuss digital process controllers and the hardware components of its direct digital controllers
6. fundamentals and innovation to solve the problems related to energy, food, environment, healthcare

UNIT – I OPEN LOOP SYSTEMS (14)

Laplace Transforms - Standard functions, Open loop systems, first order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics.

UNIT – II CLOSED LOOP SYSTEMS (14)

Closed loop control systems, development of block diagram for feed-back control systems, servo and regulatory problems, transfer function for controllers and final control element, principles of pneumatic and electronic controllers, transportation lag, transient response of closed-loop control systems, Routh-Huritz and root-locus stability of a control system.

UNIT – III FREQUENCY RESPONSE (12)

Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, Principle of Nyquist diagram, stability criterion, tuning of controller settings.

UNIT – IV ADVANCED CONTROL SYSTEMS (10)

Introduction to advanced control systems, cascade control, feed forward control, feed back controller model predictive control, Adaptive controller and Ratio controller and its industrial application

UNIT – V DIGITAL CONTROLLERS **(10)**

Introduction to Computer control loops, Digital computer, computer process Interface, digital to analog and analog to digital converters, sampling continuous signal, Hardware components of a DDC loop, supervisory controller, DCS and PLC.

TOTAL : 60 HOURS

SUGGESTED READINGS

1. Coughanowr D., Steven Leblanc, Process Systems Analysis and Control, Third Edition, McGraw Hill, New York, 2009.
2. Vyas R. P, Process Control and Instrumentation, Eighth Edition, Denett& Co, Nagpur, India, 2016.
3. Stephanopoulos G., Chemical Process Control: An Introduction to Theory and Practice, Sixth Edition, Prentice Hall of India Pvt.Ltd, New Delhi, 1998.
4. Dale E. Seborg, Duncan A. Mellichamp, Thomas F. Edgar, Francis J. Doyle, III, Process Dynamics and Control, Third Edition, John Wiley and sons, New York, 2010.

Semester-VI

18BTCE604 PRINCIPLES OF 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

1. To enable the students to study the evolution of Management, to study the functions and principles of management and to learn the application of the principles in an organization.
2. The students will learn the rights and responsibilities.
3. Infer moral judgment concerning the profession.
4. Correlate the concepts in addressing the ethical dilemmas.
5. Judge a global issue by presenting an optimum solution.
6. To make the students realize the significance of ethics in professional environment.

Course Outcomes

Upon completion of the course

1. Students will be ability to have clear understanding of managerial functions like planning, organizing, staffing, leading & controlling and have same basic knowledge on international aspect of management.
2. Recognize the role of a manager and how it relates to the organization's mission.
3. Define management, its four basic functions and skills and know critical management theories and philosophies and how to apply them
4. Recognize the concept of social responsiveness and its benefits. Explain the relationship between strategic, tactical, and operational plans.
5. Identify the stages of team development and the skills a team must acquire to become effective. • Recognize the part communication plays in the management function.
6. Define change management and explain where it fits in the management function.and the concept of continuous change and its impact on change management.

UNIT I INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS 9

Definition of Management – Science or Art – Manager Vs Entrepreneur - types of managers - managerial roles and skills – Evolution of Management – Scientific, human relations , system and contingency approaches – Types of Business organization - Sole proprietorship, partnership, company-public and private sector enterprises - Organization culture and Environment – Current trends and issues in Management.

UNIT II PLANNING 9

Nature and purpose of planning – planning process – types of planning – objectives – setting objectives – policies – Planning premises – Strategic Management – Planning Tools and Techniques – Decision making steps and process.

UNIT III ORGANISING 9

Nature and purpose – Formal and informal organization – organization chart – organization structure – types – Line and staff authority – departmentalization – delegation of authority – centralization and decentralization – Job Design - Human Resource Management – HR Planning,

Recruitment, selection, Training and Development, Performance Management , Career planning and management.

UNIT IV DIRECTING **9**

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 – barrier in communication – effective communication – communication and IT.

UNIT V CONTROLLING **9**

System and process of controlling – budgetary and non-budgetary control techniques – use of computers and IT in Management control – Productivity problems and management – control and performance – direct and preventive control – reporting.

SUGGESTED READINGS

1. JAF Stoner, Freeman R.E and Daniel R Gilbert "Management", 6th Edition, Pearson Education, 2004.
2. Stephen P. Robbins & Mary Coulter, "Management", Prentice Hall (India)PvtLtd., 10 th Edition, 2009.
3. Harold Koontz & Heinz Weihrich, "Essentials of Management", Tata McGraw Hill, 1998.
4. Robert Kreitner& Mamata Mohapatra, "Management", Biztantra, 2008.
5. Stephen A. Robbins & David A. Decenzo& Mary Coulter, "Fundamentals of Management",7 th Edition, Pearson Education, 2011.
6. Tripathy PC & Reddy PN, "Principles of Management", Tata Mcgraw Hill, 1999

Semester-V

18BTCE611 CHEMICAL REACTION ENGINEERING LABORATORY 4H-2C

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

End Semester Exam:3 Hours

Objective

1. To learn analytical experimental methods using sophisticated instruments and interpretation of experimental data
2. To learn about reaction kinetics for single, multiple, isothermal, non-isothermal reactions and reactor design procedures
3. To learn chemical engineering principles and their practical applications in the areas of mass transfer, reaction engineering and particle mechanics.
4. prediction of kinetics and modeling of kinetics data
5. familiarize with suitable measurement techniques and devices to measure concentration and temperature learn to employ various methods to determine the kinetics of reactions. quantify the effect of non-ideality of flow in chemical reactors.
6. calculate the effects of mass transfer on chemical reactions, predict errors in experimentation and compare experimental data with models

Course Outcome

After completion of the course, students are able to

1. Collect and analyze experimental data for steady state and unsteady state reactors using statistical principles, and compare results to theoretical principles.
2. Collect and analyze kinetic data to determine order, activation energy, frequency factor and rate constant in rate equation.
3. Collect RTD data from steady state reactors and analyze the deviation of real reactor from ideal reactors.
4. Conduct experiments to solve complex engineering problems effectively as an individual or team work.
5. Perform as a leader with good ethical principles to meet societal needs in the field of chemical engineering.
6. Produce a bar graph with correct scale, labels and bars State 4 ways to increase the rate of a chemical Describe the effect of particle size on the rate of a chemical reaction

EXPERIMENTS

[1] Kinetic Studies in Batch Reactor-I

[2] Kinetic Studies in Batch Reactor-II

[3] Performance Characteristics of Semi-Batch Reactor-I

[4] Performance Characteristics of Semi-Batch Reactor-II

[5] Performance Characteristics of Mixed Flow Reactor

[6] Performance Characteristics of Plug Flow Reactor

[7] Adiabatic Reactor

[8] Residence Time Distribution Studies in Plug Flow Reactor

[9] Residence Time Distribution Studies in Mixed Flow Reactor

[10] Performance Characteristics of Tubular Reactor

[11] Performance Studies of Mixed Flow Reactor in Series

[12] Determination of Activation Energy

Semester-VII

18BTCE701 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 Objective

To enable the students to understand

1. Different types of fluids, their flow characteristics and different mathematical models applied to actual situations
2. Mechanism of fluids in motion under different conditions.
3. Understand theory and basic principles of momentum.
4. Heat and mass transport and Understand theory of velocity distribution for various systems.
5. Understand Macroscopic balances for isothermal systems
6. Understand theory of thermal conductivity energy transport and diffusivity and mechanism of mass transport for homogeneous and heterogeneous systems

COURSE OUTCOMES

On completion of the course the students will be able to

1. Apply the shell momentum balances and velocity distribution in laminar flow and understand equation of continuity and motion
2. Establish the shell energy balances and temperature distributions in solids and apply the equations of change to solve heat transfer problems
3. Determine the shell mass balance and concentration distributions in systems involving diffusion and reactions
4. Analyze the analogy between the transports processes of heat, momentum and mass transfer
5. Analyze the problems involving steady state and unsteady state heat conduction in simple geometries and obtain numerical solutions for the problems.
6. Develop microscopic and macroscopic energy balances for steady and unsteady transfer processes ,Apply the individual and overall mass transfer coefficient in multi-phase systems for design applications

UNIT I FUNDAMENTALS OF TRANSPORT PHENOMENA AND VELOCITY DISTRIBUTION IN LAMINAR FLOW **9**

Importance of transport phenomena: analogous nature of transport process, basic concepts, conservation laws. Phenomenological laws of transport properties Newtonian and Non-Newtonian fluids, Rheological models, Theories of transport properties of gases and liquids, effects of pressure and temperature. Shell Momentum Balances and Boundary conditions- Flow of a Falling Film- Flow Through a Circular Tube- Flow through an Annulus- Flow of Two Adjacent Immiscible Fluids- Creeping Flow around a Sphere.

UNIT II EQUATION OF CHANGE FOR ISOTHERMAL PROCESS **9**

The Equations of Change in Terms of the Substantial Derivative-The Equation of Continuity- The Equation of Motion- Use of the Equations of Change to Solve Flow Problems- Dimensional Analysis of the Equations of Change.

UNIT IIIVELOCITY DISTRIBUTION IN TURBULENT FLOW **9**

Comparisons of Laminar and Turbulent Flows- Time-Smoothed Equations of Change for incompressible Fluids- The Time-Smoothed Velocity Profile near a Wall- Empirical Expressions for the Turbulent Momentum Flux- interphase transport in isothermal system- Definition of Friction

Factors- Friction Factors for Flow in Tubes- Friction Factors for Flow around Spheres - Friction Factors for Packed Columns-Ergun equation.

UNIT IVSHELL ENERGY BALANCES AND TEMPERATURE

DISTRIBUTIONS IN SOLIDS AND LAMINAR FLOW **9**

Shell Energy Balances; Boundary Conditions-Heat Conduction with an Electrical Heat Source-Heat Conduction with a Nuclear Heat Source- Heat Conduction with a Viscous Heat Source- Heat Conduction through Composite Walls- Heat Conduction in a Cooling Fin- Forced Convection-Free Convection-Use of equations of change to setup steady state heat transfer problems.

UNIT V CONCENTRATION DISTRIBUTIONS IN SOLIDS AND LAMINAR FLOW 9

Shell Mass Balances; Boundary Conditions- Diffusion through a Stagnant Gas Film- Diffusion with a Heterogeneous Chemical Reaction- Diffusion with a Homogeneous Chemical Reaction-Diffusion into a Falling Liquid Film (Gas Absorption)- Diffusion into a Falling Liquid Film (Solid Dissolution)- Diffusion and Chemical Reaction inside a Porous Catalyst- Diffusion in a Three-Component Gas System- equations for change for Multi Component Systems- The Equations of Continuity for a Multicomponent Mixture.

TOTAL :45

SUGGESTED READINGS

[1] Byron R.Bird, Warren E Stewart , Transport Phenomena ,John Wiley & Sons, New York,2002
[2] SissomL.E, &Pitts .D.R , Elements of Transport Phenomena, McGraw Hill,1972
[3] Brodkey R.S and Hershey H.C , Transport Phenomena – A united Approach, McGraw Hill,1983
[4] Welty J.R.,Wicks.C.E., Wilson.R.E., Fundamentals of momentum , heat and mass transfer, John Wiley & Sons,2007

Semester-VII

18BTCE711 DESIGN AND SIMULATION LABORATORY 4H-3C

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

End Semester Exam:3 Hours

Course Objective

1. To impart computational techniques for chemical engineering calculations
2. To impart the fundamental knowledge on using various analytical tools like ANSYS, FLUENT, etc., for Engineering Simulation.
3. To know various fields of engineering where these tools can be effectively used to improve the output of a product.
4. To impart knowledge on how these tools are used in Industries by solving some real time problems using these tools..
5. students will then be exposed to the applications of MATLAB to signal analysis and system design
6. To introduce MATLAB and use it as a computation and visualization tool in the study of Signals & Systems and Probability theory & Stochastic process.

Course Outcomes

The current rapid development of these combinatorial methods promises solutions to more complex problems, including the creation of new biosynthetic pathways.

1. Computational methods are also developing quickly
2. The approaches will allow us to generate the efficient, effective catalysts needed by the pharmaceutical, food and chemicals industries and should open up new opportunities for producing energy and chemicals from renewable resources.
3. Use of these tools for any engineering and real time applications
4. Acquire knowledge on utilizing these tools for a better project in their curriculum as well as they will be prepared to handle industry problems with confidence when it matters to use these tools in their employment.
5. Analyze the techno-economic feasibility of chemical manufacturing facility.
6. Develop experimental skills, work in team and develop interpersonal skills.

LIST OF EXPERIMENTS

Writing Programs and Sub Programs using C/C++ and MATLAB/SCILAB for Solving

1. Jacobi Methods, Cramer‟s Rule- “Multiple Effect Evaporator and Similar Problems.”
2. “Phase Equilibrium Problems, Equation of State Determination of Bubble and Dew Poin”t Differential Distillation- Minimum Reflux Ratio Calculations.
3. “Mass Transfer Problems- Rayleigh‟s Equation”, NTU in Absorption, Determination of Drying time from batch drying data- Determination of reactor size.
4. “Milne‟s Method, Laplace Equation, Predictor-Corrector Methods”. “Heat conduction problems and chemical reaction” Engineering problems

COMPUTER AIDED DESIGN

Design, Rating and Simulation of Chemical Engineering Equipment Using Aspen Plus / ChemcadSoftware:Mixer, Flow splitter; Flash column; pipe line and pipe pressure drop; Pump; Single and multistage compressors; Heat Exchangers; Distillation Columns; Reactors etc.

COMPUTER AIDED SIMULATION

Simulation Exercises Using Aspen Plus /Chemcad: Physical property estimations; Simulation of a flow sheet:Mass and Energy balances; Handling user specifications on output streams.

1. Introduction to HYSYS Software, HYSYS User Interface, Defining the Simulation Basis, Selecting a Unit Set, Adding a Stream, Flash Calculations
2. Adding Utilities, The Stream Property Value, Flash Calculations of a Ethanol-Water Mixture, Gas Plant Example
3. Optimization in HYSYS, Set and Adjust Logic Operations, Flash Calculation, PFD
4. Preparation, Sizing of Columns, Oil Manager / Characterization, Pipe Sizing and Pressure Drop in HYSYS, Simulation of live Project

TOTAL45

Semester-VII

18BTCE712 INSTRUMENTATION AND CONTROL LABORATORY 4H-3C

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

End Semester Exam:3 Hours

Course Objective

1. To determine experimentally the methods of controlling the processes including measurements using process simulation techniques.
2. To provide adequate knowledge in time response of systems and steady state error analysis
3. To provide sound foundation in the mathematical, scientific and engineering fundamentals to formulate, solve and analyze problems related to Instrumentation and Control Engineering.
4. To prepare graduates for employment in core / IT industries who are socially responsible and integrated with professional and ethical skills.
5. To prepare graduates to involve in research, higher studies and / or to become entrepreneurs in the long run.
6. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problem

COURSE OUTCOME

1. Students would have knowledge on the development and use of right type of control dynamics for process control under different operative conditions.
2. analyses Instrumentation amplifier, active filters, regulated power supply, V/I and I/V converters
3. Examine the signal conditioning circuit for Thermocouple, strain gauge and RTD
4. analyze Control valve, orifice plate and rotameter.
5. Inspect PID controller
6. Summarize P & ID for industrial process and Illustrate Programmable Logic Controller for digital logic gates

LIST OF EXPERIMENTS

- Single capacity liquid level process
- Time constant of a thermocouple
- Calibration of resistance thermometer
- Response of a dial thermometer
- Two capacity liquid level process without interaction
- Two capacity liquid level process with interaction
- Heat transfer dynamics of stirred tank
- Computer controlled level process analyser
- Computer controlled flow process analyser
- Computer controlled pressure process analyser
- Computer controlled temperature process analyser
- Computer controlled heat exchanger system
- Triangle simulator trainer.

PROFESSIONAL CORE ELECTIVES

18BTCEPE- Water Conservation and Management 3H-3C

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

End Semester Exam:3 Hours

Course Objective

1. Differentiate between the way unaerated and aerated lagoons function,Distinguish between suspended growth and fixed-growth systems,
2. List and describe different methods of utilizing activated sludge to stabilize wastewater
3. Describe three methods of thickening. List factors that affect drying-bed operation. Describe methods for disposing of digested or dewatered sludge.
4. To apply knowledge of mathematics, physics, chemistry, and microbiology to solve and analyze engineering problems related to water and wastewater collection, transport, quality and treatment.
5. To use the fundamental principles of mass balance, chemical kinetics and equilibrium to design water or wastewater reactors to achieve a desirable treatment goal
6. The course emphasizes on Design considerations of various unit operations and processes of Water treatment facilities.

Course Outcome

1. The students would have learnt the physical/chemical/biological characteristics and evaluation
2. Technique for sewage, they would understand the theory, engineering application, and design
3. Technique for the wastewater treatment unit process
4. Explain the function of a precipitant List chemical agents commonly used as disinfectants.
   Identify factors affecting disinfection.
5. Describe methods for applying chlorine to wastewater
6. Explain the inter-relationship between water quality parameters and plant sizing, hydraulics and layout. Able to design intake structures.

UNIT I – INTRODUCTION

Introduction: water cycle, water storage, water quality; water conservation in homes; water conservation in the work place **(9)**

UNIT II – WATER MANAGEMENT

Water management-water quality, controlling use and quality of water, water flow measurement, water quality control, testing water salinity **(9)**

UNIT III – WATER AUDIT

Preserving water quality, minimizing evaporation, water sanitation, Water audits **(9)**

UNIT IV – WASTE WATER TREATMENT

water conservation in agriculture; Waste water in Industry- Home and Agriculture–Various wastewater treatment processes – Optimization – Benefits and costs – Microbial and sanitation water treatment – Biofilm formation and removal **(9)**

UNIT V- WATER CONSERVATION

Water conservation in process industry; water conservation in construction industry; water conservation in service industry. **(9)**

TOTAL: **45 HOURS**

SUGGESTED READINGS

1. P.C.Bansil "Water Management in India", Concept Publishing company, New Delhi, First Edition, 2004.
2. G.S.Bridie and J.S.Bridie "Water Supply and Sanitary Engineering", Dhanpat Raj Publishing company (P) Ltd., New Delhi, 7th Edition, 2003
3. Austin G.T., "Shreve's Chemical Process Industries", Fifth Edition, McGraw Hill, 1998.
4. S.C. Rangwala, "Water supply and Sanitary Engineering", Eighteenth Edition, Charotar Publishing House, 2003.
5. Pandey G.N., "Text Book of Chemical Technology", Vikas Publishing House Pvt. Ltd., New Delhi, 1992.

18BTCEPE- Sustainability Engineering **3H-3C**

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

End Semester Exam:3 Hours

Course Objective:

1. To have an increased awareness among students on issues in areas of sustainability
2. To understand the role of Engineering and Technology with sustainable development
3. To know the methods, tools, and incentives for sustainable product-service system development
4. To establish a clear understanding of the role and impact of various aspects of engineering and engineering decisions on environmental, societal, and economic problems.
5. Ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
6. An ability to apply knowledge of mathematics, science, and engineering

Course Outcomes:

The student will be

1. Able to understand the different types of environmental pollution problems and their sustainable solutions
2. Able to work in the area of sustainability for research and education
3. Having a broader perspective in thinking for sustainable practices by utilizing theengineering
4. knowledge and principles gained from this course
5. Apply the knowledge of mathematics, natural science, engineering fundamentals, andenvironmental engineering specialisation to the solution of complex environmental engineering problems
6. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex environmental engineering activities with an understanding of the limitations.

UNIT-I-INTRODUCTION TO SUSTAINABILITY **(9)**

Introduction to the idea of sustainability and its relevance; Environment-related legislation;

UNIT-II-POLLUTION AND ENVIRONMENTAL CHALLENGES **(9)**

Air and water pollution; solid waste management; Local and global environmental challenges; climate change;

UNIT-III- SUSTAINABILITY TOOLS **(9)**

Tools used to ensure sustainability in engineering activities (environmental management systems and environmental impact assessment)

UNIT-IV-SUSTAINABLE HABITATS **(9)**

Green buildings; green chemistry; sustainable cities

(9)

UNIT-V-FACTORS AFFECTING SUSTAINABILITY

Sustainable transportation; sustainable sources of energy, Economic and social factors affecting sustainability.

SUGGESTED READINGS

1. Allen.D.T. and Shonnard, D.R., Sustainability Engineering : Concepts, Design and Case Studies, Prentice Hall.2010
2. Bradley.A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning,2011
3. Environment Impact Assessment Guidelines, Notification of Government of India,2006
4. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998

Total **45 Hour**

B.Tech Chemical Engineering		18-19
18BTCEPE-	Interfacial Engineering	3H-3C

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

End Semester Exam:3 Hours

Course Objectives:

1. The course aims to impart fundamental knowledge of the interfaces to the students and explain their applications.
2. Based on the basic principles of thermodynamics, fluid mechanics, mass transfer and reaction engineering, this course covers some frontiers of chemical engineering.
3. Create awareness amongst students about the social/industrial demands and role of chemical engineer in the society
4. Incorporate a culture of research and Innovation by providing students with latest facilities
5. Provide a platform to the students to interact with leading teachers, scientists and industry practitioners
6. Multi-faceted development of students through co-curricular and extra-curricular activities, participation in various events

Course outcomes

Students will be able to

1. Understand Occurrence of interfaces in science and engineering and their industrialapplications.
2. Calculate the equilibrium and dynamic contact angles
3. Understand the Adsorption of surfactants
4. Understand Interfacial tension gradient and Marangoni effect
5. Understand the characterization, preparation and applications of emulsion
6. who can cater to the needs of chemical industry, research organizations and academic institutes

UNIT-1- INTRODUCTION TO INTERFACIAL ENGINEERING

Introduction; colloid interactions and flocculation, Capillary phenomena, (9 hours)

UNIT-2- INTERFACIAL REACTIONS

Amphilic systems-surface activity, micellization (9 hours)

UNIT-3-ADSORPTION AT FLUID-FLUID AND FLUID-SOLID INTERFACES

Adsorption and film formation; flotation (9 hours)

UNIT-4-INTERFACIAL RHEOLOGY AND TRANSPORT PROCESSES

Rheology of dispersions; (9 hours)

UNIT-5-EMULSIONS

Emulsification; microemulsions (9 hours)

Total: **45 Hours**

SUGGESTED READINGS

1. Adamson, A. W. and Gast, A. P., Physical Chemistry of Surfaces, John Wiley, New York, 1997.
2. Ghosh, P., Colloid and Interface Science, PHI Learning Pvt. Ltd., New Delhi, 2009.
3. Hiemenz, P. C. and Rajagopalan, R., Principles of Colloid and Surface Chemistry, Marcel Dekker, New York, 1997.
4. Stokes, R. J. and Evans, D. F., Fundamentals of Interfacial Engineering, Wiley-VCH, New York, 1997.
5. Baszkin, A. and Norde, W., Physical Chemistry of Biological Interfaces, Marcel Dekker, New York, 2000.

18BTCEPE - Nanoscience and Nanotechnology 3H-3C

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

End Semester Exam:3 Hours

Course Objectives

1. The goal of this course is to provide an insight into the fundamentals of Nanoscience and nanotechnology.
2. The course provides basics of nanomaterial, quantum mechanics and statistical mechanics
3. To foundational knowledge of the Nanoscience and related fields.
4. To make the students acquire an understanding the Nanoscience and Applications
5. To help them understand in broad outline of Nanoscience and Nanotechnology.
6. will be able to understand the basic principles of molecular machines and overview over the mechanical like motions of molecules created by special design concepts

Course outcomes

Students will be able to

1. Acquire the knowledge of basic sciences required to understand the fundamentals of Nanomaterial
2. Acquire the knowledge of electronic, optical and magnetic properties of nanomaterial
3. Get familiarize with the basic concepts of Statistical and Quantum mechanics
4. Learn about the background on Nanoscience
5. Understand the synthesis of nanomaterials and their application and the impact of nanomaterials on environment
6. Apply their learned knowledge to develop Nanomaterial's

UNIT-1- PHYSICAL PROPERTIES OF NANOSTRUCTURED MATERIALS (9)

Introduction; surface effects and physical properties of nanomaterials

UNIT-2- ELECTRO MAGNETIC PROPERTIES (9)

Electrical, magnetic and optical properties

UNIT-3- NANOSTRUCTURED MATERIALS CHARACTERIZATION TECHNIQUES (9)

Nano scale measurement and characterization

UNIT-4- SYNTHESIS OF NANOMATERIALS (9)

Design and synthesis of nanomaterials

UNIT-5- NANOTECHNOLOGY–APPLICATIONS (9)

Nano scale devices for various applications (photovoltaic, medical diagnostics, electronics)

Total: **45 Hours**

SUGGESTED READINGS

1. Pradeep.T "A textbook of Nanoscience and Nanotechnology", Tata McGraw –Hill educationprivate ltd, 2012.

2. David. J, Griffiths,"Introduction to Quantum Mechanics", Pearson,2009.

3. Richard. L, Liboff, "Introductory Quantum Mechanics", Pearson,2003.

4. Keith stowe, "An Introduction to Thermodynamics and Statistical Mechanics", CambridgeUniversity, Newyork, 2007.

5. ClaudineHerman, "Statistical Physics", Springer, ,New York,2005.

6. Kittel. C, "Introduction to Solid State Physics", Wiley India Pvt. Ltd., 2007.

7. Rao. C. N, Muller. A, Cheetham . A. K"Nanomaterials chemistry", Wiley-VCH, 2007

18BTCEPE- Advanced Separation Process 3H-3C

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

End Semester Exam:3 Hours

Course objective

1. This course is designed to improve the ability to design heat exchangers, condensers, and packed columns. The fundamental principles of rate-based mass transfer are discussed.
2. Apply the scientific method in the resolution of advanced separation processes in the field of chemical engineering
3. Understanding of the theory concepts of the equipment, applications and the effects which the advanced separation processes produce on the quality of the products and its environmental impact.
4. Be able to evaluate current problems, applying the scientific method to solve practical problems
5. Propose and select the mathematical models describing the results, which allow to predict and simulate them
6. Ability to analyses in a critical way some of the current problems which have not yet been resolved in the field of chemical Engineering

Course Outcomes

The students will be able to:

1. Apply modern separation techniques in various applications
2. Analyze and design novel membranes for intended application
3. Analyze and design pervaporation, chromatography and dialysis-based separation processes
4. Understand advanced separation processes and their selection.
5. Understand principles and processes of adsorption, membrane separation.
6. Design an absorber or membrane unit to achieve a specified separation.

UNIT – I PROCESS OF MEMBRANE SEPARATION (9)

Definition of the membrane-Nature and structure of membranes-driving force –transport mechanism- classification of separation processes with membranes –permeate flow-polarization of the concentration – applications - membrane based separation processes

UNIT – II SEPARATION PROCESS (9)

External field induced membrane separation processes for colloidal particles; gas separation; surfactant based separation processes; centrifugal separation processes.

UNIT – III ION – EXCHANGE (9)

Ion exchange and chromatographic separation processes -analogies and differences between the adsorption processes. Applications in the industry. Ion exchange resins: capacity of the resin. Balance between phases. Calculation in extractions of ion exchange by stages and differentials.

(9)

UNIT - IV EXTRACTION OF SUPER CRITICAL FLUIDS

Supercritical fluid extraction- Definition and characteristics of the supercritical fluids. Physical-chemical properties of the supercritical fluids. Extraction with supercritical fluids: advantages and disadvantages. Liquid-fluid and solid-fluid balance. Applications

UNIT – V HYBRID PROCESS **(9)**

Definition of the hybrid process. Ways of operation. Hybrid process with membranes: reactors with membranes, distillation with per vaporation and other applications. Hybrid processes with modified absorbers. Other hybrid processes. Study of the viability of the process.

TOTAL :**45 Hours**

SUGGESTED READINGS

1. Lacey, R.E. and S.Loaeb - “Industrial Processing with Membranes ", Wiley -Inter Science, New York, 1972.
2. King, C.J. " Separation Processes ", Tata McGraw - Hill Publishing Co., Ltd., 1982.
3. Schoew, H.M. - " New Chemical Engineering Separation Techniques ", Interscience Publishers, 1972.
4. Ronald W.Roussel - “Handbook of Separation Process Technology ", John Wiley, New York, 1987.
5. Kestory, R.E. - " Synthetic polymeric membrances ", Wiley, New York, 1987.
6. Osadar, Varid Nakagawa I - " Membrance Science and Technology ", Marcel Dekkar (1992)

18BTCEPE- Polymer Science and Engineering 3H-3C

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

End Semester Exam:3 Hours

Course Objective

By the end of the course, you should be able to do the following:

1. Understand and describe the manufacture (using both traditional and non-traditional synthesis schemes) of commercially important polymers using concepts from chemical kinetics and equilibrium thermodynamics.
2. Present a basic understanding of the structure of polymer chains in solution (including, molecular weight, molecular weight distribution, chain conformation) and methods to characterize polymers in solution.
3. Describe polymer phase behavior using basic Flory-Huggins theory of polymer solutions/melts.
4. To study basic processing methods coating applications related to of the thermoplastics
5. To make aware of basics and developments in biopolymers dendrimers LCP etc.
6. Created a huge opportunity for the plastics professionals in production, quality control, product and mold design, processing machinery manufacturing, marketing etc

COURSE OUTCOME

1. Students will be able to understand the relationships between polymer molecular weight, molecular weight distribution, and the properties of polymeric materials.
2. Students will demonstrate an ability to distinguish different polymerization reactions and their mechanisms/kinetics, and learn how actual polymerization is performed in the laboratory. Students will also be able to analyze polymerization data and predict the conversion and molecular weight, which will lead to critical thinking about how to improve the setup for better polymerization.
3. Students will be able to determine polymer molecular weights and molecular weight distributions from different types of experiments. Students will learn about polymer solvent interaction and the effect of the solvents on the dimensions of the polymers in solution.
4. Students will improve and expand their skills in performing and analyzing the thermal and mechanical properties of polymers, and demonstrate an ability to predict how the molecular weight will affect these properties.
5. Students will be able to describe the viscoelastic behavior of polymers with respect to their chemical structures and molecular weights, and to construct a corresponding master curve from the experimental data, which can be used to predict the material response at different temperatures, times, and/or frequencies.
6. isolate the key design features of a product which relate directly to the material(s) used in its construction

UNIT – I CHEMISTRY OF HIGH POLYMERS (9)

Monomers, functionality, degree of polymerizations, classification of polymers, glass transition, melting transition, criteria for rubberiness, polymerization methods: addition and condensation; their kinetics, metallocene polymers and other newer techniques of polymerization, copolymerization, monomer reactivity ratios and its significance, kinetics, different copolymers, random, alternating, azeotropic copolymerization, block and graft copolymers, techniques for copolymerization-bulk, solution, suspension, emulsion.

UNIT – II POLYMER CHARACTERIZATION (9)

Solubility and swelling, concept of average molecular weight, determination of number average, weight average, viscosity average and Z-average molecular weights, polymer crystallinity, analysis of polymers using IR, XRD, thermal (DSC, DMTA, TGA), microscopic (optical and electronic) techniques.

UNIT – III SYNTHESIS AND PROPERTIES (9)

Synthesis and properties: Commodity and general purpose thermoplastics: PE, PP, PS, PVC, Polyesters, Acrylic, PU polymers. Engineering Plastics: Nylon, PC, PBT, PSU, PPO, ABS, Fluoropolymers Thermosetting polymers: PF, MF, UF, Epoxy, Unsaturated polyester, Alkyds. Natural and synthetic rubbers: Recovery of NR hydrocarbon from latex, SBR, Nitrile, CR, CSM, EPDM,IIR,BR,Silicone,TPE.

UNIT – IV POLYMER RHEOLOGY (9)

Flow of Newtonian and non-Newtonian fluids, different flow equations, dependence of shear modulus on temperature, molecular/segmental deformations at different zones and transitions. Measurements of rheological parameters by capillary rotating, parallel plate, cone-plate rheometer. viscoelasticity-creep and stress relaxations, mechanical models, control of rheological characteristics through compounding, rubber curing in parallel plate viscometer, ODR and MDR. Polymer processing: Compression molding, transfer molding, injection molding, blow molding, reaction injection molding, extrusion, pultrusion, calendaring, rotational molding, thermoforming, rubber processing in two-roll mill, internal mixer.

UNIT – V POLYMER TESTING (9)

Polymer testing: Mechanical-static and dynamic tensile, flexural, compressive, abrasion, endurance, fatigue, hardness, tear, resilience, impact, toughness. Conductivity-thermal and electrical, dielectric constant, dissipation factor, power factor, electric resistance, surface resistivity, volume resistivity, swelling, ageing resistance, environmental stress cracking resistance. Polymer Technology: Polymer compounding-need and significance, different compounding ingredients for rubber and plastics, crosslinking and vulcanization, vulcanization kinetics

TOTAL :**45 Hours**

SUGGESTED READINGS

1. P.C. Painter and M.M. Coleman, “Fundamentals of Polymer Science” ,2nd edition,2009
2. Technomic Publishing, Co.: Lancaster, PA, 1997 P.C. Painter and M.M. Coleman, “Essentials of Polymer Science& Engineering”, 1st edition]
3. Materials for Renewable and Sustainable Energy(Springer)2011
4. R.J. Young and P.A. Lovell, “Introduction to Polymers”, Chapman & Hall: London, 2011
5. P.J. Flory, “Principles of Polymer Chemistry”, Cornell University Press: Ithaca, 1967

18BTCEPE - Environmental Pollution and control 3H-3C

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

End Semester Exam:3 Hours

Course Objective

1. This course explains the concepts and strategies related to environmental management, sustainable development and various environmental systems like pollution and its control
2. Understanding of basic concepts of air pollution. Study of air pollution episodes.
3. Reasoning of the entire episode, identification of the parameters, conditions, mechanisms.
4. Study of sampling types and methods for ambient air and stack.
5. Study of macro and micro meteorology for understanding the dispersion of pollutants.
6. Simple and complex modeling for point source, line source and area source.

Course Outcome

1. Students are able to understand the meaning of environmental management. Students are also able to understand the importance of environmental management, pollution control in development of society and country.
2. Identify sources, types, and control equipment's for industrial air pollution.
3. Identify sources of water pollution, general water treatment, wastewater treatment and issues pertaining water quality degradation
4. Understand reasons for land degradation, soil quality loss, and identify essential nutrients for productivity.
5. Define reclamation process with specification for on mining area reclamation, grassland reclamation and wetland reclamation
6. Skill to assess and develop physical/chemical/biological treatment techniques for the control of hazardous wastes.

UNIT – I POLLUTION CONTROL STANDARDS (9)

Introduction (types of pollution, water standards for potable and agricultural streams, air standards);

UNIT – II AIR POLLUTION AND ITS CONTROL (9)

Air pollution - air pollutants and interaction products, preventive and control measures;

UNIT – III WATER POLLUTION AND ITS CONTROL (9)

Water pollution-waste water sampling and analysis, primary, secondary and tertiary treatment methods;

UNIT – IV SOLID WASTE MANAGEMENT (9)

Solid waste management- collection, storage and transport, processing and transformation, incineration, composting and sanitary land filling;

UNIT – V POLLUTION CONTROL IN INDUSTRY **(9)**

Pollution control in chemical process industry. Control measures in paint industry, peterochemical industry, pharmaceutical industry and dye industry;

TOTAL: **45 Hours**

SUGGESTED READINGS

1. Energy and the Environment by Robert A. Ristinen and Jack J.Kraushaav ,2011
2. Energy Ecology and the Environment by Richard Wilson and William J.Jones,2013
3. Diaz, L.F., G.M. Savage, L.L. Eggerth, and C.G. Golueke, Composting and Recycling Municipal Solid Waste, Lewis Publishers, Ann Arbor, Michigan, USA, 1993.
4. George Tchobanoglous; Integrated Solid Waste management ,McGraw-Hill Publishers,1993

18BTCEPE- Renewable Energy 3H-3C

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

End Semester Exam:3 Hours

Course Objective

1. Understand the various forms of conventional energy resources.
2. Learn the present energy scenario and the need for energy conservation
3. Explain the concept of various forms of renewable energy
4. Outline division aspects and utilization of renewable energy sources for both domestics and industrial application
5. Current energy scenario of India and world
6. Analyse the environmental aspects of renewable energy resources.

COURSE OUTCOME

Upon completion of the course, the student will be able to

1. Describe the environmental aspects of non-conventional energy resources. In Comparison with various conventional energy systems, their prospects and limitations.
2. Know the need of renewable energy resources, historical and latest developments.
3. Describe the use of solar energy and the various components used in the energy production with respect to applications like - heating, cooling, desalination, power generation, drying, cooking etc.
4. Appreciate the need of Wind Energy and the various components used in energy generation and know the classifications.
5. Understand the concept of Biomass energy resources and their classification, types of biogas Plants- applications
6. Compare Solar, Wind and bio energy systems, their prospects, Advantages and limitations.
7. Acquire the knowledge of fuel cells, wave power, tidal power and geothermal principles and applications.

UNIT-I INTRODUCTION TO RENEWABLE ENERGY (9)

Introduction world energy status, current energy scenario in India, environmental aspects of energy utilization, energy and sustainable development

UNIT-2 SOLAR ENERGY (9)

Solar energy basic concepts, flat plate and concentrating collectors, solar desalination, solar pumping, solar photo voltaic conversion, solar cells

UNIT-3 WIND ENERGY (9)

Wind energy, availability, wind power plants, wind energy conversion systems, site characteristics, and types of wind turbines

UNIT-4 BIO ENERGY **(9)**

Energy from biomass (biomass resources, biomass conversion technologies - direction combustion, pyrolysis, gasification, anaerobic digestion, bio-ethanol and biodiesel production

UNIT-5 HYDRO AND THERMAL ENERGY **(9)**

Other Renewable Sources Tidal energy; geothermal energy; hydroelectric.

TOTAL: **45 Hours**

SUGGESTED READINGS

1. Renewable Energy by Godfrey Boyle ,2011
2. Renewable Energy Resources by John Twidell and Tony Weir**.,2013**
3. Schaeffer, John. 2007. Real Goods Solar Living Sourcebook: The Complete Guide to Renewable Energy Technologies and Sustainable Living (30th anniversary edition).
4. Solar Engineering and Thermal Processes, J. A. Duffie and W.A. Beckman, 2nd Edition John Wiley and sons.,2010
5. Solar Energy, G. N. Tiwari, Narosa Publishing House,1996
6. Wind Energy Comes of Age by Paul Gipe, John Wiley & Sons Inc,2003

18BTCEPE- Optimization Methods **3H-3C**

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

End Semester Exam:3 Hours

Course Objective

1. Introduction to optimization techniques using both linear and non-linear programming.
2. The focus of the course is on convex optimization though some techniques will be covered for non-convex function optimization too.
3. After an adequate introduction to linear algebra and probability theory, students will learn to frame engineering minima maxima problems in the framework of optimization problems.
4. Enumerate the fundamental knowledge of Linear Programming and Dynamic Programming problems.
5. Learn classical optimization techniques and numerical methods of optimization.
6. Know the basics of different evolutionary algorithms.
7. Explain Integer programming techniques and apply different

Course Outcome

By the end of the course, students should be able to:

1. Learn efficient computational procedures to solve optimization problems.
2. Cast engineering minima/maxima problems into optimization framework.
3. Explain the fundamental knowledge of Linear Programming and Dynamic Programming problems.
4. Use classical optimization techniques and numerical methods of optimization.
5. Describe the basics of different evolutionary algorithms.
6. Enumerate fundamentals of Integer programming technique and apply different techniques to solve various optimization problems arising from engineering areas.

UNIT – I MATHEMATICAL PRELIMINARIES (12)

Linear algebra and matrices -Vector space, eigen analysis- Elements of probability theory- Elementary multivariable calculus

UNIT – II LINEAR PROGRAMMING (12)

Simplex method- Introduction to linear programming model - Duality- Karmarkar's method

UNIT – III UNCONSTRAINED OPTIMIZATION (8)

Conjugate direction and quasi-Newton methods- Gradient-based methods - One-dimensional search methods

UNIT – IV CONSTRAINED OPTIMIZATION **(6)**

Lagrange theorem - FONC, SONC, and SOSC conditions

UNIT – V PROJECTION METHODS **(7)**

KKT conditions - Non-linear constrained optimization models -Non-linear problems

TOTAL: **45 Hours**

SUGGESTED READINGS

1. An introduction to Optimization by Edwin P K Chong, Stainslaw Zak,2013
2. Nonlinear Programming by Dimitri Bertseka,2011

LIST OF OPEN ELECTIVES

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:

1 To make the students conversant with the basics of solid wastes and its classification.
2 To make the student acquire sound knowledge of different treatments of solid wastes.
3 To acquaint the student with concepts of waste disposals.
4 To develop an understanding of the basic concepts of hazardous waste management.
5 To acquaint the students with the basics of energy generation from waste materials.
6 Identify the methods of wastes disposals.

Course Outcomes:

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

1 Outline the basic principles of solid waste and separation of wastes.
2 Identify the concepts of treatment of solid wastes.
3 Identify the methods of wastes disposals.
4 Examine the level of hazardousness and its management.
5 Examine the possible of energy production using waste materials.
6 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:

1 To make the students conversant about green chemistry.
2 To make the student acquire sound knowledge of the atom efficient process and synthesis elaborately.
3 To acquaint the student with concepts of green technology.
4 To develop an understanding of the basic concepts of renewable energy resources.
5 To acquaint the students with the basics information on catalysis.
6 Apply the concepts combustion of green technology.

Course Outcomes:

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

1 Outline the basic principles of green chemistry.
2 Examine the different atom efficient process and synthesis elaborately.
3 Apply the concepts combustion of green technology.
4 Identify and apply the concepts of renewable energy.
5 Apply the concepts of green catalysts in the synthesis.
6 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 AckmezMudhoo, *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:

1 To make the students conversant with the information on electrochemical material.
2 To make the student acquire sound knowledge of conducting polymers.
3 To acquaint the student with concepts of energy storage devices.
4 To develop energy storage devices.
5 Apply the concepts of electrochemistry in storage devices.
6 Identify the concepts of storage devices and their applications.

Course Outcomes:

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

1 Outline the basic principles of chemistry in electrochemical material.
2 Examine the properties of conducting polymers.
3 Apply the concepts of electrochemistry in storage devices.
4 Identify the concepts of storage devices and their applications.
5 Apply suitable materials for the manufacturing of storage devices.
6 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:

1 To make the students conversant with cement and lime and its uses.
2 To make the student acquire sound knowledge of abrasives and refractories.
3 To acquaint the student with concepts of inorganic chemicals.
4 To develop an understanding of the basic concepts of explosives.
5 To acquaint the students with the basics of agriculture chemicals.
6 Identify the usage of inorganic chemicals.

Course Outcomes:

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

1 Outline the basic chemistry of cement and lime.
2 Examine the uses of abrasives and refractories.
3 Identify the usage of inorganic chemicals.
4 Identify the concepts of explosives and smoke screens.
5 Identify the usage of agriculture chemicals.
6 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:

1 To develop abilities to write technically and expressively.
2 To recognise writing as a constructive and meaningful process.
3 To practice using reading strategies for effective writing.
4 To design effective technical documents for both print and digital media.
5 To identify the qualities of good technical writing.
6 Identify the usage of inorganic chemicals.

Course Outcomes:

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

1 Create simple sentences and correct common grammatical errors in written English.
2 Use their reading ability for effective writing.
3 Restate to minimize word, sentenceand paragraph length without sacrificing clarity or substance.
4 Discuss the basic technical writing concepts and termssuch as audience analysis, jargon, format, visuals, and presentation.
5 Demonstrate the basic components of definitions, descriptions, process explanations and other common forms of technical writing.
6 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:

1 To inculcate the basics of the brief history of earth sciences.
2 To divulge knowledge on the basics of the structure of earth and earth's gravitational field.
3 To disseminate the fundamentals of the magnetic field and thermal distribution of earth.
4 To introduce the concepts of seismology and seismic waves.
5 To impart the basic knowledge of oceans.
6 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:

1 Explain basics of the history of earth sciences.
2 Discuss the concepts of the structure of earth and earth's gravitational field.
3 Describe the concepts of the magnetic field and thermal distribution of earth.
4 Explain the basics of seismic waves.
5 Discuss the basics of oceans and the properties of seawater.
6 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:

1 To disseminate the fundamentals of acoustic waves.
2 To inculcate the characteristics of radiation and reception of acoustic waves.
3 To divulge knowledge on the basics of pipe resonators and filters.
4 To introduce the features of architectural acoustics.
5 To impart the basic knowledge of transducers and receivers.
6 Explain the basic ideas of pipe resonators and filters.

Course Outcomes:

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

1 Develop the idea of the fundamentals of acoustic waves.
2 Apply the concepts of radiation and reception of acoustic waves.
3 Explain the basic ideas of pipe resonators and filters.
4 Illustrate the basics of architectural acoustics.
5 Illustrate the transducers and receivers and its applications in various electronic devices.
6 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:

1 To develop analytical skills for solving engineering problems.
2 To teach the students the basic concepts of LPP.
3 To learn the techniques to solve transportation and assignment problems.
4 To make the students study the integer programming and network analysis.
5 To analyse the results and propose recommendations to the decision-making processes in management engineering.
6 Formulate and solve transportation models and assignment models.

Course Outcomes:

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

1 Define and formulate linear programming problems and appreciate their limitations.
2 Solve linear programming problems using appropriate techniques and optimization solvers, interpret the results obtained and translate solutions into directives for action.
3 Formulate and solve transportation models and assignment models.
4 Construct linear integer programming models and discuss the solution techniques.
5 Formulate and solve problems as networks and graphs.
6 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:

1 To kindle analytical skills for solving engineering problems.
2 To impart the knowledge about inventory models.
3 To learn replacement models and simulation models.
4 To provide techniques for effective methods to solve nonlinear programming and decision making.
5 To analyse the results and propose recommendations to the decision-making processes in management engineering.
6 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:

1 Solve simple models in inventory problems and replacement problems.
2 Explain different queuing situations and find optimal solutions using models for different situations.
3 Simulate different real-life probabilistic situations using Monte Carlo simulation technique.
4 Discuss the characteristics of different types of decision-making environments and the appropriate decision making approaches and tools to be used in each type.
5 Convert and solve practical situations into replacement models.
6 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:

1 To understand basic knowledge of fuzzy sets and fuzzy logic.
2 To apply the basic knowledge of fuzzy operations.
3 To know the basic definitions of fuzzy relations.
4 To apply basic fuzzy inference and approximate reasoning.
5 To know the applications of fuzzy technology.
6 Describe the methods of fuzzy logic.

Course Outcomes:

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

1 Explain the main subject of fuzzy sets.
2 Discuss the concept of fuzziness involved in various systems and fuzzy set theory.
3 Describe the methods of fuzzy logic.
4 Comprehend the concepts of fuzzy relations.
5 Analyse the application of fuzzy logic control to real-time systems.
6 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. MichałBaczyński 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:

1 To know the fundamentals of tensors.
2 To know the series solutions to differential equations.
3 To introduce the concepts of special functions.
4 To study about calculus of variations and integral equations.
5 To familiar with the main mathematical methods used in physics.
6 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:

1 Demonstrate proficiency in mathematics and the mathematical concepts needed for a proper understanding of physics.
2 Discuss the special type of matrices that are relevant in physics and tensors.
3 Explain special functions like Bessel, Legendre, Hermite and Laguerre functions and their recurrence relations.
4 Compare different ways of solving second order differential equations.
5 Use calculus of variations and linear integral equations.
6 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.andRadmore, 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:

1 To introduce the basic concepts of vector space.
2 To know the fundamentals of linear algebra.
3 To solve the system of linear equations.
4 To study the linear transformations.
5 To introduce the concepts of inner product spaces.
6 Express linear transformations as a matrix form.

Course Outcomes:

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

1 Explain the fundamental concepts of advanced algebra and their role in modern mathematics and applied contexts.
2 Apply the fundamental concepts in their respective engineering fields.
3 Express linear transformations as a matrix form.
4 Explain the underlying theory of vector spaces over a field and inner product spaces over real or complex numbers.
5 Discuss the importance of linear algebra
6 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.

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:

1 To introduce the Java programming language and explore its current strengths and weaknesses.
2 To study the way that object-oriented concepts are implemented in the Java programming language.
3 To write working Java code to demonstrate the use of applets for client side programming.
4 Discuss the way that exceptions are detected and handled in the Java programming language.
5 Create Java code that demonstrates multiple threads of execution.
6 Describe internet telephony

Course Outcomes:

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

1 Explain the basic and advanced concepts and techniques of Java.
2 Design an application based upon the concepts of Java and advance Java.
3 Discuss the way that exceptions are detected and handled in the Java programming language.
4 Create Java code that demonstrates multiple threads of execution.
5 Describe internet telephony
6 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:

1 To study the graphics techniques and algorithms.
2 To study the multimedia concepts and various I/O technologies.
3 Explain the various latest interactive multimedia devices, the basic concepts about images and image formats.
4 Explain the data compression techniques, image compression techniques like JPEG
5 Explain the video compression techniques like MPEG, and the basic concepts about animation
6 Create an interactive multimedia presentation by using multimedia devices

Course Outcomes:

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

1 Discuss the fundamental concepts of computer animation and multimedia.
2 Explain the various latest interactive multimedia devices, the basic concepts about images and image formats.
3 Explain the data compression techniques, image compression techniques like JPEG
4 Explain the video compression techniques like MPEG, and the basic concepts about animation
5 Create an interactive multimedia presentation by using multimedia devices
6 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:

1 To assemble/setup and upgrade personal computer systems.
2 To perform installation, configuration, and upgrading of microcomputer hardware and software.
3 To install/connect associated peripherals.
4 Define the terms that are directly related to processors such ascaching, multi-threading, dual-core technology, multi-processing, and pipelining.
5 Explain the PC memories such as RAM and ROM devices.
6 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:

1 Identify the main components of the PC.
2 Use the skills to troubleshoot various power-related problems.
3 Define the terms that are directly related to processors such ascaching, multi-threading, dual-core technology, multi-processing, and pipelining.
4 Explain the PC memories such as RAM and ROM devices.
5 Discuss about motherboards and the various technologies connected to mainboards such as chipsets, buses, and various BIOS types.
6 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:

1 To understand the fundamentals of programming such as variables, conditional and iterative execution, methods, etc.
2 To understand the fundamentals of object-oriented programming in Java, including defining classes, invoking methods, using class libraries, etc.
3 Demonstrate the concepts of polymorphism and inheritance.
4 List the important topics and explain the principles of software development.
5 Create a computer program to solve specified problems.
6 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:

1 Identify classes, objects, members of a class and relationships among them needed for a specific problem.
2 Demonstrate the concepts of polymorphism and inheritance.
3 List the important topics and explain the principles of software development.
4 Create a computer program to solve specified problems.
5 Use the Java SDK environment to create, debug and run simple Java programs.
6 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.

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:

1 To understand the basic concepts of an electric hybrid vehicle.
2 To gain knowledge about the electric propulsion unit.
3 To understand and gain knowledge about various energy storage devices.
4 Evaluate the different energy management strategies.
5 Describe the concept of different energy storage devices.
6 Analyse the different motor drives used in hybrid electric vehicles.

Course Outcomes:

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

1 Explain the concept of hybrid electric vehicles.
2 Discuss the concept of hybrid electric drive-trains.
3 Evaluate the different energy management strategies.
4 Describe the concept of different energy storage devices.
5 Analyse the different motor drives used in hybrid electric vehicles.
6 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:

1 To gain knowledge about energy management.
2 To understand the basic concepts in economic analysis in energy management.
3 To understand the basic principles of an energy audit.
4 Discuss the basic concept of energy audit and types.
5 Analyse the different energy efficient motors.
6 Describe the concept of energy conservation.

Course Outcomes:

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

1 Explain the concept of energy management.
2 Analyse the different methods for economic analysis.
3 Discuss the basic concept of energy audit and types.
4 Analyse the different energy efficient motors.
5 Describe the concept of energy conservation.
6 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:

1 To understand the basic principles of PLC systems.
2 To gain knowledge about data handling functions.
3 To understand the principles of PID.
4 Interpret relay ladder diagrams.
5 Examine the issues related to using PLCs for batch processes and sequential control.
6 Describe programmable controller networking and supervisory control.

Course Outcomes:

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

1 Examine the typical PLC hardware structure.
2 Interpret relay ladder diagrams.
3 Examine the issues related to using PLCs for batch processes and sequential control.
4 Describe programmable controller networking and supervisory control.
5 Design logic circuits to perform industrial control functions of medium complexity.
6 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, analogoutputapplicationexamples, 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:

1 To gain knowledge about environmental aspects of energy utilization.
2 To understand the basic principles of wind energy conversion, solar cells, photovoltaic conversion.
3 To understand the basic principles of the fuel cell and geothermal power plants.
4 To gain knowledge about the hydro energy.
5 Explain the need of wind energy and the various components used in energy generation.
6 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:

1 Explain the need of renewable energy resources, historical and latest developments.
2 Describe the use of solar energy and the various components used in the energy production with respect to applications.
3 Explain the need of wind energy and the various components used in energy generation.
4 Discuss the need of hydro energy and the various types of hydro energy.
5 Analyse the different energy sources for energy production.
6 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:

1 To introduce the embedded systems, its hardware and software.
2 To introduce devices and buses used for embedded networking.
3 To study about task management.
4 To learn about semaphore management and message passing.
5 To study about memory management.
6 Discuss about task management.

Course Outcomes:

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

1 Discuss about embedded systems architecture.
2 Explain embedded system, its hardware and software.
3 Discuss about task management.
4 Express semaphore management and message passing.
5 Describe about memory management.
6 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:

1 To study about various speakers and microphone.
2 To learn the fundamental of television systems and standards.
3 To learn the process of audio recording and reproduction.
4 To study the various telephone networks.
5 To discuss about the working of home appliances.
6 Demonstrate the working of various optical recording systems.

Course Outcomes:

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

1 Explainthe working of various types of loud speakers.
2 Describe various types of picture tubes.
3 Demonstrate the working of various optical recording systems.
4 Distinguish various standards for colour TV system.
5 Discuss various telecommunication networks.
6 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:

1 To introduce the basic concepts of neural networks and their applications in various domain.
2 To educate how to use soft computing to solve real-world problems.
3 To have a solid understanding of the basic neural network.
4 Apply perception concept in design.
5 Design using ART phenomena.
6 Describe SOM concepts.

Course Outcomes:

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

1 Explain the basic concepts of neural networks and its applications in various domains.
2 Discuss about learning process in neural networks.
3 Apply perception concept in design.
4 Design using ART phenomena.
5 Describe SOM concepts.
6 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:

1 To introduce the basic concepts of fuzzy logic and their applications in various domain.
2 To educate how to use fuzzy computation to solve real-world problems.
3 To have a solid understanding of basic fuzzy models.
4 Describe the theory of reasoning.
5 Develop fuzzy controllers.
6 Discuss the concepts of adaptive fuzzy control.

Course Outcomes:

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

1 Explain the basic concepts of fuzzy logic and its applications in various domains.
2 Describe the theory of reasoning.
3 Develop fuzzy controllers.
4 Discuss the concepts of adaptive fuzzy control.
5 Use fuzzy computation to solve real-world problems.
6 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. DimiterDriankov, 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:

1 To provide students with an overview of communication systems.
2 To provide an overview on mobile communication.
3 To make students to have a better understanding on satellite and radar communication.
4 Explain the working of mobile cellular communication.
5 Describe various standards in use for wireless communication and its application.
6 Demonstrate some basic application of GPS.

Course Outcomes:

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

1 Discuss the past, present and future trends in mobile communication.
2 Explain the working of mobile cellular communication.
3 Describe various standards in use for wireless communication and its application.
4 Demonstrate some basic application of GPS.
5 Explain the working of radar and its applications.
6 Describethemodern 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.

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:

1 To examine the role and tasks of basic housing policies and building bye-laws.
2 To understand the process of integrated service delivery in the context of economic, social, environmental and institutional factors.
3 To analyse the innovative construction methods and materials.
4 To analyse city management strategies and strengthen the urban governance through a problem solving approach.
5 Use housing programmes and schemes.
6 Plan and design housing projects.

Course Outcomes:

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

1 Explain the importance of basic housing policies and building bye-laws.
2 Use housing programmes and schemes.
3 Plan and design housing projects.
4 Examine innovative construction methods
5 Examine innovative construction materials.
6 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:

1 To provide knowledge on machineries involved in building construction.
2 To impart knowledge onelectrical systems in buildings.
3 To understand theprinciples of illumination and design.
4 To learn therefrigeration principles and its applications.
5 To study the importance of fire safety and its installation techniques.
6 Use the principles of illumination and design.

Course Outcomes:

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

1 Explain the machineries involved in building construction.
2 Discuss the electrical system and its selection criteria.
3 Use the principles of illumination and design.
4 Illustrate the principle of refrigeration.
5 Explain the importance of fire safety and its installation techniques.
6 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:

1 To learn various distress and damages to concrete and masonry structures.
2 To know the influence of corrosion in durability of structures.
3 To understand the importance of maintenance of structures.
4 To study the various types and properties of repair materials.
5 To learn various techniques involved in demolition of structures.
6 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:

1 Explain the various distress and damages to concrete and masonry structures.
2 Discuss the durability of structures and corrosion mechanism.
3 Describe the importance of maintenance of structures, types and properties of repair materials.
4 Assess the damage of structures.
5 Apply various repair techniques
6 Explain the modern techniques and equipment adopted for the demolition of structures.
.

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:

1 To impart knowledge on parametric design and the conventions of formal engineering drawing.
2 To produce and interpret 2D and 3D drawings.
3 To communicate a design idea/concept graphically/visually.
4 To provide knowledge onmasonry bonds.
5 To understand perspective view of buildings.
6 Illustrate a design idea/concept graphically/visually.

Course Outcomes:

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

1 Explain the parametric design and the conventions of formal engineering drawing.
2 Create and interpret 2D drawings.
3 Create and interpret 3D drawings.
4 Illustrate a design idea/concept graphically/visually.
5 Discuss the various types of masonry bonds.
6 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.

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:

1 To provide an overview of how computers are being used in mechanical component design.
2 To study the various computer graphics concepts.
3 To get basic knowledge of geometric modelling.
4 To study the basics of parametric design and object representation.
5 To get basic knowledge in product design and development.
6 Explain the process involved in graphic transformations.

Course Outcomes:

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

1 Give an overview of the CAD systems and its importance.
2 Explain the ideas and principles behind the computer graphics.
3 Explain the process involved in graphic transformations.
4 Understand the operations involved in geometric modelling.
5 Describe the concepts of parametric design.
6 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:

1 To provide in-depth knowledge on industrial safety.
2 Understand the various safety techniques involved in the industrial sector.
3 Record and investigate the accident zone and prepare reports related to it.
4 Conduct basic safety inspections using strategies that they have developed.
5 Identify and demonstrate the working of safety monitoring.
6 Train about education and training based on safety.

Course Outcomes:

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

1 Understand the need and awareness of safety concepts.
2 Understand the various safety techniques involved in the industrial sector.
3 Record and investigate the accident zone and prepare reports related to it.
4 Conduct basic safety inspections using strategies that they have developed.
5 Identify and demonstrate the working of safety monitoring.
6 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:

1 To provide the basics of transport phenomena and its applications.
2 To provide the knowledge over the properties of the systems and unit systems used.
3 To understand the basics and mathematics involved in momentum transport.
4 To provide the basics and applications of energy transport.
5 To give basics and principles involved in the mass transport phenomena.
6 Understand the basic concepts involved in momentum transport.

Course Outcomes:

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

1 Understand the basic concepts of transport phenomena.
2 Understand the essentiality of properties of a system and unit systems used.
3 Understand the basic concepts involved in momentum transport.
4 Apply the mathematics involved in fluid flow problems.
5 Explain the various energy transport phenomena.
6 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:

1 Biomechanics provides key information on the most effective and safest movement patterns, equipment, and relevant exercises to improve human movement.
2 Present the nine fundamentals of biomechanics and its need.
3 Explain the nine principles used for the application of biomechanics.
4 Describe the human anatomy.
5 Explain the need for biomechanics in muscle actions.
6 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:

1 Understand the basics and importance of biomechanics.
2 Present the nine fundamentals of biomechanics and its need.
3 Explain the nine principles used for the application of biomechanics.
4 Describe the human anatomy.
5 Explain the need for biomechanics in muscle actions.
6 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.

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:

1 To teachthe basic concepts and fundamental aspects of industrial and domestic thermal systems' design.
2 To prepare the students for the positions of energy management in energy intensive industries.
3 Examine the relationship between energy systems and society.
4 Use optimization techniques for conservation of energy in chemical industries.
5 Understand economic balance in energy
6 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:

1 Plan to optimize energy using systems and procedures to meet energy demand.
2 Describe the movement of substances in the entire globe.
3 Examine the relationship between energy systems and society.
4 Use optimization techniques for conservation of energy in chemical industries.
5 Understand economic balance in energy
6 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:

1 To enable the students to learn the fertilizer manufacturing including new or modified fertilizer products and new techniques.
2 Develop the flow chart for manufacture of nitrogenous fertilizers.
3 Analyze the various processes and develop the flow chart for the manufacture of phosphatic fertilizers.
4 Develop the flow chart for the manufacture of potassic fertilizer and analyze the unit operations involved in the process.
5 Understand the fertilizers impacts and standards
6 Illustrate the quality and pollution standards permissible in fertilizer industry.

Course Outcomes:

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

1 Illustrate chemical, organic fertilizers and nutrients.
2 Develop the flow chart for manufacture of nitrogenous fertilizers.
3 Analyze the various processes and develop the flow chart for the manufacture of phosphatic fertilizers.
4 Develop the flow chart for the manufacture of potassic fertilizer and analyze the unit operations involved in the process.
5 Understand the fertilizers impacts and standards
6 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:

1 To introduce students to the principles of wastewater and solid waste treatment and management.
2 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.
3 Separate the contaminants from the effluent for treatability.
4 Determine the biomass yield and substrate utilization rate for biological treatment process and design of activated sludge process.
5 Develop a flow sheet for the waste water treatment from dairy, sugar, pulp and paper, textile and pharmaceutical industries.
6 Apply wastewater reclamation technologies

Course Outcomes:

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

1 Examine the constituents of waste water and its effects.
2 Separate the contaminants from the effluent for treatability.
3 Determine the biomass yield and substrate utilization rate for biological treatment process and design of activated sludge process.
4 Develop a flow sheet for the waste water treatment from dairy, sugar, pulp and paper, textile and pharmaceutical industries.
5 Apply wastewater reclamation technologies
6 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:

1 To provide an understanding of solid and hazardous waste engineering principles and management issues.
2 To provide students with the necessary background and knowledge pertaining to the engineering design of solid and hazardous waste facilities.
3 Deduce the source reduction, recycling and reuse techniques of solid waste.
4 Analyze the collection systems and method of transfer of solid waste.
5 Describe the processing techniques for solid and hazardous waste.
6 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:

1 Outline the salient features of solid waste management and handling.
2 Deduce the source reduction, recycling and reuse techniques of solid waste.
3 Analyze the collection systems and method of transfer of solid waste.
4 Describe the processing techniques for solid and hazardous waste.
5 Select the suitable methods for disposal of solid and hazardous waste.
6 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.

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:

1 To impart basic knowledge in bioprocess engineering.
2 To design the bioreactors for various operations.
3 To understand the principle and working of heat transfer equipments.
4 To extendtheknowledge in principle of heat transfer inside a bioreactor.
5 To construct the equipments used in mass transfer operations.
6 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:

1 To learn the scope and importance of food processing.
2 To impart basic knowledge in different food processing methods carried out in the food tech companies.
3 To extend the brief knowledge in food conservation operations.
4 To study the methods of food preservation by cooling.
5 To familiarise the students on the concepts of preservation methods for fruits.
6 To create a deeper understanding of preservation methods for vegetables.

Course Outcomes:

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

1 Describe the scope and importance of food processing.
2 Outline the various processing methods for foods.
3 Extend the knowledge in food conservation operations.
4 Describe the methods of food preservation by cooling.
5 Summarise the preservation methods for fruits.
6 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 EnachescuDauthy, *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:

1 To understand the available tools and databases for performing research in bioinformatics.
2 To expose students to sequence alignment tool in bioinformatics.
3 To construct the phylogenetic trees for evolution.
4 To get familiar with the 3D structure of protein and classification.
5 To acquire basic knowledge in protein secondary structure prediction.
6 To extend the brief knowledge in microarray data analysis.

Course Outcomes:

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

1 Summarise the basic concepts and importance of bioinformatics in various sectors.
2 Demonstrate the sequence alignment tool in bioinformatics.
3 Construct the phylogenetic trees for evolution.
4 Analyse the three-dimensional protein structure and classification using various tools.
5 Illustrate the protein secondary structure prediction by comparative modelling.
6 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:

1 To impart the skills in the field of nanobiotechnology and its applications.
2 To acquire knowledge in the nanoparticles and its significance in various fields.
3 To extend the knowledge in types and application of nanoparticles in sensors.
4 To define the concepts of biomaterials through the molecular self assembly.
5 To equip students with clinical applications of nanodevices.
6 To describe a deeper understanding of the socio-economic issues in nanobiotechnology.
7 Course Outcomes:

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

1 Develop skills in the field of nanobiotechnology and its applications.
2 Summarise the nanoparticles and its significance in various fields.
3 Extend the knowledge in types and application of nanoparticles in sensors.
4 Define the concepts of biomaterials through the molecular self assembly.
5 Outline the clinical applications of nanodevices.
6 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.

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:

1 To explain the milling, extraction and manufacture of tremendous products from cereals, pulses and oil seeds.
2 To summarise the production and processing methods of fruits and vegetables.
3 To discuss the chemical composition, processing, production, spoilage and quality of milk and milk products.
4 To outline the overall processes involved in the production of meat, poultry and fish products.
5 To review the production and processing methods of plantation and spice products.
6 Illustrate the techniques involved in the processing of dairy products.

Course Outcomes:

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

1 Discuss the various processing technologies involved in cereal, pulses and oilseed technology.
2 Demonstrate the major operations applied in fruits and vegetable processing.
3 Illustrate the techniques involved in the processing of dairy products.
4 Infer the production of different types of milk.
5 List the overall processing of meat, poultry and fish processing.
6 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:

1 To explain the basic concepts of food and nutrition.
2 To define the overall classification, function, and source of carbohydrates, lipids and proteins.
3 To discuss the overall aspects of vitamins.
4 To outline the role of health and nutritional importance of micro and macro minerals.
5 To summarise the recent trends in nutrition.
6 List the various attributes of fat and water soluble vitamins.

Course Outcomes:

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

1 Discuss the basics in the area of nutritional assessment in health and disease.
2 Categorise the recommended dietary allowances for different age groups.
3 Express the classifications, functions and sources of carbohydrates, lipids and proteins.
4 List the various attributes of fat and water soluble vitamins.
5 Report the role, bioavailability, sources and deficiency diseases of macro and micro minerals.
6 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. SunetraRoday, *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:

1 To outline the current status of snack food industry.
2 To describe the production, processing and marketing trends of potato and tortilla chips.
3 To outline the overall processing of popcorn.
4 To explain the production and processing of fruits involved in snack food preparation.
5 To summarise the sensory analysis methods and packaging techniques of snack foods.
6 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:

1 Review the overall aspects of snack food industry.
2 Develop ready to eat foods from potato and maize flour.
3 Demonstrate the various unit operations involved in the production of potato and tortilla chips.
4 Illustrate the overall aspects of popcorn production.
5 List the production, processing and manufacturing of fruit based snacks.
6 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:

1 To categorise the types of agricultural wastes.
2 To outline the production and utilization of biomass.
3 To explain the various parameters considered to be important in the designing of biogas units.
4 To review the various methods employed in the production of alcohol from the by-products of agricultural wastes.
5 To summarise the overall aspects involved in the production of paperboards and particleboards from agricultural wastes.
6 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:

1 List and group the types of agricultural wastes.
2 Develop a number of value added products from agriculture wastes.
3 Discuss the techniques and production involved in the utilization of biomass.
4 Assess the various parameters considered to be important in the designing of biogas units.
5 Illustrate the various methods employed in the production of alcohol from the by-products of agricultural wastes.
6 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.

B.Tech Chemical Engineering **2018-2019**

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

1 To impart the knowledge on constructional details and principle of operation of various automobile components.
2 To learn the function and working of various components in transmission and drive lines.
3 To study the concept and working of steering and suspension systems in an automobile.
4 To give the knowledge on wheels, tyres and brakes of automobiles.
5 To provide the information on current and future trends in automobiles.
6 To study the ignition of engine system

Course Outcomes

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

1 Demonstrate the operating principles and constructional details of various automobile components.
2 Explain the function and working of components in transmission and drive lines.
3 Identify and explain the types of steering system and suspension system.
4 Classify and describe the types of wheels, tyres and brakes of automobiles.
5 Discuss the current and future trends in the automobiles.
6 Gather the knowledge of the ignition of engine system

UNIT I ENGINE AND AUXILIARY SYSTEMS

Classification of engines – construction and working of four-stroke spark ignition (SI) engine and compression ignition (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 gear box – 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 gear box –power steering – suspension systems – need and types – independent suspension – coil spring, leaf spring, torsion bar and air suspension – 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 H Crouse and Donald L Anglin, 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.

18BEAEOE02 TWO AND THREE WHEELER 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 impart the technical knowledge on construction and working of power train and drive train of two and three wheeler vehicles.
- To familiarize with the maintenance procedures of engine and subsystems of two and three wheelers.
- To study the types of transmission, steering and suspension systems.
- To study the types of wheels, tyres and brakes for two and three wheelers.
- To study the cranking system in IC engines
- To study anti braking system of engines

Course Outcomes

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

1 Construct the frames of two and three wheelers of different layouts.
2 Demonstrate the constructional details and principle of operation of various engine components.
3 Identify and explain the types of transmission, steering and suspension systems.
4 Classify and describe the types of wheels, tyres and brakes for two and three wheelers.
5 Explain the servicing of two and three wheelers.
6 Get knowledge of practical things in cranking system

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 – gear box – 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.

B.Tech Chemical Engineering **2018-2019**

18BEAEOE03 **VEHICLE MAINTENANCE** **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

1 To understand the need for vehicle maintenance and its importance.
2 To familiarize the maintenance procedure for various components of an automobile.
3 To study the servicing of transmission and driveline components.
4 To study the procedure for steering, suspension, wheel and brake maintenance.
5 To study the fault diagnosis in the electrical and air conditioner systems.
6 To study the various services of brakings

Course Outcomes

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

1 Describe and differentiate the types of maintenance.
2 List the procedure for dismantling, servicing and assembling of engine components.
3 Demonstrate the servicing of transmission and driveline components.
4 Discuss the procedure for steering, suspension, wheel and brake maintenance.
5 Explain the fault diagnosis in the electrical and air conditioner systems.
6 To acquire the knowledge of tune-up of vehicle system

UNIT I MAINTENANCE OF RECORDS AND SCHEDULES

Need for maintenance – preventive and breakdown maintenance – requirements of maintenance – preparation of check lists – inspection schedule – maintenance of records, 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.

18BEAEOE04 MODERN VEHICLE 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

1 To impart the knowledge on trends in vehicle power plants.
2 To learn about the various advanced driver assistance systems.
3 To study the working of advanced suspension and braking systems in an automobile.
4 To give the information about motor vehicle emission and noise pollution control.
5 To provide the knowledge of vehicle telematics.
6 To study about pedestrian detections

Course Outcomes

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

1 Distinguish and describe the various modern vehicle power plant systems.
2 List and explain the various driver assistant mechanisms.
3 Identify and explain the working of advanced suspension and braking systems.
4 Apply the knowledge of motor vehicle emission and noise pollution control.
5 Describe the vehicle telematics and its applications.
6 Getting knowledge of safety of vehicles securities

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 – hydra gas suspension – closed loop suspension – indirect floating calliper disc brake – self energising disc brake – anti-skid braking system – retarders – regenerative braking – auto emergency braking – crumple zone – safety cage – airbags – seat belts – head rests.

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 – Usage Based Insurance (UBI).

Suggested Readings

1. LjuboVlacic, 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.

B.Tech Chemical Engineering **2018-2019**

18BEAEOE05	**FLEET 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

1 To impart the knowledge on personnel management, selection process, training methods and motor vehicle act.
2 To plan the vehicle routes, scheduling of vehicles and fare structure.
3 To study the motor vehicle act in terms of registration and describe the various vehicles and conduct the test of competence to drive.
4 To study the buildup of fare structure and analyze the methods of fare collection.
5 Analyze the vehicle parts, supply management and data processing.
6 To design the vehicle maintenance systems.

Course Outcomes

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

1 Apply the knowledge of personnel management and analyze the selection process and training methods.
2 Apply the motor vehicle act in terms of registration and describe the various vehicles and conduct the test of competence to drive.
3 Construct a fare structure and analyze the methods of fare collection.
4 Analyze the vehicle parts, supply management and data processing.
5 Demonstrate an electronically controlled vehicle maintenance system and analyze the work scheduling.
6 Gaining knowledge in test of competence

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 schedule – 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 B Currie 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.

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

The goal of this course is for students

1 To understand the basics of Robotics, Kinematics.
2 To understand the basics of Inverse Kinematics.
3 To explore various kinematic motion planning solutions for various Robotic configurations.
4 To study the trajectory planning for robot.
5 To understand the task level programming
6 To explore various applications of Robots in Medicine

Course Outcome

Upon completion of this course, students will be able to:

1 Explain various kinds robotics techniques, vision, planning and applications.
2 Outline the basic concept of robotics
3 Identify and discuss the Robot Vision
4 Describe about manipulators and kinematics.
5 Demonstrate Task level programming
6 Discuss the applications of robotic systems in medical field.

UNIT I INTRODUCTION

Introduction Automation and Robots, Classification, Application, Specification, Notations, Direct Kinematics Dot and cross products, Coordinate frames, Rotations, Homogeneous coordinates Link coordination arm equation – Five-axis robot, Four-axis robot, Six-axis robot

UNIT II KINEMATICS

Inverse Kinematics – General properties of solutions tool configuration, Five axis 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, Shane analysis, Segmentation – Thresholding, region labeling, Shrink operators, Swell operators, Euler numbers, Perspective transformation, Structured illumination, Camera calibration.

UNIT IV PLANNING

Task Planning Task level programming, Uncertainty, Configuration, Space, Gross motion, Planning, 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 – Gynecology, Orthopedics, Neurosurgery

Suggested Readings

1. Robert Schilling Fundamentals of Robotics-Analysis and control Prentice Hall 2003
2. J.J.Craig Introduction to Robotics Pearson Education 2005
3. Staugaard, Andrew C Robotics and Artificial Intelligence: An Introduction to Applied Machine Learning Prentice Hall Of India 1987
4. Grover, Wiess, Nagel, Oderey Industrial Robotics: Technology, Programming and Applications McGraw Hill 1986.
5. Wolfram Stadler Analytical Robotics and Mechatronics McGraw Hill,1995
6. Saeed B. Niku, Introduction to Robotics: Analysis, Systems, Applications Prentice Hall 2001
7. K. S. Fu, R. C. Gonzales 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

The goal of this course is for students:

1 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
2 To understand virtual reality, augmented reality and using them to build Biomedical engineering applications
3 To study the importance of virtual reality is getting optimized results
4 To study the importance of VR reality and safety issues
5 To study about the devices for trackers and interfaces
6 To know the intricacies of these platform to develop PDA applications with better optimality.

Course Outcomes

Upon completion of this course, students will be able to:

1 Applications of virtual reality are military and robotics.
2 Importance of virtual reality is getting optimized results
3 To know about importance of VR reality and safety issues
4 To know the application in games, movies etc
5 Gather knowledge practically about the devices for trackers and interfaces
6 Acquire practical knowledge about the VR on the web and mobile

UNIT I INTRODUCTION

The three I's of virtual reality-commercial VR technology and the five classic components of a VR system - Input Devices: (Trackers, Navigation, and Gesture Interfaces): Three-dimensional position trackers, navigation and manipulation-interfaces and gesture interfaces-Output Devices: Graphics displays-sound displays & haptic feedback..

UNIT II VR DEVELOPMENT PROCESS

Geometric modeling - kinematics modeling- physical modeling - behaviour modeling - model Management.

UNIT III CONTENT CREATION CONSIDERATIONS FOR VR

Methodology and terminology-user performance studies-VR health and safety issues-Usability of virtual reality system- cyber sickness -side effects of exposures to virtual reality environment

UNIT IV VR ON THE WEB & 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 human parameters-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. C. Burdea& Philippe Coiffet Virtual Reality Technology Second Edition, Gregory, John Wiley & Sons, Inc 2008

2. Jason Jerald The VR Book: Human-Centred Design for Virtual Reality. Association for Computing Machinery and Morgan & Claypool New York, NY, US
3. Dieter Schmalstieg& Tobias Hollerer Augmented Reality: Principles and Practice (Usability)Pearson Education (US), Addison-Wesley Educational Publishers Inc, New Jersey, United States 2016
4. Steve Aukstakalnis, Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR (Usability) Addison-Wesley Professional 1 edition, 2016
5. Robert Scoble& Shel Israel The Fourth Transformation: How Augmented Reality & Artificial Intelligence Will 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; 1 edition 2015
7. Tony Parisi Programming 3D Applications with HTML5 and WebGL: 3D Animation and Visualization for Web Pages O'Reilly Media; 1 edition 2014
8. Jos Dirksen Learning Three.js: The JavaScript 3D Library for WebGL Packt Publishing - ebooks Account; 2nd Revised ed. Edition 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

The goal of this course is for students:

1 To discuss the overview of artificial organs &transplants
2 To extend the principles of implant design with a case study
3 To explain the implant design parameters and solution in use
4 To simplify about various blood interfacing implants
5 To know the biocompatibility of artificial organs
6 To learn about the implantable medical devices

Course Outcomes

Upon completion of this course, students will be able to:

1 Explain the implant design parameters and solution inuse
2 Analyze about various blood interfacing implants
3 Evaluate response of biomaterials in living system
4 Perceive knowledge about artificial organs &transplants
5 Demonstrate different types of soft tissue replacement and hard tissuere placement
6 Assess biocompatibility of artificial organs

UNIT I ARTIFICIAL ORGANS & 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 versus absorbable devices, the missing organ and its replacement, Tissue engineering, scaffolds, cells and 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 bonding and modulus matching, Degradation of devices, natural and synthetic polymers, corrosion, wear and 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, artificial heart, 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. Kopff W.J Artificial Organs John Wiley and sons, New York, 1st edition 1976
2. Park J.B., Biomaterials Science and Engineering Plenum Press 1984
3. J D Bronzino Biomedical Engineering handbook Volume II CRC Press / IEEE Press 2000
4. R S Khandpur Handbook of Biomedical Instrumentation Tata McGraw Hill 2003

5. Joon B Park Biomaterials – An Introduction Plenum press, New York 1992
6. Yannas, I. V Tissue and Organ Regeneration in Adults New York, NY: Springer 2001
7. Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph.D, Bronzino Clinical Engineering CRC Press, 1st edition 2010
8. Myer Kutz Standard Handbook of Biomedical Engineering & Design McGraw- Hill 2003