CURRICULUM OF CHEMICAL ENGINEERING
RGUKT BASAR
(Semester – II of the Academic Year 2016 – 17)

I YEAR
II SEMESTER

S.No	Subject Code	Subject Name	(L-T)-P	C
1	CH1201	Chemical Process Calculations	4-0	4
2	PH1001	Physics	4-0	4
3	MA1201	Mathematics-II	4-0	4
4	EE1001	Basic Electrical and Electronics Engineering	4-0	4
5	CS1201	Scripting Languages	4-0	3
6	HS1201	Communication Skills – II	2-0	1
7	CE1601	Engineering Drawing	1-2	2
8	PH1601	Physics Lab	0-3	2
9	EE1601	Basic Electrical and Electronics Engineering Lab	0-3	2
Total Credits				25

L-Lectures; T-Tutorials; P-Practicals; C-Credits.

CH1201 CHEMICAL PROCESS CALCULATIONS

Externals: 60 Marks **L-T-P-C**
Internals: 40 Marks **4-0-0-4**

Objectives:

- Learn basic laws about the behavior of gases, liquids and solids and some basic mathematical tools.
- Learn what material balances are, how to formulate and apply them, how to solve them.
- Understand the heat properties such as heat capacity, latent heats for a given compound/mixtures
- To learn the concepts of heat of reaction, exothermic and endothermic reactions, heat of formation, combustion; standard heat of formation, combustion and reaction, adiabatic flame temperatures, and energy balances for models

Unit-1

Numerical techniques for solving material & energy balance equations. Explanation of log-log, semi log, triangle graphs, Composition of gaseous mixtures, liquid mixtures, solids etc. Ideal gas laws and its application, Dalton law, Raoult's law, Henry's laws, solubility and Distribution coefficient.

Unit-2

Humidity and saturation, Heat capacity of gases and gaseous mixtures, liquids & solids, Sensible heat change in liquid & gases, enthalpy changes during phase transformation. Fuels And Combustion: Types of fuels, calorific value of fuels, Proximate and ultimate analysis.

Unit-3

Material Balance without Chemical Reactions: Fundamentals; Batch and flow processes, Steady-flow and unsteady processes, Material balance calculations for single-unit and Material balances for Multiple-unit processes, Process flow sheet, Material balance with and Without recycle; Bypass, Purge streams.

Unit-4

Material Balance with Chemical Reactions: Concept of limiting and excess reactants, Extent of Reaction, Material balances involving single reaction, Material balances involving multiple reactions.

Unit-5

Energy Balances without chemical reactions, Enthalpy changes, thermo-chemistry of mixing process, dissolution of solids Energy Balances with chemical reactions: Heats of reaction,

measurement and calculation of heats of reaction - Hess's Law, formation reactions and Heats of Formation, Heats of Combustion, Energy balances for combustion reactions - adiabatic reaction temperature, theoretical flame temperature.Problems on combustion of coal, liquid fuels, gaseous fuel, sulfur and sulfur pyrites etc.

Text Books:

1. Basic Principles and Calculations in Chemical Engineering, David M Himmelblau and James B Riggs, 7th Edition, PHI.

Reference Books:

1. Chemical process principles Part-I, Material and Energy Balance, O. A. Hougen, K. M. Watson, John Wiley and Asia Publication.
2. Stoichiometry (S.I units) ,B. I. Bhatt & S. M. Vora, McGraw Hill Ltd, 3rd Edition.
3. Elementary Principles of Chemical Processes, 2nd edition, Richard M Felder, R W Rousseau. John Wiley

PH 1001 **PHYSICS**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **4-0-0-4**

Objectives:

1. To inculcate in the Students a sense of yearning to learn the basic Physics behind the applications that we look around in day to day life.

2. To deliver the basic Principles of Physics that forms the basis for the development of Technology.

3. The basic details of Solid state Physics, Optics and Electrodynamics and Quantum Physics provided in a subtle fashion dealt in finer details to have strong basics in these areas.

UNIT – I

MATHEMATICAL PHYSICS (3)

1.1 Gradient, Divergence, Curl and their physical significance

Scalar and Vector point Functions, Differential operator, Gradient , Physical significance, Divergence, Significance, Curl, Physical Significance, Vector Identities

1.2 Stokes theorem & Gauss theorem

Vector Integral Theorems, Line Integral, Surface and Volume Integrals, Stokes Theorem, Gauss-Divergence Theorem, Application

1.3 Curvilinear coordinates

Types of Coordinate systems, Polar coordinates, Cylindrical and Spherical coordinates, Equations Relating Cartesian, Spherical and Cylindrical coordinate

UNIT – II

ELECTRODYNAMICS (6)

2.1 Maxwell's Equations

Electrodynamics before Maxwell, Fixing of Ampere's Law, Maxwell Equation in matter, Boundary Conditions.

2.2 Poynting theorem and conservation laws

Continuity Equation, Poynting Theorem, Conservation Law Newton Third law in Electrodynamics

2.3 Wave equation

Wave equation, wave form Boundary conditions, Reflection and Transmission for a string

2.4 Electro Magnetic Waves in vacuum

Wave equation for E and B, Monochromatic Plane Waves, Energy and Momentum in EM Waves in vacuum

2.5 Electro Magnetic waves in Matter

Propagation in Linear Media, Reflection and Transmission at Normal Incidence Oblique Incidence

2.6 EM wave in conducting surface.

Reference Books :

1. Electrodyamics by David j.Griffiths

UNIT – III
OPTICS (12)

3.1 Interference by division of wave front (Biprism)

Introduction , Interference of Light Waves, Interference Pattern , Intensity Distribution, Fresnel Biprism

3.2 Interference by division of amplitude (Newton's rings)

Interference by Plane parallel Wave, Cosine Law, Interference by a film with Non-Parallel reflecting surface, Wedge, Newton's Rings.

3.3 Michelson's interferometer

Interference by Plane film illuminated by a point source, Michelson's Interferometer.

3.4 Fraunhoffer diffration (Single slit)

Introduction, Types of Diffraction,Single Slit Frauhoffer Diffraction, Position of Maxima and Minima,Graphical Method for determining roots

3.5 Frauhoffer diffraction Double slit & multiple slits

Double slit Fraunhoffer diffraction by N- Parallel slits

3.6 Diffraction Gratings, Grating and Resolving Power

Diffraction Grating, Construction of Grating, Grating Spectrum, Resolution, Resolving Power of a diffraction Grating

3.7 Fresnel diffraction and Zone Plate

Types of Diffraction, Fresnel diffraction, Fresnel Half Period zones, Zone plate Application of Zone, Lens

a. Production of Plane Polarised light & double refraction

Introduction , Polarisation of Light waves, Representation of various types of light, Polarization by Reflection,Brewster's Law, Laws of Malus and proof, Geometry of Calcite Crystal, Double Refraction, Nicol's Prism, Applications.

a. Quarter & Half – wave plate, elliptical & circular polarized lights

Huygen's Theory of Double Refraction, Quarter Wave plate, Half Wave Plate, Elliptically and Circularly Polarised light.

3.10 Production & detection of elliptical & circular Polarised lights

Elliptically polarised Light, Circularly polarised light, Conversion of Elliptically polarized light to Circularly polarised light, Analysis of polarized light of Different Kinds.

3.11 Theory of Laser

Introduction, Spontaneous Emission, Stimulated Emission, Relation between Spontaneous and Stimulated emission Probabilities, Population Inversion, Pumping, Active systems.

3.12 Different kinds of Lasers

Ruby laser Working Semiconductor laser,He-Ne laser ,Application of Laser.

Reference Books :

1. Engineering Physics By Malik and Singh
2. Optics by Ajoy Ghatak
3. Optics by Pedrotti and Pedrotti.

UNIT – IV

QUANTUM MECHANICS (6)

4.1 Failures of classical physics

Limitations of classical physics, Blackbody Radiation, Spectral Lines, Photoelectric Effect, Planck's Quantum Hypothesis, Einstein's Theory of photoelectric Effect, Compton effect, Existence of stationary states, Stern-Gerlach Experiment

4.2 DeBroglie waves & Uncertainity Principle

Introduction, Matter waves Electron Diffraction Experiment Standing waves of an electron in orbit, Uncertainity Principle Single Slit Experiment, Application of Uncertainty Principle.

4.3 Wave function, Schrodinger Equation & probablity interpretation

Time Dependent Schrodinger Equation ,1- D Equation for a free particle, extension to 2-D, Inclusion of forces, Probability current Density

4.4 Operators , expectation values & Time independent Schrodinger Equation

Operators ,Expectation Value, Ehrenfest Theorem, time independent schrodinger Equation and Admissibility Conditions on Wave function.

4.5 Solution for generalised potential

Motion of a particle in a Potential – Classical view .

4.6 Particle in a box

Square well potential with Rigid walls, Energies and Wave functions

Reference Books:

1. Modern Physics by A. Beiser
2. Quantum Mechanics by Aruldhas.

UNIT – V
CONDENSED MATTER PHYSICS (6)

5.1 CRYSTALLOGRAPHY-I

Introduction, Crystal ,Single, poly and Amorphous state, Lattice Points and Space Lattice, Unit cell, Primitive Unit Cell in 2-D ,Non-primitive Unit Cell in 2-D lattice ,Primitive unit cell in 3-D ,Non Primitive unit cell in 3-D,Bravais Lattice and crystal systems, Atomic Packing, Crystal structure

5.2 Crystallography-II

Miller Indices, Positions, Directions, Planes Obtaining Miller indices, Important Cubic crystal structures, SC, BCC, FCC, Closed Packed structures, Packing fraction, NaCl Structure, Diamond , ZnS Structure.

5.3 X-ray diffraction

Introduction, Bragg's Law, Diffraction Direction Experimental Methods of x-Ray Diffraction, Powder method Debye - Scherrer Method Measurement of Bragg Angle

5.4 Defects in crystals

Introduction, Classification of Imperfections, Point Defects, vacancies, Schottky defects, Intersitial, Frenkel defects, Impurities, Colour centres, Line defect Planar Defects, Volume Defects, Thermodynamical consideration for Existence of Defect equilibrium concentration of Schottky defects in metals, Equilibrium concentration of schottky defects in Ionic crystals, Frenkel defect in metals, Frenkel defects in ionic crystals

5.5 Electron theory of metals

Important properties of metals, electron theory of solids, classical free elecrtron theory, DC Electrical Conductivity, Gains of Drude Model, Sommerfeld quantum Model, Fermi Energy, Density of Energy States, carrier Concentration, Drawbacks of Sommerfeld Theroy

5.6 Band theory of solids

Introduction, Formation of Energy Bands in Crystals, Characteristics, Bonding, Classification, Intrinsic and Extrinsic Semiconductors, Band structure, Energy Bands, Fermi Level and Fermi Energy, Carrier Concentration, Density of electrons in Conduction band, Position of Fermi level, Hall Effect, Applications

Reference Books:

1. Solid state Physics by Dekker
2. Solid state Physics By C.Kittel

MA1201 **MATHEMATICS – II**

Externals: 60 Marks **L-T-P-C***
Internals : 40 Marks **4-0-0-4**

Objectives:

- To learn the concepts of Eigen values, Eigen vectors, vector spaces and its basis.
- To provide an overview of ordinary differential equations
- To study the methods of solving improper integrals and the concepts of multiple integrals
- To study vector differential and integral calculus

UNIT-I

Linear Algebra: System of Linear equations ,Vector spaces, Subspaces, Linear combination of vectors, linear dependence and independence of vectors, Basis and Dimension of Vector Space.

Linear transformations, Range and Kernel of Linear Transformations, Rank-Nullity theorem. Matrix representations of Linear Transformation.Eigenvalues and Eigenvectors of a Linear Transformation and their properties , Cayley - Hamilton Theorem, Hermitian and skew Hermitian matrices. Quadratic forms, reduction of quadratic form to canonical form by orthogonal transformation.

UNIT-II

Ordinary Differential Equations of first order: Exact first order differential equation, finding integrating factors, linear differential equations, Bernoulli's , Riccati , Clairaut's differential equations, finding orthogonal trajectory of family of curves, Newton's Law of Cooling, Law of Natural growth or decay.

UNIT-III

Ordinary Differential Equations of higher order: Linear dependence and independence of functions, Wronskian of n- functions to determine Linear Independence and dependence of functions, Solutions of Second and higher order differential equations (homogeneous & non-homogeneous) with constant coefficients, Method of variation of parameters, Euler-Cauchy equation.

UNIT-IV

Integral Calculus : Convergence of improper integrals, tests of convergence, Beta and Gamma functions - elementary properties, differentiation under integral sign, differentiation of integrals with variable limits - Leibnitz rule. Rectification, double and triple integrals, computations of surface and volumes, change of variables in double integrals - Jacobians of transformations, integrals dependent on parameters – applications.

UNIT-V

Vector Calculus : Scalar and vector fields, level surfaces, directional derivative, Gradient, Curl, Divergence, Laplacian, line and surface integrals, theorems of Green, Gauss and Stokes.

Text Books:

1. Advanced Engineering Mathematics (3rd Edition) by R. K. Jain and S. R. K. Iyengar, Narosa Publishing House, New Delhi

Suggested References:

1. Advanced Engineering Mathematics (8th Edition) by Erwin Kreyszig, Wiley-India.

2. Dr. M.D. Raisinghania, Ordinary and Partial differential equations, S.CHAND, 17^{th} Edition 2014.

*L-T-P-C stands for number of lectures, tutorials, practices and credits

EE1001/2001 BASIC ELECTRICAL & ELECTRONICS ENGINEERING

Externals: 60Marks **L-T-P-C***

Internals: 40Marks **4-0-0-4**

Objectives:

This course introduces the concept of

- Electrical DC and AC circuits, basic law's of electricity, different methods to solve the electrical networks
- Construction operational features of energy conversion devices i.e., DC and AC machines, transformers.
- It also emphasis on basics of electronics, semiconductor devices and their characteristics and operational features.

UNIT- I DC CIRCUIT ANALYSIS

Electrical Circuits - R-L-C Parameters, Voltage and Current Independent and Dependent Sources, Source Transformation – V–I relationship for Passive elements, Kirchoff's Laws, Network reduction techniques – series, parallel, series parallel, star–to-delta, delta-to-star transformation, Mesh Analysis and Nodal Analysis

UNIT- II AC CIRCUIT ANALYSIS

Single Phase AC Circuits - R.M.S. and Average values, Form Factor, steady state analysis of series, Parallel and Series parallel Combinations of R, L and C with Sinusoidal excitation, concept of reactance, Impedance, Susceptance and Admittance – phase and phase difference, Concept of Power Factor, j-notation, complex and Polar forms of representation.

Resonance – Series resonance and Parallel resonance circuits, concept of bandwidth and Q factor, Locus Diagrams for RL, RC and RLC Combinations for Various Parameters.

UNIT- III NETWORK THEOREMS AND THREE PHASE AC CIRCUITS

Network Theorems - Thevenin's, Norton's, Maximum Power Transfer, Superposition, Reciprocity, Tellegen's, Millman's and Compensation theorems

Three phase ac circuits -Three phase EMF generation, delta and Y connections, line and phase quantities, solution of three phase circuits, balanced supply voltage and balanced load, phasor diagram, measurement of power in three phase circuits

UNIT- IV BASIC ELECTRONICS

Introduction to electronics and electronic systems, Semiconductor and devices like diodes, zener diode, BJT, FET, MOSFET, Rectifier and ripple Filters, Transistor biasing. Small signal transistor amplifiers, Operational amplifiers, Feedback and Oscillators, Introduction to digital circuits

UNIT- V ELECTRICAL MACHINES

DC machines: Construction, EMF and Torque equations, Characteristics of DC generators and motors, speed control of DC motors and DC motor starters.

Transformers : Construction, EMF equation, ratings, phasor diagram on no load and full load, equivalent circuit, regulation and efficiency calculations, open and short circuit tests, auto-transformers.

Induction motors: The revolving magnetic field, principle of orientation, ratings, equivalent circuit, Torque-speed characteristics, starters for cage and wound rotor type induction motors.

TEXT BOOKS:

1. Electrical Technology- Hughes Prentice Hall, 7th edition
2. Problems In Electrical Engineering- S. Parker Smith, 9 edition
3. Electronic Devices and Circuits – R.L. Boylestad and Louis Nashelsky, PEI/PHI, 9th Ed, 2006.
4. Millman's Electronic Devices and Circuits – J.Millman and C.C.Halkias, Satyabratajit, TMH, 2/e, 1998.
5. Engineering circuit analysis- by William Hayt and Jack E. Kemmerly, Mc Graw Hill Company, 6th edition.
6. Electric Machines –by I.J.Nagrath & D.P.Kothari,Tata Mc Graw Hill, 7th Edition.2005

REFERENCES:

1. Electronic Devices and Circuits - K. Lal Kishore, B.S. Publications, 2nd Edition, 2005.
2. Electronic Devices and Circuits – Anil K. Maini, Varsha Agarwal –Wiley India Pvt. Ltd. 1/e 2009.
4. Network Theory by N.C.Jagan & C.Lakshminarayana, B.S. Publications.
5. Network Theory by Sudhakar, Shyam Mohan Palli, TMH.
6. Electrical machines-PS Bhimbra, Khanna Publishers.

CS1201 **SCRIPTING LANGUAGES**

Externals: 60Marks **L-T-P-C***

Internals: 40Marks **4-0-0-3**

Prerequisites

1. Programming in C and Data Structures.

Objectives

1. To learn scripting languages- Python, Perl, PHP

Outcome

1. Student will be able to write dynamic web pages and will also be able to build a basic search engine using python and also search through text files using Perl.

UNIT-I

Python - Introduction-Variables, Strings, numbers, comments, Lists- introducing list, lists and looping, common list operations, removing items from list, numerical lists, list comprehensions, strings as lists, tuples, file I/O, functions, conditional statements and iterative statements.

UNIT –II

Python - Dictionaries, common operations with dictionaries, looping through dictionaries, nesting, classes, inheritance, modules and classes, exceptions and testing. Exceptions, sorting, introduction to standard libraries, building a Search Engine using all the above concepts.

UNIT-III

Perl – Data types, scalar functions, Quoting Basics, Functions, Control Structures, Inputs, Error Handling.

UNIT-IV

Perl – File input output, text processing functions, Hashes, DBM Databases, Regular Expressions.

UNIT- V

HTML – Styles, links, images, Static and Dynamic pages, Paragraphs and Fonts, Lists, CSS introduction, Introduction to HTML5 and semantics.

PHP – Loops, String Functions, Email function, Data and time, Image Uploading, Error Handling.

Text Books:-

1. Programming Python, 4th Edition Powerful Object-Oriented Programming By Mark Lutz
2. Learning Perl, Randal L Schwartz.
3. Web Programming, building internet applications, Chris Bates 2nd edition, WILEY Dreamtech

HS1201 **COMMUNICATION SKILLS - II**

Externals: 60Marks **L-T-P-C***

Internals: 40Marks **2-0-0-1**

Objectives:

- To complement the comprehensibility of the Technical subjects in a better way.
- To make them competent to attempt and qualify in various tests.

UNIT-I

Writing – Letter Writing **– Formal** – Inquiry – Application - Acceptance – Apology – Complaint – Seeking leave- **Informal - E mail –** Formal **- Speaking -** Introducing oneself - Introducing others - Asking for/giving directions **- Conversations** –Developing conversation skill in specific contexts (another sub-title is SITUATIONAL VARIATIONS IN TELEPHONE OPENINGS) – Leaving a message – How to make an appointment – **(Add more**) - Conversation Practice –-

Suggestions: Check the following site for better understanding - http://www.bbc.co.uk/worldservice/learningenglish/business/talkingbusiness/unit1telephone/1connecting.shtml

Suggested References:

*L-T-P-C stands for number of lectures, tutorials, practices and credits

CE1601 ENGINEERING DRAWING

Externals: 60Marks **L-T-P-C**
Internals: 40Marks **0-0-3-2**

Objectives:

- To understand the basic concepts of drawing and use of drafter.
- To draw the basic geometrical constructions and curves used in engineering.
- To understand and draw the projections of points, lines, planes and solids.
- To know about isometric projections.

Concepts and conventions: Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning

UNIT-1

Plane curves and free hand sketching: Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle – Drawing of tangents and normal to the above curves, Scales: Construction of Diagonal and Vernier scales. Visualization concepts and Free Hand sketching: Visualization principles – Representation of three Dimensional objects – Layout of views- Free hand sketching of multiple views from pictorial views of objects

UNIT-II

Projection of points, lines and plane surfaces: Orthographic projection- principles- Principal planes- First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces - Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method

UNIT-III

Projection of solids: Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method and auxiliary plane method.

UNIT-IV

Projection of sectioned solids and development of surfaces: Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones. Development of lateral

surfaces of solids with cut-outs and holes

UNIT V

Isometric and perspective projections: Principles of isometric projection – isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions and miscellaneous problems. Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method.

Computer aided drafting (demonstration only)

Introduction to drafting packages and demonstration of their use.

Suggested Readings:

1. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 50 Edition, 2010.
2. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age publications
3. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Stores, Bangalore, 2007.
4. Luzzader, Warren.J. and Duff,John M., "Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern EconomyEdition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
5. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age

PH 1601 **PHYSICS LAB**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **0-0-3-2**

1. Coupled Pendula
2. Specific rotation - Polarimeter
3. Diffraction Grating
4. Dispersive power of a prism
5. Franck Hertz experiment
6. Photoelectric effect
7. Four probe Experiment
8. Hall effect
9. Ultrasonic Waves

EE1601/2601 BASIC ELECTRICAL & ELECTRONICS ENGINEERING LAB

Externals: 60Marks **L-T-P-C***

Internals: 40Marks **0-0-3-2**

List of Experiments:

1. Verification of Network Theorems
2. R-L-C Series Circuit
3. Series and parallel resonanance
4. Three phase power measurement by two Wattmeter method
5. Speed control of DC motor
6. OC and SC Test of Single Phase Transformer
7. OCC of separately excited DC Shunt Generator
8. V-I characteristics of Diodes and BJT
9. Half-wave and full-wave rectifiers, rectification with capacitive filters, zener diode
10. Studies on logic gates

II YEAR

II SEMESTER

S.No	Subject Code	Subject Name	(L-T)-P	Credits
1	CH2201	Process Heat Transfer	4-0	4
2	CH2202	Mechanical Unit Operations	4-0	4
3	CH2203	Mass Transfer Operations-I	4-0	4
4	CY2201	Analytical Chemistry	4-0	3
5	MM2205	Material Science	4-0	4
6	BM2201	Personality Development – I	2-0	1
7	CH2801	Process Heat Transfer Lab	0-3	2
8	CH2802	Mechanical Unit Operations Lab	0-3	2
9	CH2902	Seminar-II		1
Total Credits				25

L-Lectures; T-Tutorials; P-Practicals; C-Credits.

CH2201 PROCESS HEAT TRANSFER

Externals: 60 Marks **L-T-P-C**

Internals: 40 Marks **4-0-0-4**

Objectives:

- Study various modes of Heat transfer and their fundamental relations.
- Study conduction heat transfer and develop mathematical relations for various solid geometries.
- Understand different types of heat transfer coefficients and their estimations in various types of flows in different geometries.
- Understand the working of Heat exchangers and to learn design of double pipe, shell and tube heat exchangers and design of evaporators and conduct experiments and to submit the report.
- Understand the phenomenon of radiation, radiation shields and estimation of emissivity.

Unit-1

Introduction & Heat transfer by conduction: Nature of heat flow, Heat transfer by conduction in Solids Fourier's law ,thermal conductivity, steady state conduction in plane wall & composite walls, compound resistances in series, Thermal Insulation.

Heat flow through a cylinder, conduction in spheres, thermal contact resistance, plane wall: variable conductivity. Unsteady state heat conduction Equation for one-dimensional conduction, Semi-infinite solid, finite solid

Unit-2

Heat Transfer to Fluids without Phase change: Regimes of heat transfer in fluids, thermal boundary layer, heat transfer by forced convection in laminar flow, Heat transfer by forced convection in turbulent flow, the transfer of heat by turbulent eddies and analogy between transfer of momentum and heat.

Unit-3

Natural convection -Natural convection to air from vertical shapes and horizontal planes, effect of natural convection in laminar flow heat transfer, Free convection in enclosed spaces, mixed free & forced convection

Heat transfer to fluids with phase change -Heat transfer from condensing vapors, heat transfer to boiling liquids.

Unit-4

Heat exchange equipment : General design of heat exchange equipment, heat exchangers, condensers, Boilers and Calendrias, extended surface equipment, heat transfer in agitated vessels, scraped surface heat exchangers, heat transfer in packed beds, heat exchanger effectiveness (NTU method).

Unit-5

Radiation -Properties and definitions, black body radiation, real surfaces and the gray body. Absorption of radiation by opaque solids, radiation between surfaces, radiation shielding, radiation to semi transparent materials.
Evaporators – Various types of Evaporators, performance of tubular evaporators, capacity and economy, single and multiple effect evaporators, vapour recompression.

Text Books

1. Unit Operations of Chemical Engineering, W. L. McCabe, J. C. Smith & Peter Harriot, 6th Edition. McGraw-Hill
2. Transport processes and Unit operations, Christie J. Geankoplis, PHI.

References: .

1. Process heat transfer, D. Q. Kern, McGraw-Hill.
2. Heat Transfer, 9^{th} ed., J.P. Holman, McGraw-Hill, New York.,2004
3. Heat Transfer by B. K. Dutta

CH2202 MECHANICAL UNIT OPERATIONS

Externals: 60 Marks **L-T-P-C**
Internals: 40 Marks **4-0-0-4**

Objectives:

This course deals with the different mechanical unit operations in chemical engineering. Specific attention is given on particle and separation techniques.

- Student will gain knowledge on various mechanical separation operations used in chemical industry.
- Classify and identify the storage, mixing and transportation equipment.
- Calculate the average size of solid particles of a given solid sample. Describe size reduction equipment and distinguish between different size reduction equipment.
- Choose the type of filtration process for a solid liquid separation.
- Explain the flow patterns in an agitator.

Unit-1

Introduction to unit operations ; Properties, handling and mixing of particulate solids: Characterization of solid particles, properties of particulate masses, storage and mixing of solids-Bulk storage, Bin storage & Silos, Transportation of solid particulate mass, belt, screw, apron conveyers, bucket elevators, pneumatic conveying.

Unit-2

Size reduction -Principles of comminution, size reduction equipment-Crushers (Jaw Crusher, Gyratory Crusher), Grinders (Ball mill, Tumbling mills), Ultra fine grinders (Fluid energy mills), Cutting machines, Equipment operation-Open circuit & closed circuit operation. Laws of crushing: Kick's law, Bond's law, Rittinger's law.

Screening, differential & cumulative analysis, Industrial screening equipments-Stationary screens and grizzlies, Gyrating screens, Vibrating screens, comparison of ideal and actual screens, Material balances over screen, capacity and effectiveness of screens;

Unit-3

Filtration, Types of filters, cake filters, constant rate filtration, constant pressure filtration, centrifugal filters-Plate and Frame filter press, Chamber press, Rotary Drum filter, Vacuum Nutch filter, top suspended batch centrifuge, filter aids, Principles of cake filtration. Clarifying filters, liquid clarification, gas cleaning, Principles of clarification. Cross flow filtration, types of membranes, micro filtration.

Unit-4

Separations based on motion of particles through fluids, gravity settling processes-gravity classifiers, sorting classifiers- float and sink method, differential settling method, coagulation, flocculation and flocculating agents, centrifugal settling processes-cyclone separators & hydro cyclones. Centrifugal decanters-Tubular & Disk centrifuge.

Unit-5

Electro-static precipitators. Flotation-separation of ores, flotation agents, Magnetic separators-Ball Norton machine, magnetic pulley separator & magnetic drum separator.

Agitation and mixing of liquids: Agitation of liquids, Types of impellers-propellers, turbines, paddles. Flow patterns in agitated vessels, power consumption in agitated vessels.

Text Book:

1. Unit Operations in Chemical Engineering, W.L. McCabe and J.C. Smith and Peter Harriott, Mc Graw Hill, 7^{th} ed. 2001.

References Books:

1. Chemical engineers hand book, J.H. Perry, 7th ed. Mc Graw Hill
2. Introduction to Chemical Engineering, J.T.Banchero & W.L. Badger., TMH, 1997.

CH2203 MASS TRANSFER OPERATIONS – I

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks **4-0-0-4**

Objectives:

- To discuss the fundamental concepts of mass transfer principles and to apply those concepts to real engineering problems.
- To impart the basic concepts of molecular diffusion, mass transfer coefficients and analysis of different mass transfer processes
- Applies the concepts of diffusion mass transfer, mass transfer coefficients, convective mass transfer, inter-phase mass transfer, equipment for gas-liquid operations.

Unit-1

Classification of the Mass-Transfer Operations. Molecular Diffusion in Fluids: Molecular diffusion, Fick's Law of Diffusion, Equation of Continuity, binary solutions, Steady State Molecular Diffusion in Fluids at Rest and in Laminar Flow. Gas-Phase Diffusion Coefficient: Use of Stefan Tube. Liquid-Phase Diffusion Coefficient estimation.

Unit-2

Basics of Diffusion in Solids and Unsteady State Diffusion. Mass Transfer Coefficients: F-type and k-type coefficients, Theories of Mass Transfer: Film theory, Penetration theory, surface renewal theory and Boundary layer theory. Wetted wall column. Mass, Heat and Momentum Transfer Analogies.

Unit-3

Inter-Phase Mass Transfer: Concept of Equilibrium, Diffusion between Phases, material Balances in Steady State Co-current and Countercurrent Processes, Stages, Kremser-Brown equations.

Gas-Liquid Operations: Tray Towers, Tray efficiency: Murphree tray efficiency. Packed Bed Towers- Types of Packing. Tray Towers Vs Packed Towers.

Unit-4

Absorption and Stripping: Absorption equilibrium, Ideal and Non-Ideal Solutions: Raoult's law, Henry's law. Selection of a Solvent for Absorption, one component transferred: material balances, minimum liquid-gas ratio for absorbers. Countercurrent multistage operation: one component transferred, the Absorption factor, determination of number of stages. Continuous-contact equipment: HETP, HTU, NTU determination.

Unit-5

Humidification and Dehumidification: Humidification Principles, Absolute Humidity, Unsaturated vapor-gas mixtures, adiabatic saturation curves, wet bulb temperature, the Lewis

relation, the Psychometric chart and its use. Description of cooling towers- construction and operation.

Drying: Definitions, Drying operations: Batch drying, the rate of batch drying, the mechanism of batch drying. Continuous drying: Classification drying equipment: Conveyer dryer, rotary dryers.

Text Book:

1. Mass Transfer Operations, 3rd ed., R. E. Treybal, McGraw-Hill, New York.
2. Principles of Mass Transfer and Separation processes, Binary K. Dutta PHI Learning Pvt. Ltd., New Delhi, 2012

Reference Books:

1. Unit operations in chemical engineering, W.L. McCabe and J.C. Smith and Peter Harriott, Mc Graw Hill, 7th ed. 2001.

CY2201 **ANALYTICAL CHEMISTRY**

Externals: 60 Marks **L-T-P-C**

Internals: 40 Marks **4-0-0-3**

Objectives:

- To acquire basic principles of simple instrumental methods for estimation of organic/inorganic species.
- To acquire basic knowledge of industrial separations
- To acquire Knowledge in Characterization of the Materials synthesized by chemical industry
- To understand the Preparations, properties and reactions of materials

UNIT-I

Basic Principles of Quantitative Analysis

Limitations of analytical methods, Classification of errors, Acuracy, Precision, How to reduce systematic errors, Significant figures, Calculators and Computers, Mean and Standard deviation, Distribution of Random errors, Reliability of Results, Confidence interval , Comparison of results, Comparing the means of two samples.

UNIT-II

Chromatographic Methods:

Column chromatography-general principles, terminology: retention time, rotation volume, separation factor, resolution of peaks. Principles of gas chromatography, block diagram of gas chromatograph - detectors (FID, ECD), stationary phases for column, mobile phases, chromatogram, qualitative analysis, special plots, quantitative analysis, HPLC: Principles of High Performance Liquid Chromatography. Block diagram of HPLC Systems, function of each component, stationary phases, eluting solvents, pumps, detectors, quantitative applications of HPLC. Ion chromatography - separation of anions and cations. Suppressed & non-suppressed ion chromatography. Numerical calculations.

Unit-III

Thermal methods of Analysis:

Introduction to Thermal methods, Thermogravimetric Analysis (TGA)-principles, and applications (determination of drying temperatures, kinetic methods, automatic thermo gravimetric Analysis) DTA: Differential thermal analysis-Principles and applications (exothermic and endothermic peaks, heat of reaction, catalysis, decompositions etc.,)

DSC: Differential scanning calorimettry, principles & applications (exothermic & endothermic peaks, compound purity determination, percentage crystallinity, glass transition temperature).

Unit-IV

Electro-Analytical Techniques

Polarography: Definition, advantage of dropping mercury electrode, factors affecting on limiting current, Half wave potentials and significance, Applications of Polarography

Amperometric Titrations: Basic principle involved in the Amperometry, Amperometric Titrations and applications, Advantages and disadvantages of Amperometric Titrations

Unit-V

Spectrophotometric Methods:

Introduction to Analysis: Qualitative & Quantitative Analysis; Conventional & Instrumental methods of analysis. Molecular spectrophotometry-Beer's law Block diagram of UV-Visible Spectrophotometer – quantitative analysis direct method for the determination metal ions: Chromium, Manganese, Iron, etc in alloys. Simultaneous Spectrophotometric determination of chromium, manganese. Infrared spectrometry-Functional group analysis of organic compounds using infrared spectra. Quantitative analysis of organic molecules. Flame photometry-principles & applications. (Determination of Sodium, Potassium and Calcium.)

Course Outcome:

The student may acquire enough knowledge on industrial processes and Identification of Products using different analytical and instrumental techniques.

Suggested References:

1. Quantitative analysis, R.A.Day & A.L. Underwood , 5th edition, Printice- Hall of India Pvt. Ltd., 2000.
2. Vogel's Text Book of Qualitative chemical analysis, J. Mendham, R.C.Denney, J. Darnes, M.J.K. Thomas, Persar education 6th edition, 2002.
3. Elements of Physical Chemistry-Peter Atkins, Oxford Uni.Press, 3rd Edition, 2010.
4. Instrumental methods of Chemical Analysis, E.W. Ewing, McGraw Hill.
5. Instrumental Methods of Analysis, H.H. Willard, L.L. Merrit, J.A. Dean and F.A. Shette, Jr, CBS Publishers and Distributors, New Delhi.
6. Atkin's Physical Chemistry – P. Atkins and J. De Paula, Oxford Univ.Press, 9th Edition, 2012
7. Instrumental lMethods of Chemical Analysis, Gurdeep R.Chatwal, Sham K.Ananad, Himalayha publishing House,5th Edition, 2012.
8. Advanced physical chemistry – Gurudeepraj, Goel Publishing House, 2000
9. Essentials of Physical Chemistry- Arun Bahl, B.S.Bahl and G.D.Rulasi, S.Chand Publishers, New Delhi.

MM2206 **MATERIAL SCIENCE**

Externals: 60 Marks **L-T-P-C**
Internals: 40 Marks **4-0-0-4**

Objectives:

- Understand concepts on properties and selection of metals, ceramics, and polymers for design and manufacturing.
- Study variety of engineering applications through knowledge of atomic structure, electronic structure, chemical bonding, crystal structure, x-rays and x-ray diffraction, defect structure.
- Study Microstructure and structure-property relationships, Phase diagrams, heat treatment of steels.
- Study detailed information on types of corrosion and its prevention.
- Learn information on selection of materials for design and manufacturing.

Unit-1

Introduction: Engineering Materials – Classification – levels of structure.

Crystal Geometry and Structure Determination: Space lattice and Unit cell. Bravais lattices, crystal systems with examples. Lattice coordinates, Miller indices, Bravais indices for directions and places: crystalline and non crystalline solids; ionic, covalent and metallic solids; packing efficiency, coordination number; structure determination by Bragg's X-ray diffraction and powder methods.

Unit-2

Crystal Imperfection: Point defects, line defects-edge and screw dislocation, Berger's circuit and Berger's vectors, dislocation reaction, dislocation motion, multiplication of dislocations during deformation , role of dislocation on crystal properties; surface defects, dislocation density and stress required to move dislocations.

Unit-3

Basic thermodynamic functions: phase diagrams and phase transformation: Primary and binary systems-general types with examples; tie line& lever rule, non equilibrium cooling: phase diagrams of Fe-Fe_3-C, Pb-Sn, Cu-Ni systems.

Phase transformations in Fe-Fe_3-C steels, Time-Temperature-Transformation (TTT) curves for eutectoid steels and plain carbon steels; effect of alloying elements on properties of steels; types of steels, alloys and other metals used in chemical industry.

Unit-4

Elastic, an elastic and plastic deformations in solid materials; rubber like elasticity, visco elastic behavior (models); shear strength of real and perfect crystals, work hardening mechanisms, cold

working, hot working; dynamic recovery, recrystallization, grain growth, grain size and yield stress, Brief description of heat treatment in steels.

Magnetic materials: Terminology and classification, magnetic moments due to electron spin, ferro-magnetism and related phenomena, domain structure, hysteresis loop, soft and hard magnetic materials.

Unit-5

Fracture in ductile and brittle materials, creep: mechanism of creep and methods to reduce creeping in materials, creep rates and relations. Fatigue-mechanisms and methods to improve fatigue resistance in materials. Composite materials: types; stress-strain relations in composite materials, applications.

Oxidation and Corrosion: Mechanisms of oxidation, oxidation resistant materials, principles and types of corrosion, protection against corrosion.

Text Book:

1. Materials Science and Engineering, 5thed. V. Raghavan, PHI Learning Pvt. Ltd., New Delhi, 2009.

References:

1. Elements of Materials Science, L.R. Van Vlack,
2. Science of Engineering Materials, vols. 1&2, Manas Chanda, McMillan Company of India Ltd.

BM2201 PERSONALITY DEVELOPMENT – I

External Examination: 60 Marks **L-T-P-C**

Internal Examination: 40 Marks **2-0-0-1**

Guidelines: Learning approach is based on Real time case studies with class room activities

Course Objectives:

1. To develop interpersonal skills and be an effective goal oriented team player.
2. To develop professionals with idealistic, practical and moral values.
3. To develop communication and problem solving skills.
4. To re-engineer attitude and understand its influence on behavior.
5. To enhance holistic development of students and improve their employability skills.

UNIT – I

SELF ANALYSIS **(6 hours)**

SWOT Analysis, Who am I, Personality Traits, Importance of Self Confidence, Self Esteem.

UNIT – II

GOALS SETTINGS **(6 hours)**

Short term, Long term goal settings, SMART concept

Diversifying Risk and Optimizing Opportunities

UNIT – III

TEAM DYNAMICS WITH INTERPERSONAL SKILLS **(8 hours)**

Team Dynamics, Team Work, Interpersonal Skills

Behavioral Skills GD, PI, Body Language Public Speaking, Verbal, Non Verbal Communications

UNIT – IV

CREATIVITY AND RATIONALITY **(8 hours)**

Out of Box thinking, Idea Generation with creativity

Brain Storming, Effective group meetings, Rationalization of ideas and way to effective implementation

- **Class room and team activities coupled with group tasks depending upon time availability**

CH2801 PROCESS HEAT TRANSFER LAB

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **0-0-3-2**

Objectives:

- This lab will provide practical knowledge on various heat transfer process and equipment like heat exchangers and evaporators.
- Learn basic Heat transfer principles.
- Impart the knowledge in heat transfer measurements and different heat transfer equipment
- Learn how the convection takes place in natural and forced convection and gain knowledge of the heat transfer taking place in different heat exchangers.

List of Experiments :

1. Determination of total thermal resistance and thermal conductivity of composite wall.
   Major equipment - Composite wall Assembly
2. Determination of thermal conductivity of a metal rod.
   Major equipment - Thermal Conductivity apparatus
3. Determination of natural convective heat transfer coefficient for a vertical tube.
   Major equipment - Natural convection heat transfer apparatus
4. Determination of critical heat flux point for pool boiling of water.
   Major equipment- Pool boiling apparatus
5. Determination of forced convective heat transfer coefficient for air flowing through a pipe
   Major equipment – Forced convection heat transfer apparatus
6. Determination of overall heat transfer coefficient in Shell and Tube heat exchanger.
   Major equipment – Shell and Tube heat exchanger apparatus
7. Determination of thermal conductivity of a Liquid.
   Major equipment - Thermal Conductivity apparatus
8. Determination of Stefan – Boltzmann constant.
   Major equipment - Stefan Boltzmann apparatus
9. Determination of emissivity of a given plate at various temperatures.
   Major equipment - Emissivity determination apparatus

CH2802 MECHANICAL UNIT OPERATIONS LAB

Externals: 60Marks **L-T-P-C***

Internals: 40Marks **0-0-3-2**

Objectives:

- To enable the students to develop a sound working knowledge on different types of crushing equipments and separation characteristics of different mechanical operation separators.

List of experiments:

1. To determine the time of grinding in a ball mill for producing a product with 80 % passing a given screen.
   Major equipment - Ball mill Apparatus, Sieve shaker, Different sizes of sieves, weighing balance.
2. To verify the laws of crushing using any size reduction equipment and to find out the working index of the material.
   Major equipment – Jaw Crusher, Sieve shaker, Different sizes of sieves, Weighing Balance, Energy meter.
3. To find the effectiveness of hand screening and vibrating screen of a given sample.
   Major equipment - Vibrating Sieve shaker, Different sizes of sieves, Weighing Balance.
4. To achieve beneficiation of a ore using froth flotation technique.
   Major equipment - Froth flotation cell
5. To obtain batch sedimentation data and to calculate the minimum thickener area under given conditions.
   Major equipment- Sedimentation apparatus
6. To determine the specific cake resistance and filter medium resistance of slurry in plate and frame filter press.
   Major equipment - Plate and frame filter press.
7. To determine reduction ratio of a given sample in .a grinder Major equipment - Grinder
8. To determine the viscosity of a liquid by using stokes law and by VISCOMETER Instrument
9. To calculate separation efficiency of particles in a mixture using cyclone separator

CH2902 **Seminar-II**

Externals: 100 Marks **L-T-P-C**

0-0-0-1

Objectives:

- To improve the presentation skills
- To prepare PPT more effectively

Student has to chose a topic related socio-economic matter to give a power point presentation

III YEAR
II SEMESTER

S.No	Subject Code	Subject Name	(L-T)-P	Credits (C)
1	CH3201	Chemical Reaction Engineering-II	4-0	4
2	CH3202	General Chemical Technology	4-0	4
3	CH3203	Energy Engineering	4-0	4
4	CH3204	Plant Design and Economics	4-0	3
5	CS3001	Object Oriented Programming through Java	4-0	4
6	HS3201	Soft Skills	2-0	1
7	CH3801	Chemical Reaction Engineering Lab	0-3	2
8	CS3601	Object Oriented Programming through Java Lab	0-3	2
9	CH3902	Seminar-III		1
10	CH3000	Comprehensive Viva-I		1
Total Credits				26

L-Lectures; T-Tutorials; P-Practicals; C-Credits.

Every student must do 8 weeks of Summer Internship after E3-Sem2 Examination. The evaluation of Summer Internship will be done in the beginning of E4-Sem1.

CH3201 CHEMICAL REACTION ENGINEERING-II

Externals: 60 Marks **L-T-P-C**
Internals: 40 Marks **4-0-0-4**

Objectives:

- Learn to characterize and diagnose the non-ideal reactors. Learn the modeling of Non-ideal flow reacting vessels.
- Calculate the conversions in non-ideal reactor using various flow models.
- Understand the concepts in heterogeneous reaction systems. Determine the rate controlling step in catalytic reactions. Understand the internal and external diffusion effects.
- Learn the factors influencing catalyst decay, the role of pore diffusion on catalyst activity rate.
- Learn the kinetics and reactor design of various heterogeneous reaction systems

Unit-1

Non-Ideal Flow: Basics of Non-Ideal Flow; E, the age distribution of fluid, the RTD, Pulse Response Experiments; Conversion in Non-Ideal flow reactors; Compartment Models,

Unit-2

The Dispersion Model-Axial Dispersion, Correlations for Axial Dispersion, Chemical Reaction and Dispersion.

The Tanks-in-series Model- RTD, Chemical Conversion

Unit-3

The Convection Model for Laminar Flow: The Pure Convection Model and its RTD, Chemical Conversion in Laminar Flow reactors.

Earliness of Mixing, Late mixing, Segregation and RTD: Self Mixing of a single fluid, Mixing of two miscible fluids

Unit-4

Reactions Catalyzed by solids: Heterogeneous Reactions-Introduction:
Solid Catalyzed Reactions: The Rate Equation For surface Kinetics, Pore diffusion resistance combined with surface kinetics, porous catalyst particles, Heat effects during reaction, Performance equations for reactors containing porous catalyst particles, Experimental methods for finding rates. Rate-Controlling Step.
Various types of fixed bed reactors and fluidized bed reactors.
Deactivating Catalysts-Mechanisms of Catalyst deactivation, rate and performance equation

Unit-5

Non-Catalytic Systems:
Fluid-Fluid Reaction Kinetics; Fluid-Fluid reactor design
Fluid-Particle Reaction Kinetics-Selection of a model, Shrinking Core Model for spherical particles of unchanging size, Rate of reaction for shrinking spherical particles; Rate-Controlling Step.

Text Books:

1. Chemical Reaction Engineering, Octave Levenspiel, 3rd Edition, John Wiley & Sons India Edition

Reference Books:

1. Elements of Chemical Reaction Engineering, Scott Fogler. H, 4th Edition. PHI
2. The Engineering of Chemical Reactions, 2nd ed., L.D. Schmidt, Oxford University Press, New Delhi, 2010

CH3202 **GENERAL CHEMICAL TECHNOLOGY**

Externals: 60 Marks **L-T-P-C**

Internals: 40 Marks **4-0-0-4**

Objectives:

- Unit operations unit processes involved in manufacture of important and widely employed organic and inorganic chemicals.
- Develop skills in preparing /presenting a neat Engineering drawing for Chemical Process Industries.
- Impart clear description of one latest process along with its Chemistry, Process parameters, Engineering Problems and Optimum Conditions.
- Demonstrate the importance of updating the latest technological developments in producing products economically and environment friendly.
- Appreciate the usage of other engineering principles such as Thermodynamics, Heat, mass and momentum transfer in operation and maintain the productivity

Unit-1

Introduction to Chemical Technology, Unit Operation, Unit Process & varies Process flow diagrams. Introduction to various symbols & application of unit operations in Process Flow diagrams.

Unit-2

Detailed study of manufacturing process of Inorganic Industry-1- Sulfur and Sulfuric acid Industry, Nitrogen Industry-Ammonia, Nitric acid by ammonia oxidation process, Urea from ammonium carbamate, Ammonium nitrate.

Unit-3

Detailed study of manufacturing process of Inorganic Industry-2-Phosphorus Industry-phosphorus production by electric furnace method, phosphoric acid production by strong acid(H_2SO_4) process & by HCl leaching process, Superphosphate & Triple Superphosphate.

Unit-4

Chlor-Alkali Industries:-manufacture of soda-ash by solvay process, electrolytic process for chlorine-caustic soda production.

Cement Industry.

Detailed study of manufacturing process of Organic Industry-1:

Soap, Detergent and Glycerin-“continuous process for fatty acids, soap and glycerin”,

Sugar and Starch Industry-extraction of sucrose from sugarcane, starch production from maize, production of dextrin by starch hydrolysis.

Unit-5

Paper and Pulp Industry: Sulfate(Kraft) Pulp process-preparation of wood pulp by sulfate process, chemical recovery from sulfate pulp digestion liquor, chemical recovery from neutral pulp digestion liquor. paper making process.
Fermentation Industry-ethyl alcohol by fermentation.
Introduction to Water Gas, Producer Gas ,Natural Gas & Synthesis Gases, Introduction to Petroleum Industry, Introduction to Polymer Industry.

Text books:

1. Shreve's Chemical Process Industries edited by Austin, Mc.graw-Hill.5th ed.1985.
2. Dryden's Outlines of Chemical Technology edited by M. Gopal Rao and M. Sittig, 2nd ed. 1973.

References:

1. Industrial Chemistry by B.K. Sharma,
2. Hand book of industrial chemistry Vol 1& II K.H.Davis & F.S. Berner Edited by S.C. Bhatia, CBS publishers
3. Chemical Technology: G.N. Panday, Vol 1& Vol II.

CH3203 ENERGY ENGINEERING

Externals: 60 Marks **L-T-P-C**
Internals: 40 Marks **4-0-0-4**

Objectives:

- To acquaint the student with the conventional energy sources and their utilization.
- Importance of heat recovery and energy conservation methods and energy audit

Unit-1

Sources of energy, types of fuels- energy and relative forms. Calorific value- gross and net value, calculation of calorific value from fuel analysis, experimental determination energy resources present and future energy demands with reference to India.
Coal: origin, occurrence, reserves, petrography, classification, ranking, analysis, testing, storage, coal carbonization and byproduct recovery, liquefaction of coal, gasification of coal, burning of coal and firing mechanism, burning of pulverized coal.

Unit-2

Liquid fuels: petroleum: origin, occurrence, reserves, composition, classification, characteristics, fractionation, reforming, cracking, petroleum products, specification of petroleum products, burning of liquid fuels.
Natural gas, coke oven gas, producer gas, water gas, LPG, burning of gaseous fuels, hydrogen (from water) as future fuel, fuel cells, flue gas, analysis: orsat apparatus

Unit-3

Steam Plant: Run time cycle, boiler plant, steam cost, steam distribution and utilization, combined heat and power systems, energy from biomass and biogas plants, gas purification, solar energy, wind energy, energy storage

Unit-4

Waste heat recovery, sources of waste heat and potential application, various types of heat recovery systems, regenerators, recuperators, waste heat boilers

Energy conservation: conservation methods in process industries, theoretical analysis, practical limitations.

Unit-5

Energy auditing: short term, medium term, long term schemes, energy conversion, energy index, energy cost, representation of energy consumption, Sankey diagram, energy auditing.

Text Books:

1. Fuels, Furnaces and Refractories, O.P.Gupta
2. Fuels and Combustion, 3rd ed., Samir Sarkar, Universities Press, 2009.

Reference Books:

1. Non-conventional Energy Resources, G.D.Rai, Khanna Publishers
2. Fuel and Energy, Harker and Backhurst, Academic press London 1981
3. Fuel Science- Harker and Allen, Oliver and Boyd, 1972

CH3204 PLANT DESIGN AND ECONOMICS

Externals: 60 Marks **L-T-P-C**
Internals: 40 Marks **4-0-0-3**

Objectives:

- To familiarize the students about various economic aspects of chemical processes
- Learn basics of Cost estimation, Working Capital and Capital Investment and understand the time value of money
- Learn the importance of Cash flow diagrams and Break-even analysis.
- Study depreciation methods and methods of estimation of profitability of an industry
- Study the procedures adopted for Replacement and Selection from Alternatives.

Unit-1

Introduction to Chemical engineering plant design, Process design development, factors affecting profitability of investments. Optimum design- economic design and operational design

Unit-2

Process design considerations Design- project procedure- types of designs, feasibility survey, and process development. Flow diagrams, the preliminary design.

Unit-3

Cost and Asset accounting: Basic relations in accounting, the balance Sheet, the income statement. Cost estimation: Capital investments, types and methods for estimating capital investment. Cost Indexes. Cost factors in capital investment: six-tenth factor rule.

Unit-4

Interest and Investment Costs: Simple Interest, Compound Interest, Continuous Interest, Present worth and Discount, Annuities, Perpetuities and Capitalized costs.

Taxes and insurances, type of taxes: federal income taxes, insurance-types of insurance, self-insurance.

Depreciation: Types of depreciation,services life, salvage value, present value, methods for determining depreciation, single unit and group depreciation.

Unit-5

Profitability analysis: rate of return on discounted cash flow, net present value (NPV), payback period. Annual cost method, present worth method, equivalent alternatives, rate of return method, payout time method, effect of source of capital, replacement of existing facilities.

Optimum Design and Design Strategy, Break even chart.

Text Books

1. Peters Max. S., Timmerhaus Klaus D.and Ronald E West "Plant Design and Economics for Chemical Engineers".2003 5th Edition McGraw Hill.
2. Chemical Engineering Plant Design, C. Vilbrandt and Dryden C.E. 4th Edition, McGraw Hill Book Co., 1959.

Reference Books:

1. Process Engineering Economics, H.E. Schweyer, McGraw Hill Co., New York, Kogakusha Co., Ltd., Tokyo. 1955.

CH3001 OBJECT ORIENTED PROGRAMMING STRUCTURES THROUGH JAVA

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **4-0-0-4**

Objectives:

- To be able to differentiate between structures oriented programming and object oriented programming.
- To be able to use object oriented programming language like Java and associated libraries to develop object oriented programs.
- To Able to understand and apply various object oriented features like inheritance, data abstraction, encapsulation and polymorphism to solve various computing problems using Java language.
- To be able to apply concepts of operator overloading, constructors and destructors.
- To be able to apply exception handling and use built-in classes

UNIT-1:

Introduction to OOPS: Paradigms of Programming Languages, Basic concepts of Object Oriented Programming, Differences between Procedure Oriented Programming and Object Oriented Programming, Objects and Classes, Data abstraction and Encapsulation, Inheritance, Polymorphism, Dynamic binding, Message communication, Benefits of OOP , Application of OOPs.

Java : History, Java features, Java Environment, JDK, API.

Introduction to Java : Types of java program, Creating and Executing a Java program, Java Tokens, Keywords, Character set, Identifiers, Literals, Separator, Java Virtual Machine (JVM), Command Line Arguments, Comments in Java program.

UNIT -2:

Elements: Constants, Variables, Data types, Scope of variables, Type casting, Operators: Arithmetic, Logical, Bit wise operator, Increment and Decrement, Relational, Assignment, Conditional, Special operator, Expressions – Evaluation of Expressions

Decision making and Branching: Simple if statement, if, else statement, Nesting if, else, else if Ladder, switch statement, Decision making and Looping: While loop, do, While loop, for loop, break, labelled loop, continue Statement.-, Simple programs

Arrays: One Dimensional Array, Creating an array, Array processing, Multidimensional Array, Vectors, Wrapper classes, Simple programs

UNIT-3:

Strings: String Array, String Methods, String Buffer Class, Simple programs

Class and objects: Defining a class, Methods, Creating objects, Accessing class members, Constructors, Method overloading, Static members, Nesting of Methods, this keyword, Command line input, Simple programs

Inheritance: Defining a subclass, Deriving a sub class, Single Inheritance, Multilevel Inheritance, Hierarchical Inheritance, Overriding methods, Final variables and methods, Final classes, Finalizer methods, Abstract methods and classes, Visibility Control: Public access, Private access, friend, protected. Interfaces: Multiple Inheritance, Defining interface, Extending interface, Implementing Interface, Accessing interface variables, Simple programs

UNIT- 4:

Packages: Java API Packages, System Packages, Naming Conventions, Creating & Accessing a Package, Adding Class to a Package, Hiding Classes, Programs

Applets: Introduction, Applet Life cycle, Creating & Executing an Applet, Applet tags in HTML, Parameter tag, Aligning the display, Graphics Class: Drawing and filling lines, Rectangles, Polygon, Circles, Arcs, Line Graphs, Drawing Bar charts, Programs

AWT Components and Even Handlers: Abstract window tool kit, Event Handlers, Event Listeners, AWT Controls and Event Handling: Labels, TextComponent, ActionEvent, Buttons, CheckBoxes, ItemEvent, Choice, Scrollbars, Layout Managers- Input Events, Menus, Programs

UNIT-5:

Exception Handling: Limitations of Error handling, Advantages of Exception Handling, Types of Errors, Basics of Exception Handling, try blocks, throwing an exception, catching an exception, finally statement

Multithreading: Creating Threads, Life of a Thread, Defining & Running Thread, Thread Methods, Thread Priority, Synchronization, Implementing runnable interface, Thread Scheduling.

I/O Streams: File, Streams, Advantages, The stream classes, Byte streams, Character streams.

JDBC, ODBC Drivers, JDBC ODBC Bridges, Seven Steps to JDBC, Importing java SQL Packages, Loading & Registering the drivers, Establishing connection. Creating &Executing the statement.

Suggested References:

1. Programming with Java - E. Balagurusamy
2. Java the complete reference, 7th editon, Herbert schildt, TMH.
3. Understanding OOP with Java, updated edition, T. Budd, pearsoneduction.
4. Object oriented Programming in Java - Dr. G.Thampi
5. Let us Java – Yashavant Kanetkar - BPB Publications, New Delhi - First Edition 2012
6. An Introduction to Oops with Java - C Thomas WU - TataMc-Graw Hill, New Delhi - 4th Edition

7. Object oriented Programming through Java - ISRD Group - TataMc-Graw Hill, New Delhi - Eight Reprint 2011

HS3201 **SOFT SKILLS**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **2-0-0-1**

Objectives:

- To implement practically the skills needed for employment.
- To deal with the society in an acceptable way maintaining ethical standards.
- To make them competent to attempt and qualify in various tests.

UNIT-I

PPTs – Introduction - Oral presentation – Power point Presentation – Individual presentation – Group presentation

UNIT-III

Group Discussions - Speaking in Group Discussions - Discussing Problems and Solutions - Creating a Cordial and Cooperative Atmosphere - Using Persuasive Strategies - Being Polite and Firm - Turn-taking Strategies - Effective Intervention - Reaching a Decision - **Organizational GD** - Brainstorming - Nominal Group Technique - Delphi Technique - **GD as Part of Selection Process** - Characteristics - Evaluation and Analysis - Approach to Topics and Case Studies

UNIT-IV

Interviews – Types of interviews – Body language – Fluency – Etiquettes – Mock interviews

UNIT-V

Formal Letters and Email - Introduction - Formats of Written Correspondence - Types of Messages - **Letter Writing** - The Seven Cs of Letter Writing - Purpose - Structure - Layout - Principles - Planning a Letter - **Cover Letters** - Writing the Cover Letter - Academic and Business Cover Letters - Cover Letters Accompanying Résumés - **Emails** - Advantages and Limitations - Style, Structure, and Content - Email Etiquette - Effectiveness and Security

Suggested References:

1. Business Communication – Meenakshi Raman
2. Presenting to Win - Jerry Weissman
3. Boring to Bravo - Kristin Arnold
4. Advanced Presentations by Design- Andrew Abela

CH3801 CHEMICAL REACTION ENGINEERING LAB

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **0-0-3-2**

Objectives:

- Operate lab equipments like CSTR, Batch, PFR reactors.
- Analyze the concentration versus time data and determine the specific rate constant and the order of the reaction.
- Compare theoretical and experimental conversions in a CSTR and PFR.
- Estimate RTD and model parameters in a CSTR, PFR, packed bed and CSTRin-series.

List of Experiments:

1. To determine the specific reaction rate constant of a reaction of a known order using a batch reactor
2. To determine the specific reaction rate constant of a reaction of a known order using a CSTR.
3. Determination of the activation energy of a reaction using a Batch reactor, CSTR
4. To determine the order of the reaction and the rate constant using a tubular reactor.
5. CSTRs in series- comparison of experimental and theoretical values for space times and volumes of reactors.
6. Mass transfer with chemical reaction (solid-liquid system)
7. RTD in tubular reactor
8. RTD in Mixed flow reactor.
9. Study catalytic reaction

CH380 OBJECT ORIENTED PROGRAMMING STRUCTURES THROUGH JAVA LAB

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **0-0-3-2**

Objectives:

- To be able to apply an object oriented approach to programming and identify potential benefits of object-oriented programming over other approaches.
- To be able to reuse the code and write the classes which work like built-in types.
- To be able to design applications which are easier to debug, maintain and extend.
- To be able to apply object-oriented concepts in real world applications.

Experiments:

1. A program to illustrate the concept of class with constructors, methods and overloading.
2. A program to illustrate the concept of inheritance and dynamic polymorphism.
3. A program to illustrate the usage of abstract class.
4. A program to illustrate multithreading.
5. A program to illustrate thread synchronization.
6. A program to illustrate Exception handling.
7. A program to illustrate user-defined Exceptions
8. A program to demonstrate use of User-defined Packages.
9. A program using String Tokenize.
10. A program using Linked list class
11. A program using Tree Set class
12. A program using Hash Set and Iterator classes
13. A program using Map classes.
14. A program using Enumeration and Comparator interfaces.
15. A program using File and Filename Filter
16. A program to illustrate the usage of Byte and Character I/O streams.
17. A program to illustrate the usage of Serialization.
18. Program using Data class.\
19. An application involving GUI with different controls, menus and event handling.
20. A program to implement an applet.

For the detailed list of programs refer the lab manual.

Note: Any experiment according to the syllabus of CS2203 can be substituted

CH3902 **SEMINAR-III**

Externals: 100 Marks **L-T-P-C**

0-0-2-1

Objectives:

- To improve the presentation skills
- To prepare PPT more effectively

Student has to chose a topic related chemical engineering area to give a power point presentation

CH3000 **COMPREHENSIVE VIVA - I**

Externals: 100 Marks **L-T-P-C**

0-0-0-1

Objectives:

- To test knowledge of the student in core subjects covered upto the end of third year of engineering
- To prepare the student to face technical interview.

Student has to appear before a panel of department faculty to test his knowledge/skills acquired in core departmental subjects.

CH3900 **SUMMER INTERNSHIP**

External Advisor: 30 Marks **L-T-P-C**

Department Assessment: 70 Marks **0-0-8-6**

Objective:

- To get industrial /research experience

Every student must do 8 weeks of Summer Internship after E3-Sem2 Examination. The evaluation of Summer Internship will be done in the beginning of E4-Sem1.

IV YEAR
II SEMESTER

S.No	Subject Code	Subject Name	(L-T)-P	Credits (C)
1		Open Elective-I	4-0	3
2		Elective-II	4-0	3
3	CH4800	Major Project		12
4	CH4000	Comprehensive Viva Voce-II		1
Total Credits				**19**

List of Electives of Department of Chemical Engineering

S.No	Elective	Subject Code	Subject Name	(L-T)-P	Credits (C)
1	Elective-II	CH4501	Petroleum Refinery Engineering	4-0	3
2		CH4502	Environmental Pollution Control Engineering	4-0	3
3	Open Elective-I	CH4504	Computational Fluid Dynamics	4-0	3

L-Lectures; T-Tutorials; P-Practicals; C-Credits.

Open Elective: Under Open Elective category a **s**tudent can register for any Subject offered by any other departments too.

CH4501 PETROLEUM REFINERY ENGINEERING
(Elective-II)

Externals: 60Marks **L-T-P-C**
Internals: 40Marks **4-0-0-3**

Objectives:

- Learn the formation, refining of crude oil and products of refinery.
- Understand the means of processing data including thermal properties, important products characteristics.
- Develop skills in drawing neat flow diagrams of different petroleum refining processes
- (cracking/reforming/alkylation/isomerization/hydrocracking etc.,) that are aimed at producing high value/demand products.
- Identify important testing methods for important petroleum products.

Unit-1

Origin of prtoleum crude oil: thernal properties of petroleum fractions, petroleum evaluation, charecterization of crude oil: TBP and other distillation tests. Petroleum products, their properties, specification and testing , different properties like flash point, fire point, smoke point, aniline point, carbon residue, kinematic viscosity, pour point, freezing point etc.

Unit-2

Fractions of petroleum: dehydration and desalting of crudes, heating of crude-pipe still heaters, distillation of petroleum, blending of gasoline

Treatment techniques: fractions – impurities, gasoline treatment, kerosene treatment, treatment of lubes, wax and purification.

Unit-3

Thermal and catalytic cracking process: Cracking, theory of thermal cracking reactions, properties of cracked materials, depth of cracking and soaking factor, rate of reaction, heat of decomposition, visbreaking.

Unit-4

Thermal and catalytic cracking process: Cracking for the production of gasoline, catalytic cracking, commercial cracking catalysts, catalytic cracking process, fixed bed crackers, moving bed crackers, houdri flow process, flexi cracking.

Unit-5

Hydrotreatment process in refining: hydro-desulfurization, hydrofinishing, production of lube oil base stock

Text Books:

1. Petroleum refining Engineering, WL Nelson Mc Graw Hill company, 4th addition:
2. Modern Petroleum Refining Processes, B.K.Bhaskara Rao, Oxford & IBH Publishing, 2002, 4th ed:

CH4502 ENVIRONMENTAL POLLUTION AND CONTROL ENGINEERING
(Elective-II)

Externals: 60 Marks **L-T-P-C**
Internals: 40 Marks **4-0-0-3**

Objective:
The aim of this course is that the students will learn the essential principles used in industrial pollution abatement and pertinent environmental legislations.

Unit-1

Engineering, ethics and environment; Ecological systems and pollution; Fundamental definitions of pollution parameters – air and water quality criteria, standard and legislation EIA, EIS and EMP. Air and water pollution management through waste minimization.

Unit-2

Industrial air pollution management: air pollution meteorology, industrial plume behavior, types of plumes, Gaussian Plume model.

Unit-3

Outlines of industrial air pollution control. Section, design and performance analysis of air pollution control equipment: gravity settling chambers, air cyclones, electro-static precipitators, filters and scrubbers.

Unit-4

Industrial water pollution management: waste water treatment processes: Pre-treatment, primary and secondary treatment processes. Advanced waste water treatment processes

Unit-5

Design of sedimentation tanks and biological treatment processes.Solid waste management.

Text Books:

1. Environmental pollution and control management, Rao C.S. – Wiley Eastern Limited, India.
2. Pollution control in process industries by S.P. Mahajan TMH, 1985.

CH4504 COMPUTATIONAL FLUID DYNAMICS
(Open Elective-I)

Externals: 60 Marks **L-T-P-C**
Internals: 40 Marks **4-0-0-3**

Objective:

- To be able to apply to apply the conservation laws to fluids in motion under different conditions
- To learn modeling of fluid flow under different conditions
- To learn how to convert differential equations to difference equations and to learn grid generation methods
- To simulate the model

Unit-1 Conservation Laws And Turbulence Models

Governing equations of fluid flow and heat transfer –mass conservation, momentum and energy equation, differential and integral forms, conservation and non-conservation form. Characteristics of turbulent flows, time averaged Navier Strokes equations, turbulence models-one and two equation, Reynolds stress, LES and DNS

Unit-2 Finite Differnce Approximation

Mathematical behaviour of PDE, finite difference operators, basic aspects of discretization by FDM, explicit and implicit methods, error and stability analysis

Unit-3 Finite Volume Method

Diffusion problems – explicit and implicit time integration; Convection-diffusion problems – properties of discretisation schemes, central, upwind, hybrid, QUICK schemes; Solution of discretised equations.

Unit-4 Flow Field Computation

Pressure velocity coupling, staggered grid, SIMPLE algorithm, PISO algorithm for steady and unsteady flows

Unit-5 Grid Generation

Physical aspects, simple and multiple connected regions, grid generation by PDE solution, grid generation by algebraic mapping.

Text Books:

1. Computational Fluid Dynamics: The Basics with Applications, Anderson, J. D., McGraw-Hill, 1995.
2. Computational Techniques for Fluid Dynamics, Fletcher, C. A. J., Springer Verlag, 1997.

References:

1. An Introduction to Computational Fluid Dynamics:The Finite Volume Method, Versteeg, H.K. and Malalasekera, W.,Pearson Education Ltd., 2007.
2. Computational Fluid Dynamics, Chung T.J , Cambridge University Press 2003.
3. Computational Fluid Flow and Heat Transfer, Muralidhar, K., and Sundararajan, T., Narosa Publishing House, New Delhi, 2001.
4. Numerical heat transfer fluid flow, Subas, V. Patankar Hemisphere Publishing Corporation, 1980.

CH4800 MAJOR PROJECT

External panel: 60 Marks **L-T-P-C**

Internal advisor: 40 Marks **0-0-12-12**

Student has to do complete practical/computational/theoretical work on the chosen/allotted area of project work and must submit a detailed report.

CH4000 COMPREHENSIVE VIVA-II

Externals: 100 Marks **L-T-P-C**

0-0-0-1

Objectives:

- To test knowledge of the student in core subjects covered upto the end of fourth year of engineering
- To prepare the student to face technical interview.

Student has to appear before a panel of department faculty to test his knowledge/skills acquired in all core departmental subjects.