

COURSE OBJECTIVES

To enable students to

- analyse different methods to find solution for a large system of linear equations
- find the intermediate values for a series of given data
- develop efficient algorithms for solving problems in science, engineering and technology
- solve the nonlinear differential equations that cannot be solved by regular conventional method.
- apply finite element method to increase the accuracy of second order differential equations

UNIT I SOLUTION OF EQUATIONS AND EIGEN VALUE PROBLEMS 15

Solution of equation – Iteration method : Newton Raphson method – Solution of linear system by Gaussian elimination and Gauss - **Jordon method – Iterative method** – Gauss-Seidel method – Inverse of a matrix by Gauss Jordon method – Eigen value of a matrix by power method.

UNIT II INTERPOLATION AND APPROXIMATION 15

Lagrangian Polynomials – **Divided differences – Newton's Divided Difference- Hermite Interpolation Polynomial and Interpolating with a cubic spline** – Newton's forward and backward difference formulas.

UNIT III NUMERICAL DIFFERENTIATION AND INTEGRATION 15

Differentiation using interpolation formulae – Numerical integration by trapezoidal and Simpson's 1/3 – Romberg's method – Two and Three point Gaussian quadrature formulas – **Double integrals using trapezoidal and Simpsons' rule.**

UNIT IV INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS 15

Single step methods: Taylor series method – Modified Euler method for first order equation – Fourth order Runge – Kutta method for solving first and second order equations – Multistep methods: Milne's and Adam's predictor and corrector methods.

UNIT V BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS 15

Finite difference solution of second order ordinary differential equation – Finite difference solution of one dimensional heat equation by explicit and implicit methods – One dimensional wave equation and two dimensional Laplace and Poisson equations.

TOTAL PERIODS 75

COURSE OUTCOMES

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

- solve the solutions of equations and Eigen value problems.
- be familiar with numerical interpolation and approximations of functions.
- be familiar with numerical integration and differentiation.
- understand numerical solution of ordinary differential equations.
- understand numerical solution of Boundary value problems of Partial differential equations.

TEXT BOOKS

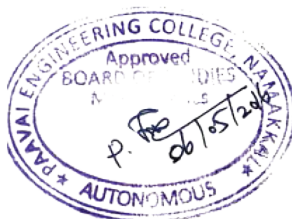
1. Erwin Kreyszig., “Advanced Engineering Mathematics” 10th edition, Wiley Publications, 2010.
2. T. Veerarajan. and T. Ramachandran, “Numerical Methods with programming in C”, 2nd ed., Tata McGraw-Hill, 2006.

REFERENCES

1. P. Kandasamy, K. Thilagavathy and K. Gunavathy, “Numerical Methods”, S.Chand Co. Ltd., New Delhi, 2003
2. Gerald C.F. and Wheatley, P.O., “Applied Numerical Analysis” 6th Edition, Pearson Education Asia, New Delhi, 2002.
3. M.K.Jain , S.R.K. Iyengar , R.K.Jain , “Numerical Methods For Scientific & Engineering Computation” , New Age International (P) Ltd , New Delhi , 2005.
4. M.B.K. Moorthy and P.Geetha, “Numerical Methods” , Tata McGraw Hill Publications company, New Delhi, 2011.

CO/PO MAPPING

Mapping of course outcomes with programme outcomes (1/2/3 indicates strength of correlation)3-Strong, 2-Medium, 1- Weak														
CO's	Programme Outcome (POs)													
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CO1	2	2	1	1	2	1	1	-	-	-	-	1	2	3
CO2	2	2	2	1	2	-	-	-	1	-	-	2	2	3
CO3	3	2	1	2	2	-	-	-	1	2	-	1	2	3
CO4	3	2	2	2	2	-	-	-	-	1	-	2	2	3
CO5	2	3	2	1	3	-	-	-	-	-	1	1	2	3



COURSE OBJECTIVES

To enable students to

- know the mechanism of molecular diffusion of gases and liquids
- understand the mass transfer between two insoluble phases
- familiar with interface simultaneous transfer of mass and energy
- express equilibrium moisture content of a substance and drying methods.
- how soluble components are removed from a solution.

UNIT I DIFFUSION**9**

Molecular and eddy diffusion in gases and liquids-steady state diffusion under stagnant and laminar flow conditions-Diffusivity measurement and prediction-multi component diffusion- diffusion in solids and its applications.

UNIT II INTERPHASE MASS TRANSFER**9**

Individual mass transfer coefficients-Relationship between individual and overall mass transfer coefficient - Theories of mass transfer-mass transfer in laminar and turbulent flow. Analogies: Reynolds, Chilton- Colburn and Taylor – Prandtl analogy. Co-current and counter-current operations-Equilibrium and operating line concept- Operating characteristics of stage wise and differential contactors-NTU and HTU concept.

UNIT III HUMIDIFICATION**9**

Basic concepts and terminologies-Adiabatic saturation process and theory of wet bulb temperature-psychrometric chart for Humidification and dehumidification calculations-Cooling towers-Principle and design.

UNIT IV DRYING**9**

Theory and mechanism of drying-drying characteristics of materials-batch and continuous drying-calculation for continuous drying- Drying equipments: tray, rotary, drum, spray dryer and their applications.

UNIT V CRYSTALLIZATION**9**

Principles of crystallization-super saturation-theory of homogeneous and heterogeneous nucleation-law of crystal growth and growth coefficients-Calculations involving material and energy balances-Methods of crystallization based on super saturation and industrial equipment.

TOTAL PERIODS 45**COURSE OUTCOMES**

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

- predict the rate of diffusion of gases and liquids and find the convective mass transfer coefficient.
- show the interrelation of the resistances and driving forces and can design equation relating the rate of transfer to the total required transfer area.

- find the fundamental properties of air-water systems and humidity.
- improve storage life and reduce transportation costs by selecting proper drying methods and equipments.
- find the yield and purity of the commercial crystallization.

TEXT BOOKS

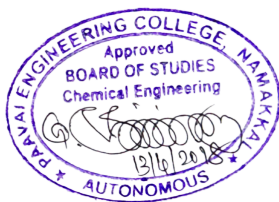
1. Anantharaman N. and Meera Sheriffa Begum K.M., —Mass Transfer: Theory and Practicel, Prentice Hall of India, New Delhi, 2011.
2. Treybal Robert E., —Mass Transfer Operations, 3rd Edition, McGraw-Hill Book Company, 1980.

REFERENCES

1. Binay K.Dutta, “Principles of Mass Transfer and Separation Processes”, PHI Learning Ltd,2013.
2. K.V. Narayanan, B. Lakshmikutty, “Mass Transfer: Theory and Applications” First Edition, CBS Publications and distributors (2014).
3. Coulson, J.M. and Richardson, J.F., “Chemical Engineering” Vol. I and II, 4th Edition, Asian Books Pvt. Ltd., India, 1998.
4. Sinha, A. P., and Parameswar De. Mass transfer: principles and operations. PHI Learning Pvt. Ltd., 2012.

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CO3	2	2	-	3	2	-	-	-	-	-	-	-	2	-
CO4	2	2	-	3	2	-	-	-	-	-	-	-	2	-
CO5	2	2	-	3	2	-	-	-	-	-	-	-	2	-



COURSE OBJECTIVES

To enable students to

- learn the basic concepts and properties of thermodynamics and its application to flow and non-flow process.
- study Carnot principles and its application to heat engine and refrigerator.
- understand the clear concepts on P-V-T behavior, Equations of state, compressibility charts, equation of state and fugacity.
- have sound knowledge on entropy and enthalpy calculations in reversible and irreversible process.
- know the thermodynamic aspects of compression of fluids.

UNIT I**9**

Definitions and Basic Concepts- State and Path functions- Thermodynamic systems – closed, open and isolated - Equilibrium, Energy, Work-modes of work - concept of Temperature and Heat- Zeroth Law- First law – application to closed and open systems- internal energy- specific heat capacities- enthalpy – steady flow process with reference to various thermal equipments.

UNIT II**9**

Statements of the second law – Kelvin, Planck and Clausius statements- Reversible and irreversible processes - heat engine and refrigerator -Criterion of reversibility- Carnot cycle and Carnot principles, Thermodynamic Temperature scale-Clausius inequality, Entropy and its calculation- Third law.

UNIT III**9**

The PVT behavior of fluids- laws of corresponding states and equation of states approaches to the PVT relationships of non-ideal gas- problems; compressibility factors, generalized equations of state, property estimation via generalized equation of state; fugacity and fugacity coefficients of real gases.

UNIT IV**9**

Measurable quantities -basic energy relations, Maxwell relations- thermodynamic formulations to calculate Enthalpy- internal energy and entropy as function of pressure and temperature, other formulations involving C_p and C_v - complex thermodynamic formulations, thermodynamic properties of an ideal gas- entropy change in reversible and irreversible process.

UNIT V**9**

Thermodynamic aspects of compression process- classification of compression processes- basic equation for change of state of gases-the work expression for different situations-the effect of clearance volume-multistage Compression-convergent divergent flow-Ejectors.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- calculate the heat and work requirements for the given flow or non-flow processes.
- evaluate the thermal performance of different heat engines and refrigeration cycles through the calculation of their thermal efficiency or coefficient of performance.
- experiment the thermodynamic properties and to assess the feasibility of any process.
- analyze and apply thermodynamic formulations and relations in solving problems related to complex thermodynamic systems as well as to meet environmental and societal needs
- to classify the compression process and its effects in various compression equipments- calculate the heat and work requirements for the given flow or non-flow processes.

TEXT BOOKS

1. Smith, J.M., Van Ness, H.C and Abbot M.M “Introduction to Chemical Engineering Thermodynamics” McGraw Hill Publishers, VI edition, 2003
2. Narayanan, K.V. A Textbook of Chemical Engineering Thermodynamics Prentice Hall India, 2004

REFERENCES

1. Kyle, B.G., “Chemical and Process Thermodynamics III Edition”, Prentice Hall of India Pvt. Ltd., 1999.
2. Elliott J.R., Lira, C.T., “Introductory chemical engineering thermodynamics”, Prentice Hall, 1998
3. Rao, Y.V.C., “Chemical Engineering Thermodynamics” Universities Press, 2005
4. Pradeep ahuja,” Chemical Engineering Thermodynamics”, PHI Learning Ltd (2009).

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CO3	2	2	2	3	-	-	-	-	-	-	-	-	2	1
CO4	2	2	2	3	-	-	-	-	-	-	-	-	2	1
CO5	2	2	2	3	-	-	-	-	-	-	-	-	2	1



COURSE OBJECTIVES

To enable students to

- comprehend the unit operations/ processes in chloro alkali industries
- understand the practical methods of production sulphur and its byproducts in a chemical factory.
- know the various operations involved in cements and glass manufacture
- have knowledge on Industrial manufacture of ammonia and nitrogen
- gain knowledge on nitrogen industries in the manufacture of plant nutrients, agrichemicals and fertilizers

UNIT I INTRODUCTION AND CHLOR-ALKALI INDUSTRIES 9

The role of a Chemical Engineers in process industries-**importance of block diagrams and flow charts-unit Operations - unit processes**- Manufacture of Soda ash and sodium bicarbonate, Sodium chloride, chlorine and Caustic soda; bleaching powder and related bleaching agents.

UNIT II SULPHUR AND SULPHURIC ACID INDUSTRIES 9

Sulfur pollution - Mining of Sulphur, Manufacture of sulfur, Sulfuric acid and sulphur trioxide sodium sulphate, sodium thiosulphate. Hydrochloric acid.

UNIT III SILICATE INDUSTRIES 9

Manufacture of gypsum, plaster of paris, Types and manufacture of Portland cement, Manufacture of glasses and special glasses, Ceramics.

UNIT IV NITROGEN AND PHOSPHORUS INDUSTRIES 9

Synthetic ammonia, Nitric acid, Urea, Ammonium nitrate, sulphate, phosphate. **Phosphate rock beneficiation and phosphoric acid – phosphorus tri, penta chloride**.

UNIT V FERTILIZER INDUSTRIES 9

Plant nutrients, growth elements and regulators-Manufacture of ammonia based fertilizers, single and triple super Phosphate, ammonium phosphate-Chloride, nitrate and phosphate of Potassium-Compound and bio-fertilizers.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- understand the role of chemical engineers in process industries and develop block diagrams and flow charts for manufacture of different chemicals
- impart knowledge on various aspects of sulphur production engineering including storage and handling.
- gain the techniques involved in types and production of cement.
- analyze the usage of acids and various chemicals production.
- have idea about production of fertilizers and its impact to environmental issues.

TEXT BOOKS

1. Austin G.T., —Shreve's Chemical Process Industries, 5th Edition, McGraw-Hill International Book Company, Singapore, 2012.
2. Gopala Rao M. and Marshall Sittig, — Dryden's Outlines of Chemical Technology, 3rd Edition, East-West Press, New Delhi, 2008.

REFERENCES

1. Srikumar Koyikkal, "Chemical Process Technology and Simulation", PHI Learning Ltd (2013).
2. W.V. Mark & S.C. Bhatia, "Chemical process Industries Volume I" CBS Publishers limited.
3. W Smith, R Chapman, "Chemical Process Industries: Inorganic Chemicals and Allied Industries Volume 1", CBS Publishers & Distributors limited.
4. Shreve, Randolph Norris, and Joseph A. Brink Jr., "Chemical Process Industries" No. 4th Edition. McGraw-Hill Book Co., 1977.

CO/PO MAPPING

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CO4	-	-	-	-	3	-	1	-	1	-	2	-	2	1
CO5	-	-	-	-	3	-	1	-	1	-	2	-	2	1



COURSE OBJECTIVES

To enable students to

- have the awareness of safety codes and safety programmes
- identify and prevent the hazards and safe handling of materials.
- can design a plant with necessary safety measures.
- maintain the chemical process without complete breakdown of plant and loss of life.
- study the legal aspects to be followed in chemical industries.

UNIT I INTRODUCTION TO SAFETY PROGRAMMES**9**

Need for safety, Safety programs, Training & Education - Safety codes: NFPA, IS and OSHA standards; color codes for pipe lines. Materials Safety Data sheets; safety in storage and handling of chemicals. Personal protective Equipments.

UNIT II PLANT HAZARDS**9**

Chemical process industries; potential hazards; high pressure; high temperature operation; dangerous and toxic chemicals; highly radioactive materials; safe handling and operation of materials and machineries; **planning and layout. Hazards- fire, explosion and radiation; Occupational diseases - effects.**

UNIT III INDUSTRIAL SAFETY**9**

Safety in operations and processes. Runaway reactions, unstable products; Safety Studies – HAZOPS, HAZANS, Event tree and risk analysis. periodic inspection and study of plant layout and constant maintenance; Using CPM and PERT techniques: periodic advice and checking to follow safety procedures; proper selection and replacement of handling equipment

UNIT IV ACCIDENTS**9**

Industrial accidents – accident costs – identification of accident spots; remedial measures; identification and Fire analysis of causes of injury to men and machines – accident prevention – accident proneness – fault tree analysis. prevention and fire protection. Construction and working of fire extinguishers.

UNIT V LEGAL ASPECTS**9**

Factories act, ESI act and Workmen's compensation act, Role of Government, safety organizations, management and trade unions in promoting industrial safety. Emergency response systems for hazardous goods basic rules and requirements which govern the chemical industries.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- use Personal Protective Equipment's for a hazardous environment.
- identify and protect the effect of occupational health hazards.
- ensure the safety procedures and commissioning of chemical plant
- minimize the opportunities for personal injury and property damage.
- know the employees benefit acts and its procedure.

TEXT BOOKS

1. Fawcett H.H. and Wood W.S., —Safety and Accident Prevention in Chemical Operation, 2nd Edition, Interscience, 1982.
2. D.B Dhone, Plant safety and maintenance, Nirali Prakashan Publication, 1st edition, (2014).

REFERENCES

1. William H., —Industrial Safety Handbook, 2nd Edition, McGraw Hill, (1968).
2. Loss Prevention and Safety Promotion in Chemical Process Industries, Vol. I, II, III Published by Institution of Chemical Engineers U.K., (1983).
3. Crawl, Daniel A., and Joseph F. Louvar. Chemical process safety: fundamentals with applications, Pearson Education, 2001.
4. Green, Don W., and Robert H. Perry. Perry's Chemical Engineers' Handbook.

CO/PO MAPPING

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CO4	-	-	-	-	-	3	2	2	2	2	1	1	2	1
CO5	-	-	-	-	-	3	2	2	2	2	1	1	2	1



COURSE OBJECTIVES

To enable students to

- estimate the chemical contents present in the given soap and oil samples and their separation methods.
- estimate the chemical contents present in the given cement and coal samples their separation methods.
- analyze the different fuel analysis studies
- estimate the chlorine content present in the given sample.

LIST OF EXPERIMENTS**I. Soap Analysis**

- a. Estimation of total fatty acid
- b. Estimation of percentage alkali content

II. Oil Analysis

- a. Estimation of free acid
- b. Determination of Saponification value
- c. Determination of iodine value

III. Cement Analysis

- a. Estimation of Silica content
- b. Estimation of mixed oxide content
- c. Estimation of calcium oxide content

IV. Coal Analysis

- a. Estimation of Sulphur present in coal
- b. Ultimate analysis of coal
- c. Proximate analysis of coal

V. Analysis of Bleaching Powder

- a. Estimation of available chlorine

VI. Analysis of fuels

- a. Flash point
- b. Fire point
- c. Cloud point
- d. Pour point
- e. Aniline point.

VI. Analysis of milk

- a. Detection of adulterants in whole milk

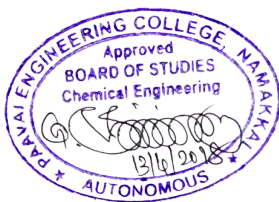
COURSE OUTCOMES

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

- estimation of TFM and alkali content in soap sample
- determination of chemical contents present in cement and coal
- various studies in analyzing fuel samples
- determination of various adulterants in milk sample

CO/PO MAPPING

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CO4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	-	-	-	-	-	-	-	-	-	-	-	-	-	-



COURSE OBJECTIVES

To enable students to

- acquire fundamental and industrial knowledge about heat transfer modes like conduction
- gain fundamental and industrial knowledge about modes like convection
- obtain fundamental and industrial knowledge about heat transfer modes like radiation
- study about various heat exchangers used in industries

LIST OF EXPERIMENTS

1. Composite wall
2. Natural and Forced Convection
3. Stefan Boltzmann experiment – Radiation.
4. Emissivity Apparatus
5. Double pipe Heat Exchanger (Parallel and Counter flow)
6. Plate type Heat Exchanger
7. Shell and Tube Heat Exchanger
8. Condenser (Horizontal)
9. Condenser (Vertical)
10. Open Pan Evaporator
11. Heat transfer in extended surfaces

TOTAL PERIODS 60

REFERENCES

1. Rajput “Process Heat Transfer “, McGraw-Hill, (1999).
2. K.A. Gavhane, “Heat Transfer”, Eighteenth Edition, Niralai Publication (2015).
3. Coulson, J.M. and Richardson, J.F., “Chemical Engineering” Vol. I, 4th Edn., Asian Books Pvt. Ltd., India, (1998).
4. Yunus A. Cengel, “Heat Transfer: A Practical Approach” 2nd Edition, Mcgraw Hill Education (2011).

COURSE OUTCOMES

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

- calculate heat transfer through conduction using classical models.
- calculate heat transfer through different types of convection using classical models.
- estimate coefficients for different types of exchangers in different surfaces
- calculate heat transfer through radiation using classical models.

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CO5	2	2	1	1	1	-	-	-	-	-	1	2	2	3



COURSE OBJECTIVES

To enable students to

- understand the principles and analysis the rate equation for reactors.
- acquire knowledge about various reactors and their performance equation.
- evaluate selectivity and yield for parallel and mixed reactions.
- understand RTD and various types of models.
- know preparation of catalysis

UNIT I ELEMENTS OF REACTION KINETICS**15**

Classification of chemical reactions, rate equation, Reaction Mechanism –elementary and non-elementary reaction; Temperature dependency- Arrhenius law, collision theory and transition theory. Analysis of experimental reactor data: Integral and differential method, constant and variable volume batch reactor

UNIT II IDEAL REACTORS**15**

Performance equations for Batch, Semi-batch and steady state flow reactors.

UNIT III DESIGN FOR SINGLE AND MULTIPLE REACTIONS**15**

Size comparison of Single reactors, multiple reactor system, Reactions in Parallel and Series, Yield and Selectivity. Recycle reactor, Autocatalytic reactions

UNIT IV NON-IDEAL FLOW**15**

Residence time distribution studies; models for non-ideal flow- dispersion and tanks-in-series; conversion in non- ideal reactors

UNIT V GAS-SOLID NON-CATALYTIC REACTORS**15**

Models for explaining kinetics; volume and surface models; controlling resistances and rate controlling steps; Industrial reactors-fixed, fluidized, trickle bed and air lift reactors.

TOTAL PERIODS 75**COURSE OUTCOMES**

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

- apply the principles of reaction kinetics and formulate rate equations and analyze the batch reactor data.
- understand the ideal reactor concepts and to develop the performance equation to workout conversion and space time
- analyze the experimental kinetic data to select a suitable reactor combination for a application and to evaluate selectivity and yield for parallel and mixed reactions.
- perform RTD analysis in non-ideal flow reactors and calculation of conversion
- understand the basics of catalysis and industrial catalytic reactors.

TEXT BOOKS

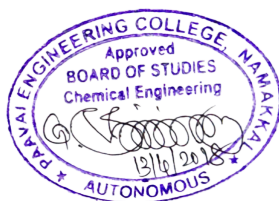
1. Levenspiel O., —Chemical Reaction Engineeringl, 4th Edition, Wiley India Pvt. Ltd., New Delhi, (2009).
2. K.A. Gavhane, Chemical Reaction Engineering I & II”, Nirali Prakashan Publication, (2015).

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1. Smith J.M., “Chemical Engineering Kinetics”, 3rd Edition, McGraw-Hill, New York, (1981).
2. Fogler H.S., “Elements of Chemical Reaction Engineering”, 4th Edition, Prentice Hall of India, New Delhi, (2008).
3. Missen, Ronald W., Charles A. Mims, and Bradley A. Saville. “Introduction To Chemical Reaction Engineering and Kinetics”. J. Wiley,, 1999.
4. Carberry, James J. Chemical and Catalytic Reaction Engineering. Courier Corporation, 2001.

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CO5	-	-	-	-	3	-	1	-	1	-	2	-	2	1



COURSE OBJECTIVES

To enable students to

- attain knowledge on advances and challenges in paper and pulp industries.
- know the various operations involved in extraction of oil and manufacture of soap/detergents.
- identify the types of petroleum and its processing methods.
- classify the types and methods by which elastomers and polymers are made.
- understand the properties of paint and its production methods.

UNIT I PULP AND PAPER INDUSTRIES AND SUGAR AND STARCH INDUSTRIES 9

Manufacture of pulp and paper- Raw and refined sugar- Starch, Cellulose and their derivatives- Soaps and detergents.

UNIT II OILS, FATS, INDUSTRIES 9

Vegetable oils and animal fats, their nature, analysis and extraction methods, hydrogenation of oils, fatty acids and alcohols, waxes.

UNIT III PETROLEUM AND PETROCHEMICAL INDUSTRIES 9

Petroleum refining-Physical and chemical conversion products- lubricating oils, petrochemical precursors, methane, olefins, acetylenes and aromatics and products obtained from them by various unit processes.

UNIT IV RUBBER AND POLYMERS 9

Polymerization processes – different types -Natural rubber; Synthetic rubber such as SBR, NBR, CR – ABS, Fundamental methods of processing of synthetic Rubbers. Polymerization processes-Manufacture of Nylons, Viscose Rayon, Cellulose Acetate, PVC, Polyesters.

UNIT V PAINT AND PIGMENTS 9

Properties of paint and their functions – manufacture – pigments, varnishes, lacquers.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- select proper raw materials and develop solution for shortcomings.
- apply principles of chemical engineering oils, fats/ soap manufacturing units
- know the process by which petroleum refining and its derivatives are formed.
- analyze the methods to synthesize the polymer depending upon its application.
- classify the chemical process industry into industrial categories of base, intermediate end-products and specialty chemicals manufacturers

TEXT BOOKS

1. Austin G.T., —Shreve's Chemical Process Industries, 5th Edition, McGraw-Hill International Book Company, Singapore, 2012.

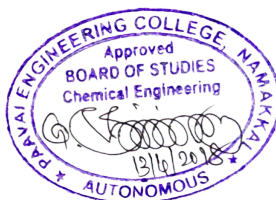
- Gopala Rao M. and Marshall Sittig, — Dryden's Outlines of Chemical Technology, 3rd Edition, East- West Press, New Delhi, 2008.

REFERENCES

- Srikumar Koyikkal, "Chemical Process Technology and Simulation", PHI Learning Ltd (2013).
- W.V. Mark & S.C. Bhatia, "Chemical process Industries Volume I" CBS Publishers limited.
- W Smith, R Chapman, "Chemical Process Industries: Inorganic Chemicals and Allied Industries Volume 1", CBS Publishers & Distributors limited.
- Shreve, Randolph Norris, and Joseph A. Brink Jr. "Chemical Process Industries". No. 4th Edition. McGraw-Hill Book Co., 1977.

CO/PO MAPPING

Mapping of course outcomes with programme outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1- Weak														
COs	Programme Outcome (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	3	-	1	-	1	-	2	-	2	1
CO2	-	-	-	-	3	-	1	-	1	-	2	-	2	1
CO3	-	-	-	-	3	-	1	-	1	-	2	-	2	1
CO4	-	-	-	-	3	-	1	-	1	-	2	-	2	1
CO5	-	-	-	-	3	-	1	-	1	-	2	-	2	1



COURSE OBJECTIVES

To enable students to

- deal with the methods by which soluble vapor is absorbed from its mixture.
- know the basic requirement and technique for a separation of components by distillation.
- identify the process by which homogeneous mixture is separated by various extractors.
- understand the operation by which solid extraction is done.
- enrichment of a chemical substance at the surface of the solid.

UNIT I DISTILLATION 15

Vapour-liquid equilibria, Raoult's law. Methods of distillation: simple distillation - calculations using Rayleigh Equation, Flash vaporization,

UNIT II CONTINUOUS FRACTIONATION 15

Introduction to Continuous fractionation- Fenske equation; fractionation of binary system Design calculations by McCabe-Thiele and Ponchon-Savarit methods; Steam, azeotropic, extractive and low pressure distillation

UNIT III ABSORPTION 15

Choice of solvent, Co-current and counter-current operations, Kresmer Equation for plate tower, overall column volumetric mass transfer coefficients; Equipment for gas absorption: Mechanically agitated vessels, Packed and plate columns.

UNIT IV LEACHING AND EXTRACTION 15

Solid-liquid equilibria; calculations in single stage, multi stage cross flow and counter current leaching, Leaching Equipment - batch and continuous - Bollman, Rotocel extractors. Solvent selection criteria; distribution coefficient - Single stage operation, Multistage operation for partially miscible and immiscible systems. Extraction equipment – mixer settlers, spray, Packed columns, Rotating disc contactors - Pulsed extractors.

UNIT V ADSORPTION 15

Types - Characteristics and choice of adsorbents. Adsorption isotherms and breakthrough curve. Single and multiple cross current and counter current operation. Adsorption equipment for batch and continuous operation, Industrial applications.

TOTAL PERIODS 75

COURSE OUTCOMES

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

- recover the solute by selecting suitable absorbent and absorption columns.
- identify and choose the methods of distillation for the separation of binary liquid mixture.
- calculate the number of stages required for high extraction efficiency and can select the solvents.
- find the number of stages required for leaching.

- calculate the quantity of adsorbent required for the adsorption operation.

TEXT BOOKS

1. Treybal Robert E., —Mass Transfer Operations, 3rd Edition, McGraw-Hill Book Ltd., 1980.
2. N. Anantharaman, K.M. Meera Sheriffa Baegum, “Mass Transfer Theory and practice” PHI.

REFERENCES

1. K.A. Gavhane, “Mass Transfer II” Nirali Prakashan Publication, (2016).
2. Geankopolis C.J., —Transport Processes and Separation Process Principles, 4th Edition, PHI, 2004
3. McCabe, W.L., Smith, J.C., and Harriot, P., “Unit Operations in Chemical Engineering”, 7th Edition., McGraw-Hill, 2005.
4. Seader, Henley, Roper “Separation Process Principles”, Wiley, 2010

CO/PO MAPPING

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Programme Outcome (POs)														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	-	3	2	-	-	-	-	-	-	-	2	-
CO2	2	2	-	3	2	-	-	-	-	-	-	-	2	-
CO3	2	2	-	3	2	-	-	-	-	-	-	-	2	-
CO4	2	2	-	3	2	-	-	-	-	-	-	-	2	-
CO5	2	2	-	3	2	-	-	-	-	-	-	-	2	-



COURSE OBJECTIVES

To enable students to

- understand the properties of solution and determine the partial molar properties from mixture properties and vice-versa.
- apply the criterion for equilibrium between phases to engineering systems with two or more co-existing phases
- apply chemical reaction equilibrium for thermodynamic analysis of homogeneous reactions.
- have sound knowledge on chemical reaction equilibrium and their calculations.
- have knowledge on refrigeration and their methods.

UNIT I PROPERTIES OF SOLUTIONS 9

Partial molar properties, Chemical potential – Fugacity and activity in solutions - standard states definition and choice, Gibbs-Duhems equation, Mixing - excess properties of mixtures.

UNIT II PHASE EQUILIBRIA 9

Criteria for phase equilibrium between phases and stability in single, multi component and non-reacting systems in terms of chemical potential, and fugacity, vapour-liquid equilibrium in ideal solutions, Phase diagram for binary solutions - P-x-y and T-x-y diagrams using Antoine equations, azeotrope.

UNIT III CORRELATION AND PREDICTION OF PHASE EQUILIBRIA 9

Activity coefficient-composition models, thermodynamic consistency of phase equilibria, application of the correlation and prediction of phase equilibria in systems of engineering interest particularly to distillation and liquid extraction processes

UNIT IV CHEMICAL REACTION EQUILIBRIA 9

Chemical Reaction Equilibria: Criteria of equilibrium; standard free energy change and reaction equilibrium constant;

UNIT V THERMODYNAMIC EQUILIBRIUM 9

Effect of temperature and pressure on reaction equilibrium constant; homogeneous chemical reactions Thermodynamic analysis and prediction of equilibrium, Compositions.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- calculate the partial molar property of ideal and non-ideal solutions.
- evaluate the effect of Temperature and pressure in multicomponent systems.
- explain the activity composition models in chemical process.
- predict the free energy data by calculating the composition in chemical reaction equilibrium.
- classify the Refrigeration process and evaluate the performance in various cycles.

TEXT BOOKS

1. Narayanan, K.V. A Textbook of Chemical Engineering Thermodynamics Prentice Hall India, (2004).
2. Smith, J.M., Van Ness, H.C and Abbot M.M “Introduction to Chemical Engineering Thermodynamics “, McGraw Hill Publishers, VI edition, (2003).

REFERENCES

1. Kyle, B.G., “Chemical and Process Thermodynamics III Edition”, Prentice Hall of India Pvt. Ltd.,
2. Rao, Y.V.C., “Chemical Engineering Thermodynamics” Universities Press, (2005).
3. Gopinath Halder,” Introduction to Chemical Engineering Thermodynamics”, PHI Learning Ltd
4. K.A. Gavhane, “Chemical Engineering Thermodynamics II”, Nirali Prakashan, (2010).

CO/PO MAPPING

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CO3	2	2	2	3	-	-	-	-	-	-	-	-	2	1
CO4	2	2	2	3	-	-	-	-	-	-	-	-	2	1
CO5	2	2	2	3	-	-	-	-	-	-	-	-	2	1



COURSE OBJECTIVES

To enable students to

- provide effective use of chemical industries utilities.
- understand the process plant utilities
- study optimization techniques
- optimize various parameters in chemical industries
- will understand the importance of health, safety and the environment in process industries.

UNIT I IMPORTANT OF UTILITIES 9

Hard and Soft water, Requisites of Industrial Water and its uses. **Methods of water Treatment such as Chemical Softening and Demineralization, Resins used for Water Softening** and Reverse Osmosis. Effects of impure Boiler Feed Water.

UNIT II STEAM AND STEAM GENERATION 9

Properties of Steam, problems based on Steam, Types of Steam Generator such as Solid Fuel Fired Boiler, **Waste Gas Fired Boiler and Fluidized Bed Boiler. Scaling and Trouble Shooting.** Steam Traps and Accessories.

UNIT III REFRIGERATION 9

Refrigeration Cycles, Methods of Refrigeration used in Industry and Different Types of Refrigerants such as Monochlorodifluoro Methane, Chlorofluoro Carbons and Brins. Refrigerating Effects and Liquefaction Processes.

UNIT IV COMPRESSED AIR 9

Classification of compressor, reciprocating compressor, single stage and two stage compressor, velocity Diagram for Centrifugal Compressor, Slip Factor, Impeller Blade Shape. Properties of Air Water Vapors and **use of Humidity Chart. Equipments used for Humidification, Dehumidification and Cooling Towers**

UNIT V FUEL AND WASTE DISPOSAL 9

Types of Fuel used in Chemical Process Industries for Power Generation such as Natural Gas, Liquid Petroleum Fuels, Coal and Coke. **Internal Combustion Engine**, Petrol and Diesel Engine. Waste Disposal.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- will understand the importance of health, safety and the environment in process industries.
- knowledge about Steam, power, water, air is extensively used in process industries
- understand its efficient operation economically in industries.
- safe operation for the survival of industries
- understand effective use of chemical industries utilities

TEXT BOOKS

1. D.B.Dhone, "Plant Utilities", Nirali Prakashan Publication
2. Sathiyamoorthy Manickkam "Chemical Plant Utilities" LAMBERT Academic Publishing

REFERENCES

1. P. N. Ananthanarayan, "Basic Refrigeration & Air conditioning", Tata McGraw Hill, New Delhi,
2. P. L. Ballaney, "Thermal Engineering", Khanna Publisher New Delhi, 1986.
3. Perry R. H. Green D. W. "Perry's chemical Engineer's Handbook", McGraw Hill, New York, 2007.
4. Eckenfelder, W. W, Jr. "Industrial Water Pollution Control" McGraw-Hill: New York, 1966.

CO/PO MAPPING

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CO3	3	1	1	2	1	2	2	-	1	1	2	2	2	3
CO4	3	1	2	2	1	1	1	-	-	1	-	2	2	3
CO5	2	2	1	1	1	2	2	-	-	-	1	2	2	3



COURSE OBJECTIVES

To train the students to

- for separation using distillation
- for characteristics study of different dryers
- estimation of coefficients in cooling tower
- studies on Ion-exchange, RDC and Gas-Liquid absorption

LIST OF EXPERIMENTS

1. Separation of binary mixture using Simple distillation
2. Separation of binary mixture using Steam distillation
3. Separation of binary mixture using Packed column distillation
4. Measurement of diffusivity
5. Liquid-liquid extraction
6. Drying characteristics of Vacuum Dryer
7. Drying characteristics of Tray dryer
8. Drying characteristics of Rotary dryer
9. Water purification using ion exchange columns
10. Mass transfer characteristics of Rotating disc contactor
11. Estimation of mass/heat transfer coefficient for cooling tower
12. Demonstration of Gas – Liquid absorption

TOTAL PERIODS 60

COURSE OUTCOMES

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

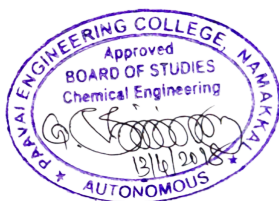
- determine important data for the design of process equipment like distillation
- determine important data for operation of extractor
- evaluate the data for diffusivity and drying
- understand the mass transfer principles which are having wide applications in various industries

REFERENCES

1. McCabe, W.L, Smith J.C and Harriot, P., “Unit Operations in Chemical Engineering”, McGraw-Hill, Fourth Edition, 1984.
2. Geankoplis, Christie J. “Mass Transport Phenomena” Holt, Rinehart and Winston, 1972.
3. Robert Treybal, “Mass Transfer Operations”, McGraw-Hill.
4. Seader, Henley, Roper “Separation Process Principles”, Wiley, 2010

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CO3	2	2	-	3	2	-	-	-	-	-	-	-	2	-
CO4	2	2	-	3	2	-	-	-	-	-	-	-	2	-



All Tables/Chemical Engineers' Handbook/Data Books/Graph Sheets are permitted during the Examination.

COURSE OBJECTIVES

To develop skill to design and install process equipment used widely in the chemical industry.

- basic drawing for cyclone separator,
- basic drawing for Filters and centrifuge
- basic drawing for different vessels
- basic drawing for nuts, bolts and screws

LIST OF EXPERIMENTS

1. Basic design and drawing considerations of machine elements (bolts, nut and screws)
2. Basic design and drawing considerations of machine elements
3. Basic design and drawing considerations of Cyclone Separator
4. Basic design and drawing considerations of Thickener
5. Basic design and drawing considerations of Centrifuge
6. Basic design and drawing considerations of Filters.
7. Basic design and drawing considerations of Crystallizers
8. Basic design and drawing considerations of agitated vessel
9. Basic design and drawing considerations of Jacketed vessel
10. General design and drawing considerations of Pressure vessel
11. General design and drawing considerations of Storage vessel and tall columns

TOTAL PERIODS 60

COURSE OUTCOMES

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

- have skill to design and install process equipment like cyclone separator
- have skill in design and drawing of filters and centrifuge
- have skill in design and drawing of different vessels such as agitated and jacketed
- have skill in design and drawing considerations in nut, bolts and screws

REFERENCES

1. McCabe, W.L, Smith J.C and Harriot, P., "Unit Operations in Chemical Engineering", McGraw-Hill, Fourth Edition, 1984.
2. M.V.Joshi and V.V. Mahajan, "Process Equipment Design", MacMillan India Ltd.
3. S.D.Dawande, "Process Design of Equipments", Central Techno Publications, Nagpur, 2000.
4. R.H. Perry, "Chemical Engineers' Handbook", McGraw-Hill.
5. J.M. Coulson and J.Richardson, "Chemical Engineering", vol. 6, Asian Books Printers Ltd.

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CO1	3	1	2	1	-	-	-	-	-	-	-	-	3	3
CO2	1	1	3	2	-	-	-	-	-	1	-	-	1	2
CO3	3	2	3	3	2	-	-	-	-		-	2	3	3
CO4	3	2	2	1	3	-	-	-	-		-	1	3	2



COURSE OBJECTIVES

To enable students to

- understand the biochemical process and microbial structure.
- introduce the Immobilized enzyme technology and their kinetics.
- acquire the knowledge on cellular growth structure and their kinetics.
- know the techniques in gas-liquid mass transfer and their power requirements.
- familiarize about the membrane separation and purification methods.

UNIT I INTRODUCTION**9**

Industrial biochemical processes with typical examples, comparing chemical and biochemical processes, development and **scope of biochemical engineering as a discipline. Industrially important microbial strains; their classification; structure;** cellular genetics.

UNIT II KINETICS OF ENZYME ACTION**9**

Kinetics of enzyme catalyzed reaction: the enzyme substrate complex and enzyme action, modulation and regulation of enzyme activity, types of inhibition. Immobilized enzyme technology: **enzyme immobilization, Immobilized enzyme kinetics;** effect of external mass transfer resistance.

UNIT III KINETICS OF MICROBIAL GROWTH**9**

Kinetics of cellular growth in batch and continuous culture, models for cellular growth unstructured, structured and cybernetic models, medium formulation. **Thermal death kinetics of cells and spores, stoichiometry of cell growth and product formation, Design and analysis of biological reactors.**

UNIT IV TRANSPORT PHENOMENA**9**

Transport phenomena in bioprocess systems: **Gas-liquid mass transfer in cellular systems,** determination of, heat oxygen transfer rates, power requirements for sparged and agitated vessels, **scaling of mass transfer equipment transfer**

UNIT V DOWN STREAM PROCESSING**9**

Downstream processing: Strategies to recover and purify products; separation of insoluble products, filtration and centrifugation; **cell disruption-mechanical and non-mechanical methods;** separation of soluble products: liquid-liquid extractions, membrane separation (dialysis, ultrafiltration and reverse osmosis), **chromatographic Separation** - gel permeation chromatography, electrophoresis, final steps in purification –crystallization and drying.

TOTAL PERIODS 45**COURSE OUTCOMES**

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

- explain the Basic biochemical engineering principles and applications relevant to bioprocesses.
- choose the immobilized techniques and their substrates.
- design the suitable biological reactors and models for cellular growth.
- determine the heat and mass transfer oxygen rates.

- sketch the steps in purification methods.

TEXT BOOKS

1. J.E.Bailey and D.F.Ollis, "Biochemical Engineering Fundamentals" 2nd ed, 1986, McGraw Hill.
2. Michael L. Shuler and Fikret Kargi, "Bioprocess Engineering" 2nd edition, Pearson education.

REFERENCES

1. James M.Lee, "Biochemical Engineering", Prentice-Hall-1992.
2. Pauline M. Doran, "Bioprocess Engineering Principles", Academic Press.
3. H.W. Blanch and D.S. Clark, Marcel Dekker, "Biochemical Engineering", 1997.
4. Aiba, S; Humphrey, A.E., Milli, N.R., "Biochemical Engineering" 2nd ed., Academic Press, 1973.

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CO5	1	-	2	-	3	1	-	-	-	-	2	-	2	1



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- introduce the Immobilized enzyme technology and their kinetics.
- acquire the knowledge on cellular growth structure and their kinetics.
- know the techniques in gas-liquid mass transfer and their power requirements.
- familiarize about the membrane separation and purification methods.

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Transport phenomena in bioprocess systems: Gas-liquid mass transfer in cellular systems, determination of, heat oxygen transfer rates, power requirements for sparged and agitated vessels, scaling of mass transfer equipment transfer

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Downstream processing: Strategies to recover and purify products; separation of insoluble products, filtration and centrifugation; cell disruption-mechanical and non-mechanical methods; separation of soluble products: liquid-liquid extractions, membrane separation (dialysis, ultrafiltration and reverse osmosis), chromatographic Separation - gel permeation chromatography, electrophoresis, final steps in purification –crystallization and drying.

TOTAL PERIODS 45**COURSE OUTCOMES**

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

- explain the Basic biochemical engineering principles and applications relevant to bioprocesses.
- choose the immobilized techniques and their substrates.
- design the suitable biological reactors and models for cellular growth.
- determine the heat and mass transfer oxygen rates.

- sketch the steps in purification methods.

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1. J.E.Bailey and D.F.Ollis, "Biochemical Engineering Fundamentals" 2nd ed, 1986, McGraw Hill.
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CO4	1	-	2	-	3	1	-	-	-	-	2	-	2	1
CO5	1	-	2	-	3	1	-	-	-	-	2	-	2	1



COURSE OBJECTIVES

To enable students to

- understand the legal requirements of product development and manufacturing.
- understand the ethical responsibility involved in industrialization of pharmaceutical products.
- understand the chemical and biochemical process.
- design of tablets and formulations for coating pills and capsules in various drying process.
- acquire knowledge on separation techniques in various analytical methods.

UNIT I INTRODUCTION**9**

Development of drugs and pharmaceutical industry; organic therapeutic agents use and economics

UNIT II DRUG METABOLISM AND PHARMACO KINETICS**9**

Drug metabolism; physico-chemical principles; Pharmacokinetics-action of drugs on human bodies.

Antibiotics- gram positive, gram negative and broad-spectrum antibiotics; hormones

UNIT III IMPORTANT UNIT PROCESSES AND THEIR APPLICATION**9**

Chemical conversion processes; alkylation; carboxylation; condensation and cyclisation; dehydration,

Esterification, halogenation, oxidation, sulfonation; complex chemical conversions fermentation.

UNIT IV MANUFACTURING PRINCIPLES & PACKING AND QUALITY CONTROL**9**

Compressed tablets; wet granulation; dry granulation or slugging; advancement in granulation; direct oral liquids; compression, tablet presses formulation; coating pills; capsules sustained action dosage forms; parenteral solutions, injections; ointments; standard of hygiene and manufacturing practice. packing techniques; quality control.

UNIT V PHARMACEUTICAL PRODUCTS & PHARMACEUTICAL ANALYSIS**9**

Vitamins; cold remedies; laxatives; analgesics; nonsteroidal contraceptives; external antiseptics; antacids and others. Analytical methods and tests for various drugs and pharmaceuticals – spectroscopy, chromatography, Fluorimetry, polarimetry, refractometry, pH metry.

TOTAL PERIODS 45**COURSE OUTCOMES**

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

- develop the immune system structure and functions.
- aware of immunity to various pathogens and environmental impact on socio-chemical methods.
- explain the principles behind the production of therapeutic/diagnostic molecules.
- understand the concepts and mechanism of drying process (different mechanism).
- elaborate the concepts and mechanism behind the different types of separation techniques.

TEXT BOOKS

1. Parrott, Eugene L. Pharmaceutical Technology: Fundamental Pharmaceutics. Burgess Publishing Company, 1970.

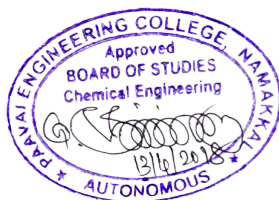
2. Rawlines, E.A.; "Bentleys Textbook of Pharmaceutics ", III Edition, Bailliere Tindall, London, 1977

REFERENCES

1. Yalkonsky, S.H.; Swarbrick. J.; "Drug and Pharamaceutical Sciences ", Vol.I, II, III, IV, V, VI and VII, Marcel Dekkar Inc., New York, 1975.
2. "Remingtons Pharmaceutical Sciences ", Mack Publishing Co., 1975.
3. Swarbrick, James. Encyclopedia of pharmaceutical technology. CRC Press, 2013.
4. Ford, James L., and Peter Timmins. Pharmaceutical thermal analysis: techniques and applications Ellis Horwood, 1989.

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CO4	1	-	2	-	3	1	-	-	-	-	2	-	2	1
CO5	1	-	2	-	3	1	-	-	-	-	2	-	2	1



COURSE OBJECTIVES

To enable the students to

- focus on papermaking science and technology and is
- understand various methods for wood preparation and pulping
- become familiar with the processing and bleaching of pulp
- understand the finishing and surface treatment of various grades of paper
- demonstrate various methods for testing of pulp and paper

UNIT I INTRODUCTION**9**

Introduction Basic pulp and paper technology – Wood haves dry – Wood as a raw material

UNIT II WOODYARD OPERATION**9**

Wood yard operation - Mechanical pulping – Chemical pulping – Secondary fiber pulp processing.

UNIT III PAPER MACHINE**9**

Paper Machine wet and addition paper machine dry and Paper machine - Wet and operation

UNIT IV PAPER AND PAPERBOARD**9**

Paper and paperboard frames and products – Surface treatments – Finishing operation– End uses

UNIT V PROPERTIES AND TESTING OF PULP AND PAPER**9**

Properties and Testing of pulp and paper Process control – Quality assurance – Water and air pollution control

TOTAL PERIODS 45**COURSE OUTCOMES**

At the end of this course, the student would be able to

- understand various methods for wood preparation and pulping
- familiar with the processing and bleaching of pulp
- understand the finishing and surface treatment of various grades of paper
- demonstrate various methods for testing of pulp and paper
- demonstrate control measures relevant to solid, liquid and gaseous pollution from pulp and paper industry

TEXT BOOKS

1. Pulp and paper chemistry and Technology Monica ER Monica, Goran Gellerstedt Gunnar Hennksson De Gneyter 2009.
2. Smook G.A., —Handbook for Pulp & Paper Technologistsl, 3rd Edition, Angus Wilde Publications, Incorporation, 2003.

REFERENCES

1. Britt, Kenneth W. "Handbook of pulp and paper technology." In Handbook of pulp and paper technology. Reinhold Publishing Corp., 1964.
2. Young, Raymond A., and Masood Akhtar, eds. Environmentally friendly technologies for the pulp and paper industry. John Wiley & Sons, 1998.
3. Austin, G.T., —Shreve's Chemical Process Industries, 5th Edition, McGraw-Hill International Book Company, Singapore, 1984.
4. Kent J.A., —Riggel's Hand Book of Industrial Chemistry, Van Nostrand Reinhold, 1974.

CO/PO MAPPING

Mapping of course outcomes with programme outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1- Weak														
COs	Programme Outcome (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	2	-	3	3	-	3	-	-	2	-	2	2
CO2	3	-	2	-	3	3	-	3	-	-	2	-	2	2
CO3	3	-	2	-	3	3	-	3	-	-	2	-	2	2
CO4	3	-	2	-	3	3	-	3	-	-	2	-	2	2
CO5	3	-	2	-	3	3	-	3	-	-	2	-	2	2



COURSE OBJECTIVES

To enable students to

- familiar with the history associated with the development of the field of Nano science,
- familiar with the key technological advances which facilitated the advancement of the field.
- understand the underlying reasons for the unique properties associated with nanomaterial.
- familiar with the instrumentation and technologies currently utilized to manipulate and fabricate a variety of nanomaterial currently in use or under investigation.
- understand the current and potential applications of these materials in the various areas of biomedicine, agriculture, energy production, enhanced catalysis

UNIT I INTRODUCTION**9**

Nano scale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering- multilayered Classifications of nanostructured materials- nano particles- quantum dots, nanowires-ultra-thin films- materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties. Introduction to properties and motivation for study (qualitative only).

UNIT II GENERAL METHODS OF PREPARATION**9**

Bottom-up Synthesis, Top-down Approach: Co-Precipitation, Ultra sonication, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.

UNIT III NANOMATERIALS**9**

Nano forms of Carbon - Buckminster fullerene- grapheme and carbon nanotube, Single wall carbon Nanotubes (SWCNT) and Multi wall carbon nanotubes (MWCNT)- methods of synthesis(arc-growth, laser ablation, CVD routes, Plasma CVD), structure-property Relationships applications- Nano metal oxides-ZnO, TiO₂, MgO, ZrO₂, NiO, Nano alumina, CaO, AgTiO₂, Ferrites, Nano clays functionalization and applications-Quantum wires, Quantum dots-preparation, properties and applications

UNIT IV CHARACTERIZATION TECHNIQUES**9**

X-ray diffraction technique, Scanning Electron Microscopy – environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques, AFM, SPM, STM, SNOM, ESCA, SIMS Nano indentation.

UNIT V APPLICATIONS**9**

Nano InfoTech: Information storage- Nano computer, molecular switch, super chip, Nano crystal, Nano biotechnology: Nano probes in medical diagnostics and biotechnology, Nano medicines, Targeted drug delivery, Bio imaging –Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical Systems (NEMS)- Nano sensors, Nano crystalline silver for bacterial inhibition, Nanoparticles for subcarrier products - In Photostat, printing, solar cell, battery.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- familiar with the methods utilized in the characterization of nanomaterial
- Enrich the latest technology and various preparation methods.
- familiar with the specific applications and uses of nanomaterial in the various areas of biomedicine, biotechnology, materials science.
- familiar with the methods and instrumentation utilized to manipulate and fabricate nanomaterial into larger Scale micro-sized entities.
- design and choose appropriate techniques for engineering applications in nano sciences.

TEXT BOOKS

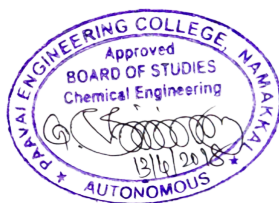
1. A.S. Edelstein and R.C. Cammearata, eds., “Nanomaterials: Synthesis, Properties and Applications”, Institute of Physics Publishing, Bristol and Philadelphia, 1996.
2. N John Dinardo, “Nano scale characterization of surfaces & Interfaces”, 2nd edition, Weinheim Cambridge, Wiley-VCH, 2000.

REFERENCES

1. G Timp (Editor), “Nanotechnology”, AIP press/Springer, 1999.
2. Akhlesh Lakhtakia (Editor), “The Hand Book of Nano Technology, Nanometer Structure, Theory, Modeling and Simulations”. Prentice-Hall of India (P) Ltd, New Delhi, 2007.

CO/PO MAPPING

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CO3	3	-	2	-	3	1	-	-	-	-	2	-	2	2
CO4	3	-	2	-	3	1	-	-	-	-	2	-	2	2
CO5	3	-	2	-	3	1	-	-	-	-	2	-	2	2



COURSE OBJECTIVES

To enable students to

- learn the sources, generation, storage, processing and disposal of municipal solid waste.
- understand the nature and characteristics of municipal solid wastes
- ability to plan waste minimization and design storage
- make the students conversant with different aspects of the types
- process waste and utilize it in energy forms.

UNIT I SOURCES AND TYPES**9**

Sources and types of municipal solid wastes-waste generation rates-factors affecting generation, characteristics-methods of sampling and characterization; Effects of improper disposal of solid wastes-Public health and environmental effects. Elements of solid waste management –Social and Financial aspects Municipal solid waste (M&H) rules – **integrated management-Public awareness; Role of NGO's.**

UNIT II ON-SITE STORAGE AND PROCESSING**9**

On-site storage methods – Effect of storage, materials used for containers – segregation of solid wastes – Public health and economic aspects of open storage – waste segregation and storage – case studies under Indian conditions – source reduction of waste – **Reduction, Reuse and Recycling.**

UNIT COLLECTION AND TRANSFER**9****III**

Methods of Residential and commercial waste collection – Collection vehicles – Manpower– Collection routes – Analysis of collection systems; **Transfer stations – Selection of location, operation & maintenance;** options under Indian conditions – Field problems- solving.

UNIT IV OFF-SITE PROCESSING**9**

Objectives of waste processing – **Physical Processing techniques and Equipments;** Resource recovery from solid waste composting and biomethanation; Thermal processing options – case studies under Indian Conditions.

UNIT V DISPOSAL**9**

Land disposal of solid waste; Sanitary landfills – site selection, design and operation of sanitary landfills – Landfill liners – **Management of leachate and landfill gas- Landfill bioreactor**– Dumpsite Rehabilitation

TOTAL PERIODS 45**COURSE OUTCOMES**

Upon completing the course

- an understanding of the nature and characteristics of municipal solid wastes
- understood the regulatory requirements regarding municipal solid waste management
- ability to plan waste minimization and design storage

- ability to process waste and utilize it in energy forms.
- sound knowledge on collection, transport, processing and disposal of solid waste

TEXTBOOKS

1. Tchobanoglous, G., Theisen, H. M., and Eliassen, R. "Solid. Wastes: Engineering Principles and Management Issues". McGraw Hill, New York, 1993.
2. Paul T Willams, "Waste Treatment and Disposal", John Wiley and Sons, 2000

REFERENCES

1. Bhide A.D. and Sundaresan, B.B. "Solid Waste Management Collection", Processing and Disposal, 2001
2. George Tchobanoglous and Frank Kreith "Hand book of Solid waste Management", McGraw Hill, New york 2002

CO/PO MAPPING

Mapping of course outcomes with programme outcomes (1/2/3 indicates strength of correlation)3-Strong, 2-Medium, 1- Weak														
Programme Outcome (POs)														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	2	1	1	-	-	-	-	-	-
CO2	-	-	-	-	-	2	1	1	-	-	-	-	-	-
CO3	-	-	-	-	-	2	1	1	-	-	-	-	-	-
CO4	-	-	-	-	-	2	1	1	-	-	-	-	-	-
CO5	-	-	-	-	-	2	1	1	-	-	-	-	-	-



COURSE OBJECTIVES

To enable students to

- elucidate the latest developments in treatment technologies and their application in diverse pollution sources including industries.
- provide fundamentals of fluid mechanics and understanding of motion of water
- design of treatment plants for various industries
- understand the biological and chemical treatment.
- acquire knowledge of advance treatment and membrane separation processes.

UNIT I WASTEWATER TREATMENT AN OVERVIEW 9

Terminology – Regulations – Health and Environment Concerns in wastewater management– **Constituents in wastewater inorganic**– Organic and metallic constituents.

UNIT II PROCESS ANALYSIS AND SELECTION 9

Components of wastewater flows – Analysis of Data – **Reactors used in wastewater treatment**– Mass Balance Analysis – Modeling of ideal and non-ideal flow in Reactors – Process Selection.

UNIT III CHEMICAL UNIT PROCESSES 9

Role of unit processes in wastewater treatment chemical coagulation – **Chemical precipitation for improved plant performance chemical oxidation** –Neutralization – Chemical Storage.

UNIT IV BIOLOGICAL TREATMENT 9

Overview of biological Treatment – **Microbial metabolism**– Bacterial growth and energatus – Aerobic biological oxidation – Anaerobic fermentation and oxidation – Trickling filters – Rotating biological contractors. Combined aerobic processes – Activated sludge film packing

UNIT V ADVANCED WASTEWATER TREATMENT 9

Technologies used in advanced treatment – **Classification of technologies Removal of Colloids and suspended particles** – Depth Filtration – Surface Filtration – Membrane Filtration Absorption – Ion Exchange – Advanced oxidation process.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- define the quality parameters typically used to characterize wastewater and explain the different classes of treated wastewater.
- describe various types of process units used for preliminary, primary and secondary treatment and explain how they achieve the target level of treatment.
- recognize and discuss emerging technologies for advanced wastewater treatment and water recycling.

- discuss water and wastewater treatment solid wastes management
- propose a treatment system for a given wastewater to achieve a specified end use

TEXT BOOKS

1. Wastewater Engineering Treatment and Reuse: Mc Graw Hill, G. Tchobanoglous, FI Biston, 2002.
2. Industrial Wastewater Management Treatment and Disposal by Wastewater McGraw Hill III Edition 2008.

REFERENCES

1. Eckenfelder, W. W, Jr. "Industrial Water Pollution Control" McGraw-Hill: New York, 1966.
2. A. D. Patwardhan "Industrial Wastewater Treatment "PHI, 2009.

CO/PO MAPPING

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	2	-	3	3	-	3	-	-	2	-	2	2
CO2	3	-	2	-	3	3	-	3	-	-	2	-	2	2
CO3	3	-	2	-	3	3	-	3	-	-	2	-	2	2
CO4	3	-	2	-	3	3	-	3	-	-	2	-	2	2
CO5	3	-	2	-	3	3	-	3	-	-	2	-	2	2



COURSE OBJECTIVES

To enable the students to

- understand the fundamentals in transport processes
- study fundamentals to solve real life problems involving transports of momentum
- do energy and mass balance analysis.
- develop steady and time dependent solutions along with their limitations.
- analyse industrial problems along with appropriate boundary conditions.

UNIT I TRANSPORT PHENOMENA - FUNDAMENTALS 9

Importance of transport phenomena - analogous nature of transfer process - basic concepts - conservation laws - Newtonian and non - **Newtonian fluids** - rheological models - theories of transport properties of gases and liquids effect of pressure and temperature

UNIT II SHELL MOMENTUM TRANSPORT IN LAMINAR FLOW 9

General method of shell balance approach to transfer problems - boundary conditions - momentum flux and velocity distribution in falling film - circular tube - annulus and two adjacent immiscible fluids - creeping flow around a Sphere - **Equations of Continuity and Motion - solutions to flow problems.**

UNIT III SHELL ENERGY AND TEMPERATURE DISTRIBUTION IN LAMINAR FLOW 9

Heat Conduction with Electrical, Nuclear and Viscous Heat Sources; Heat Conduction - Composite Walls and Cooling Fin; Forced and Free Convection; Use of equations of change to solve heat transfer problems- tangential flow in an annulus with viscous Heat Generation and Transpiration cooling.

UNIT IV SHELL MASS BALANCE AND CONCENTRATION DISTRIBUTION IN LAMINAR FLOW 9

Diffusion - Stagnant Gas Film, Heterogeneous and Homogeneous Chemical Reactions, Falling Liquid Film (Gas Absorption); **Diffusion and Chemical Reaction inside a Porous Catalyst.**

UNIT V ANALOGIES BETWEEN TRANSPORT PROCESSES 9

Importance of analogy - development and applications of analogies between momentum and mass transfer – Reynolds – Prandtl - **Von Karman and Colburn analogies**

TOTAL PERIODS 45

COURSE OUTCOMES

On completion of the course the students will be able to

- understand the principles of momentum, heat and mass transport by developing mathematical models to determine respective fluxes
- apply the shell momentum balance and velocity distribution in laminar flow and understand equation of continuity and motion

- use equations of change to solve heat transfer problems; Develop shell balance approach for condensation and convection
- develop solutions for homogeneous and heterogeneous chemical reactors by applying shell mass balance
- analyze the analogy between the transports processes of heat- momentum and mass transfer

TEXT BOOKS

1. R.B. Bird- W.E. Stewart and E.W. Lightfoot, “Transport Phenomena”, John Wiley II Edition 2006.
2. J.R. Welty- R.W. Wilson- and C.W.icks Rorer G.E- Wilson R.W. “Fundamentals of Momentum Heat and Mass Transfer, 5th Edition, John Wiley and Sons, 2007.

REFERENCES

1. L.S.Sissom and D.R.Pitts “Elements of Transport Phenomena”, McGraw- Hill, New York- 1972.
2. R.W.Fahien “Elementary Transport Phenomena”, McGraw-Hill- New York- 1983.
3. Robert- S Brodkey- Harry C. Hershey, “Transport Phenomena A Unified Approach ”, Brodkey Publishing 2003
4. Geankoplis Christie J. “Mass transport phenomena”. Holt- Rinehart and Winston- 1972.

CO/PO MAPPING

Mapping of course outcomes with programme outcomes (1/2/3 indicates strength of correlation)3-Strong, 2-Medium, 1- Weak														
COs	Programme Outcome (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	1	1	1					1	2	3
CO2	2	2	1	1	1	1	1	-	-	-	-	1	2	3
CO3	2	2	2	1	1	-	-	-	1	-	-	2	2	3
CO4	3	2	1	2	1	-	-	-	1	1	-	2	2	3
CO5	3	2	2	2	1	-	-	-	-	1	-	2	2	3



COURSE OBJECTIVES

To enable the students to

- have knowledge on Laplace transformation
- have knowledge about first order system and their dynamics in open loop system.
- design various control schemes
- convert the model to a form amenable to solution and analysis
- apply the control system in various processes.

UNIT I LAPLACE TRANSFORMATION 7+6

Laplace transformation and its application in process control- transient response for standard input functions- development of block diagram

UNIT II OPEN LOOP SYSTEMS 9+6

First order system, First order system in series - linearization and its application in systems and their dynamics - transportation lag. Second order system

UNIT III CLOSED LOOP SYSTEMS 12+6

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 - transient response of closed-loop control systems and their stability.

UNIT IV FREQUENCY RESPONSE 9+6

Introduction to frequency response of closed-loop systems - control system design by frequency response techniques - Bode diagram - stability criterion - tuning of controllers Z-N tuning rules - C-C tuning rules.

UNIT V ADVANCED CONTROL SYSTEMS 8+6

Introduction to advanced control systems - cascade control - feed forward control - Smith predictor - control of distillation towers and heat exchangers - introduction to computer control of chemical processes.

TOTAL PERIODS 75

COURSE OUTCOMES

Upon the completion of the course- students will be able to

- understand the working principle of various instruments.
- apply the Laplace transforms for different systems
- model and study the system behavior
- check the stability criterion and follow the tuning rules
- gain knowledge on different control stations

TEXT BOOKS

1. Stephanopoulos. G. "Chemical Process Control", Prentice Hall of India- 2003
2. Donald R Coughnour "Process Systems Analysis and Control", 3rd Edition. McGraw Hill- New York- 2008

REFERENCES

1. Marlin- T. E.- "Process Control"- 2nd Edition- McGraw Hill- New York- 2000.
2. Jason L. Speyer- Walter H.Chung- "Stochastic Processes- Estimation- and Control"- PHI Ltd (2013).
3. Peter Harriott- "Process Control" Tata McGraw-Hill Education-2000
4. Nageshwar Govind Das, Sudheer S.Bhagade "Process Dynamics and Control" PHI Ltd (2013).

CO/PO MAPPING

Mapping of course outcomes with programme outcomes (1/2/3 indicates strength of correlation)3-Strong, 2-Medium, 1- Weak														
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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	1	1	1	-	-	-	2	1	2	3
CO2	2	2	2	1	1	2	2	-	1	-	-	2	2	3
CO3	3	1	1	2	1	2	2	-	1	1	2	2	2	3
CO4	3	2	2	2	1	1	1	-	-	1	-	2	2	3
CO5	2	2	1	1	1	2	2	-	-	-	1	2	2	3



COURSE OBJECTIVES

To enable the students to

- have the knowledge on planning and techniques of measurement of work.
- attain the importance of cost estimation and projects.
- estimate the project profit and techniques for investment.
- analyze the performance, preparation of annual report.
- sustain the knowledge on economic balance.

UNIT I PRINCIPLES OF MANAGEMENT AND ORGANISATION 9

Planning, organization, staffing, coordination, directing, controlling, communicating, organization as a process and a structure; types of organizations. Method study; work measurement techniques; basic procedure; motion study; motion economy; principles of time study; elements of production control; forecasting; planning; routing; scheduling; dispatching; costs and costs control, inventory and inventory control.

UNIT II INVESTMENT COSTS AND COST ESTIMATION 9

Time Value of money; capital costs and depreciation, estimation of capital cost, manufacturing costs and working capital, capital budgeting and project feasibility.

UNIT III PROFITABILITY, INVESTMENT ALTERNATIVE AND REPLACEMENT 9

Estimation of project profitability, sensitivity analysis; investment alternatives; replacement policy; forecasting sales; inflation and its impact.

UNIT IV ANNUAL REPORTS AND ANALYSIS OF PERFORMANCE 9

Principles of accounting; balance sheet; income statement; financial ratios; analysis of performance and growth.

UNIT V ECONOMIC BALANCE 9

Economic decisions in Chemical Plant - Economics of size - Essentials of economic balance – Economic balance approach, economic balance for insulation, evaporation, heat exchanger

TOTAL PERIODS 45

COURSE OUTCOMES

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

- know the importance of planning and types of organization.
- have knowledge on value of money and how to utilize for the projects.
- impact the investment alternatives and its forecasting.
- gain the knowledge on balance sheet and their performance.
- attain the idea of economic growth and balance.

TEXT BOOKS

1. Peters, M. S. and Timmerhaus, C. D. RE West , “Plant Design and Economics for Chemical Engineers”, III Edn, McGraw Hill, 2003.

2. Holand, F.A., Watson, F.A. and Wilkinson, J.K., "Introduction to Process Economics", 2nd Edn, John Wiley, (1983)

REFERENCES

1. Perry, R. H. and Green, D., "Chemical Engineer's Handbook", 7th Edition, McGraw Hill.
2. Allen, L.A., "Management and Organization", McGraw Hill

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CO3	3	1	1	2	1	2	2	-	1	1	2	2	2	3
CO4	3	2	2	2	1	1	1	-	-	1	-	2	2	3
CO5	2	2	1	1	1	2	2	-	-	-	1	2	2	3



All Tables / Chemical Engineers' Handbook / Data Books / Graph Sheets are permitted during the Examination

COURSE OBJECTIVES

To determine experimentally the response and controlling methods

- for first and second order system
- for Open and closed loop on level- flow and thermal system
- for control valve with different characteristics
- tuning of pressure system with loop study

LIST OF EXPERIMENTS

1. Response to the first order system
2. Response to the second order system
3. Response of Non-Interacting level System
4. Response of Interacting level System
5. Open loop study on a thermal system
6. Closed loop study on a level system
7. Closed loop study on a flow system
8. Closed loop study on a thermal system
9. Tuning of a pressure system
10. Characteristics of different types of control valves
11. Flow co-efficient of control valves
12. Closed loop study on a pressure system

TOTAL PERIODS 60

COURSE OUTCOMES

Upon the completion of the course- students will be able to

- have knowledge on the development and use of right type of control dynamics for level and thermal
- have knowledge on the development and use of right type of control dynamics for flow and pressure
- have knowledge on controlling processes under different operative conditions
- have knowledge on different characteristic of control valve

TEXT BOOKS

1. Stephanopoulos- G. "Chemical Process Control" - Prentice Hall of India, 2003.
2. Coughnowr. D "Process Systems Analysis and Control", 3rd Edn.- McGraw Hill- New York- 2008

REFERENCES

1. Marlin- T. E.- "Process Control "- 2nd Edition- McGraw Hill- New York- 2000

CO/PO MAPPING

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CO3	3	2	1	2	2	-	-	1	1	1	-	2	2	3
CO4	2	3	2	2	2	-	-	-	1	1	-	2	2	3
CO5	2	2	1	1	1	-	-	-	-	-	1	2	2	3



COURSE OBJECTIVES

To enable the students to

- impart knowledge on design of batch reactors
- gain knowledge on CSTR reactor
- study about coupled reactors
- learn about performance characteristics of reactors

LIST OF EXPERIMENTS

1. Kinetic studies in a Batch reactor
2. Kinetic studies in a Plug flow reactor
3. Kinetic studies in a CSTR
4. Kinetic studies in a Packed bed reactor
5. Kinetic studies in a PFR followed by a CSTR
6. RTD studies in a PFR
7. RTD studies in a Packed bed reactor
8. RTD studies in a CSTR
9. Studies on micellar catalysis
10. Study of temperature dependence of rate constant using CSTR.
11. Combined reactor

TOTAL PERIODS 60

COURSE OUTCOMES

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

- get a sound working knowledge on different types of reactors.
- Learn kinetics studies
- evaluate the RTD studies
- learn the temperature dependence of reactor

TEXT BOOKS

1. Scott Fogler H., “Elements of Chemical Reaction Engineering”, Third Edition, Prentice Hall of India, Eastern Economy Edition, New Delhi, 2006.
2. Lanny D. Schmidh, “The Engineering of Chemical Reactions”, Second Edition, Oxford University Press, 2005
3. G.Fronment, K.B.Bischoff, “Chemical Reactor Analysis and Design” , John Wiley and Sons, 1979

CO/PO MAPPING

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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CO2	2	1	-	2	-	-	-	-	-	-	1	-	2	-
CO3	2	1	-	2	-	-	-	-	-	-	1	-	2	-
CO4	2	1	-	2	-	-	-	-	-	-	1	-	2	-
CO5	2	1	-	2	-	-	-	-	-	-	1	-	2	-



(All Tables/Chemical Engineers' Handbook/Data Books/Graph Sheets are permitted during the Examination.)

COURSE OBJECTIVES

To enable the students to

- learn basic drawing for cooling tower, drier and evaporator
- design and draw heat exchanger
- know about basic drawing for distillation
- basic drawing for extraction and absorption

LIST OF EXPERIMENTS

1. Basic design and drawing considerations of cooling tower
2. Basic design and drawing considerations of evaporator
3. Basic design and drawing considerations of drier
4. Basic design and drawing considerations of heat exchanger
5. Basic design and drawing considerations of reboiler
6. Basic design and drawing considerations of sieve tray distillation
7. Basic design and drawing considerations of bubble cap distillation
8. Basic design and drawing considerations of packed column distillation
9. General design and drawing considerations of absorption column
10. General design and drawing considerations of extraction equipment

TOTAL PERIODS 60

COURSE OUTCOMES

Upon the completion of the course- students will be able to

- have skill to design and install process equipments like cooling tower- drier - evaporator
- have skill in design and drawing of heat exchanger
- have skill in design and drawing of different types of distillation
- have skill in design and drawing for extractor and absorption

TEXT BOOKS

1. Kuppan Thulukkanam- "Heat Exchanger Design Handbook, Second Edition" CRC press 2013
2. J.M. Coulson and J.Richardson- "Chemical Engineering"- vol. 6- Asian Books Printers Ltd.

REFERENCES

1. R.H. Perry- "Chemical Engineers' Handbook"- McGraw-Hill
2. McCabe- W.L- Smith J.C and Harriott- P.- "Unit Operations in Chemical Engineering"- McGraw-Hill Fourth Edition- 2010.
3. S.D.Dawande "Process Design of Equipments" Central Techno Publications- Nagpur- 2000.
4. M.V.Joshi and V.V. Mahajan- "Process Equipment Design"- MacMillan India Ltd.

CO/PO MAPPING

Mapping of course outcomes with programme outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1- Weak														
COs	Programme Outcome (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	2	1	1	-	1	-	-	1	2	3
CO2	2	2	2	2	1	-	-	-	1	-	-	2	2	3
CO3	3	2	1	2	2	-	-	1	1	1	-	2	2	3
CO4	3	3	2	2	3	-	-	-	1	1	-	2	2	3
CO5	2	2	1	1	1	-	-	-	-	-	1	2	2	3



COURSE OBJECTIVES

To enable the students to

- know the fundamentals of energy conversion.
- understand the interaction between different energy system.
- gain knowledge on the relevance and applications of nuclear and biomass energy.
- comprehend the principles of power generation using hydro, wind and solar energy.
- understand about energy management and conducting energy audit in chemical industries.

UNIT I ENERGY 9

Introduction to energy – Global energy scene – Indian energy scene - Units of energy - conversion factors – general classification of energy - energy crisis - energy alternatives

UNIT II NUCLEAR ENERGY & FOSSIL FUELS 9

Nuclear energy - Fission and fusion - Types of nuclear reactors. Coal - types and classification – Conversion. Technologies – Petroleum - products and properties - shale oil and gas - Oil - tar sand - Natural gas-CNG and LNG

UNIT III RENEWABLE ENERGY SOURCES 9

Fundamentals of Power generation systems – Hydro – Wind – solar - Geothermal and ocean energy - fuel cells.

UNIT IV BIOMASS ENERGY 9

Biomass origin – Resources - Biomass estimation - Thermochemical conversion - Biological conversion - Chemical Conversion - Hydrolysis & hydrogenation – solvolysis - bio crude - biodiesel power generation gasifier – biogas - Integrated gasification.

UNIT V ENERGY CONSERVATION & MANAGEMENT 9

Energy forecasting and planning - Energy conservation - Waste heat recovery and heat pipes - Energy Audit in Chemical process industries - Cogeneration practices in industries

TOTAL PERIODS 45

COURSE OUTCOMES

Upon the completion of the course- students will be able to

- apply the fundamentals of energy conversion in applications.
- understand the sources- applications and conversion technologies for nuclear and fossil fuels
- grasp the principles of power generation using hydro- wind and solar energy
- gain knowledge on the relevance and applications of biomass energy
- understand the importance on the necessary of conservation and audit

TEXT BOOKS

1. Rao- S. and Parulekar- B.B - “Energy Technology”- Khanna Publishers- 2005.
2. Rai- G.D - “Non-conventional Energy Sources”- Khanna Publishers- New Delhi- 1984.

REFERENCES

1. Nejat Veziroglu- "Alternate Energy Sources"- IT- McGraw Hill- New York
2. El. Wakil- "Power Plant Technology"- Tata McGraw Hill- New York- 2002.
3. Albert Thumann- P.E.- C.E.M & William J Younger C.E.M- "Handbook of Energy Audit by 7th edition" Fairmont Press 2008
4. Nagpal- G.R.- "Power Plant Engineering"- Khanna Publishers- 2008

CO/PO MAPPING

Mapping of course outcomes with programme outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1- Weak														
COs	Programme Outcome (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	2	1	1	-	1	-	-	1	2	3
CO2	2	2	2	2	1	-	-	-	1	-	-	2	2	3
CO3	3	2	1	2	2	-	-	1	1	1	-	2	2	3
CO4	3	3	2	2	3	-	-	-	1	1	-	2	2	3
CO5	2	2	1	1	1	-	-	-	-	-	1	2	2	3



COURSE OBJECTIVES

The objective of the project is

- to make use of the knowledge gained by the student at various stages of the degree course.
- to make students to prepare a report individually on the project assigned to him and submit it to the department.
- to prepare report based on the information available in the literature or data obtained in the laboratory/ industry.
- students- in addition will be permitted to undertake industrial/ consultancy project
- student can work- outside the department- in industries/Research labs for which proportional weight age will be given in the final assessment.

GUIDELINES

1. The students are expected to get formed into a team of convenient groups of not more than 4 members for a project.
2. Every project team shall have a guide who is the member of the faculty of the institution.
3. The group must identify and select the problem to be addressed as their project work through literature survey and finalize a comprehensive aim and scope of their work.
4. Reviews of the progress of the project work must be conducted by a team of faculty (minimum 3 and a maximum of 5) along with their faculty guide as a member the review team.
5. Progress of project work must be monitored by the project guide and committee periodically.
6. Attendance for review is mandatory. If a student fails to attend review for some valid reasons, one more chance may be given
7. The project report should be submitted by the students around the first week of April.

COURSE OUTCOME

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

- take up any challenging practical problems and find solution by formulating proper methodology
- collect literature through research journals and identify the gap in selected area
- devise the methodology to find solution through gathering complete knowledge on materials/design procedure/analysis and optimisation techniques/ availability of experimental setup/ company permission and other documentation procedures to execute the project.
- prepare project report as per format and confidently face viva voce with proper PPT for presentation

CO/PO MAPPING

Mapping of course outcomes with programme outcomes (1/2/3 indicates strength of correlation)3-Strong, 2-Medium, 1- Weak														
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CO1	3	2	1	1	2	1	2	-	1	-	-	2	3	3
CO2	2	3	2	2	1	-	-	-	1	1	-	3	2	3
CO3	3	2	1	2	2	-	-	1	1	2	-	2	2	3
CO4	2	3	2	2	3	-	-	-	1	2	-	3	3	3
CO5	3	3	1	1	1	-	-	-	-	-	1	3	3	3



COURSE OBJECTIVES

To enable students to

- understand the occurrence of petroleum- exploration techniques- types of rigs and platforms
- examine the composition of natural gas- compression- purification- liquefaction.
- understand the shale oil occurrence- extraction and purification
- understand the storage- transportation of natural gas and power generation in industrial needs
- examine the hydrodynamic equations for flow- PVT properties and multiphase flow correlations

UNIT I OCCURRENCE AND EXPLORATION 9

Occurrence of petroleum - types of reservoirs - Exploration Methods. **Drilling and Production of crude** and natural Gas - types of rigs and platforms.

UNIT II NATURAL GAS 9

Composition and properties - **compression and liquefaction of natural gas** - purification methods - Shale gas: Occurrence - extraction and purification.

UNIT III STORAGE AND TRANSPORT 9

Storage and transportation of Natural gas- application in Chemical Process- Power generation- domestic - Industrial and transportation sectors.

UNIT IV APPLIED HYDRODYNAMICS IN OIL WELLS 9

Hydrodynamic equations for flow of fluids through porous media - **PVT properties for oil gas systems** - Multiphase flow correlations to determine flow ratio and pressure traverse in flowing oil wells

UNIT V REGULATORY PROBLEMS 9

Safety - environmental and economic aspects of oil and gas exploration - **Oil Spill Management** Alaska and Gulf of Mexico case studies.

TOTAL PERIODS 45

COURSE OUTCOMES

Upon the completion of the course- students will be able to

- understand the occurrence of petroleum- exploration techniques- types of rigs and platforms
- examine the composition of natural gas- compression- purification- liquefaction and understand the shale oil occurrence- extraction and purification
- understand the storage- transportation of natural gas and power generation in industrial needs
- examine the hydrodynamic equations for flow- PVT properties of gas and multiphase flow correlations.
- recognize legal aspects governing gas oil exploration- oil spill management and case studies

TEXT BOOKS

1. Katz Donald L. and Lee Robert L. "Natural Gas Engineering" McGraw Hill Publishing Company- New York- 1990.

2. Medici M. "The Natural Gas Industry"- Newnes-Butterworths- London- 1974.

REFERENCES

1. Econonides M.J. And Daniel A. "Petroleum Production Systems"- Prentice Hall Petroleum Engineering Series- 2012.
2. William C Lyons- Gary C Plisga- "Standard Hand Book of Petroleum and Natural Gas Engineering"- 2nd Edition- Gulf Professional Publishing- 2004.
3. Boyun Guo- Ali Ghalambor- "Natural Gas Engineering Handbook"-2nd Edition- Gulf Publishing Company-2014
4. G.G.Nasr- N.E.Connor- "Natural Gas Engineering and safety challenges"- Springer Publishing- 2014

CO/PO MAPPING

Mapping of course outcomes with programme outcomes (1/2/3 indicates strength of correlation)3-Strong, 2-Medium, 1- Weak														
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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	1	1	1	-	-	-	2	1	2	3
CO2	2	2	2	1	1	2	2	-	1	-	-	2	2	3
CO3	3	1	1	2	1	2	2	-	1	1	2	2	2	3
CO4	3	2	2	2	1	1	1	-	-	1	-	2	2	3
CO5	2	2	1	1	1	2	2	-	-	-	1	2	2	3



COURSE OBJECTIVES

To enable the students

- to develop an understanding of the basic concepts of polymer technology
- to study the molecular weight distribution, Condensation polymerization and transition in polymers.
- to understand the principles related to the synthesis and characterization of polymers.
- to comprehend the properties and manufacturing processes of polymers
- to grasp the methods of preparation and moulding of plastics

UNIT I INTRODUCTION**9**

History of Macromolecules - structure of natural products like cellulose rubber - proteins - concepts of macromolecules - Staudinger's theory of macromolecules - difference between simple organic molecules and Macromolecules.

UNIT II ADDITION POLYMERIZATION**9**

Chemistry of Olefins and Dienes - double bonds - Chemistry of free radicals - monomers – functionality - Polymerization: Initiation - types of initiation - free radical polymerization - cationic polymerization - anionic polymerization - coordination polymerization - industrial polymerization – bulk - emulsion - suspension and solution polymerization techniques - Kinetics – Copolymerization concepts.

UNIT III CONDENSATION POLYMERIZATION**9**

Simple condensation reactions - Extension of condensation reactions to polymer synthesis - functional group reactivity - poly condensation - kinetics of poly condensation - Carother's equation - Linear polymers by poly condensation - Interfacial polymerization - cross linked polymers by condensation - gel point.

UNIT IV MOLECULAR WEIGHTS OF POLYMERS**9**

Difference in molecular weights between simple molecules and polymers - number average and weight average molecular weights - degree of polymerization and molecular weight - molecular weight distribution - poly dispersity - molecular weight determination. Different methods – Gel Permeation Chromatography

UNIT V TRANSITIONS IN POLYMERS**9**

First and second order transitions - Glass transition - T_g - multiple transitions in polymers - experimental study - significance of transition temperatures - crystallinity in polymers - effect of crystallization in polymers - factors affecting crystallization crystal nucleation and growth - relationship between T_g and T_m - Relationship between properties and crystalline structure.

TOTAL PERIODS 45**COURSE OUTCOMES**

At the end of this course- the student would be able to

- understand the principles related to the synthesis and characterization of polymers.

- develop the knowledge to characterize the plastics by using different instruments
- gain insight into the structure and properties of polymers
- comprehend the properties and manufacturing processes of polymers
- grasp the methods of preparation and moulding of plastics

TEXT BOOKS

1. Billmeyer.F.W.-Jr “Text Book of Polymer Science”- Ed. Wiley, Interscience- 1984
2. Gowariker.V.T, Viswanathan.N.V and Sreedar.J. “Polymer Science”, 9th Reprint- New Age International Pvt. Ltd, India- 1996.

REFERENCES

1. Joel-R.F; “Polymer Science and Technology”- Eastern Economy Edition- 1999
2. Rodriguez- F.- Cohen.C.- Oberic.K and Arches- L.A.- “Principles of Polymer Systems”- 5th edition- Taylor and Francis- Great Britain- London- 2003
3. Arora M.G. and Singh M. “Polymer Chemistry”- Anmol Publications Pvt. Limited- 2003.
4. Seymour.R.B. and Carraher.C.E.- Jr.- “Polymer Chemistry”, 2nd Ed.- Marcel Dekker- 1988.

CO/PO MAPPING

Mapping of course outcomes with programme outcomes (1/2/3 indicates strength of correlation)3-Strong, 2-Medium, 1- Weak														
COs	Programme Outcome (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	1	1	1	-	-	-	2	1	2	3
CO2	2	2	2	1	1	2	2	-	1	-	-	2	2	3
CO3	3	1	1	2	1	2	2	-	1	1	2	2	2	3
CO4	3	2	2	2	1	1	1	-	-	1	-	2	2	3
CO5	2	2	1	1	1	2	2	-	-	-	1	2	2	3



COURSE OBJECTIVES

To enable the students to

- acquire knowledge on general aspects on food industry and their needs.
- categories the quality and nutritive aspects of food.
- point out the processing methods and their preservation.
- familiarize the food preservation methods.
- know the production and utilization of food products.

UNIT I INTRODUCTION**9**

General aspects of food industry; world food needs and Indian situation.

UNIT II FOOD CONSTITUENTS, QUALITY AND DERIVATIVE FACTORS**9**

Constituents of food; quality and nutritive aspects; food additives; standards; deteriorative factors and their Control.

UNIT III GENERAL ENGINEERING ASPECTS AND PROCESSING METHODS**9**

Preliminary processing methods; conversion and preservation operations.

UNIT IV FOOD PRESERVATION METHODS**9**

Preservation by heat and cold; dehydration; concentration; drying irradiation; microwave heating; sterilization and pasteurization; fermentation and pickling; packing methods.

UNIT V PRODUCTION AND UTILISATION OF FOOD PRODUCTS**9**

Cereal grains; pulses; vegetables; fruits; spices; fats and oils; bakery; confectionery and chocolate products; soft and alcoholic beverages; dairy products; meat; poultry and fish products.

TOTAL PERIODS 45**COURSE OUTCOMES**

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

- explain the general aspects of food industries, food products, food constituents.
- analyzes the quality, standards and detractive factors and their control.
- understand the engineering aspects of food processing and preservation and its various methods.
- study the various kinds of food products; their production and utilization to the standard.
- design the equipment for food industries.

TEXT BOOKS

1. Jowitt R., Hygienic Design and Operation of Food Plant, AVI Pvt. Co., West Port, 1980.
2. Head man D.R. and Singh R.P., Food Processing Technology, AVI Pvt. Co., West Port.

REFERENCES

1. Brennan J., Butters G.J.R., Cowell, N.D. and AEV Lilly, —Food Engineering Operations, 3rd Edition, Applied Scientific Publishers, London, 1990.
2. Ronald H. Schmidt and Gary E. Rodrick, —Food Safety Handbook, John Wiley and Sons, New Jersey, 2005.
3. Charm S.E., The Fundamentals of Foods Engineering, The AVI Publishing Co., Westport, 1963

4. Heid J.L. Joslyn M.A., Fundamentals of Food Processing Operation, The AVI publishing Co., West port 1967.

CO/PO MAPPING

Mapping of course outcomes with programme outcomes (1/2/3 indicates strength of correlation)3-Strong, 2-Medium, 1- Weak														
COs	Programme Outcome (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	1	1	1	-	-	-	2	1	2	3
CO2	2	2	2	1	1	2	2	-	1	-	-	2	2	3
CO3	3	1	1	2	1	2	2	-	1	1	2	2	2	3
CO4	3	2	2	2	1	1	1	-	-	1	-	2	2	3
CO5	2	2	1	1	1	2	2	-	-	-	1	2	2	3



COURSE OBJECTIVES

To enable the students to

- identify the grand challenges of green chemistry and consider what it will take to resolve them.
- explain the meaning and importance of low dose adverse chemical effects and endocrine disruptors, which present major environmental and health threats.
- develop an understanding of the importance of pollution and wastefulness in modern cultures by reflecting on the big chemistry, big technology issues such as energy use and the protection of the atmosphere.
- gain the knowledge of energy calculation and environmental wastes.
- acquire knowledge on various assessment methods.

UNIT I QUALITY ISSUES AND RISK ASSESMENT**9**

Overview of Major Environmental Issues, Global Environmental Issues. **Air Quality Issues**-Water Quality Issues, Ecology, Natural Resources, Description of Risk-Value of Risk Assessment in the Engineering Profession-Risk-Based Environmental Law-Risk Assessment **Concepts-Hazard Assessment**. Dose-Response-Risk Characterization.

UNIT II ENVIORNMENTAL EXPOSURE**9**

Pollution Prevention- Pollution Prevention Concepts and Terminology. Chemical Process Safety-Responsibilities for Environmental Protection. Environmental Persistence. **Classifying Environmental Risks- Based on Chemical Structure-Exposure Assessment for Chemicals in the Ambient Environment**

UNIT III POLLUTION PREVENTION**9**

Green Chemistry. Green Chemistry Methodologies. Quantitative/Optimization- Based Frameworks for the design of Green Chemical Synthesis Pathways- Green Chemistry Pollution Prevention in Material Selection for Unit Operations.-Pollution Prevention for Chemical Reactors. Pollution Prevention for Separation devices- **Pollution Prevention Applications for Separative Reactors.-Pollution Prevention in Storage Tanks.**

UNIT IV PROCESS AND ESTIMATION INTEGRATION**9**

Process Energy Integration. Process Mass Integration. Case Study of a Process Flow sheet- **Estimation of Environmental Fates of Emissions and Wastes.**

UNIT V COST AND LIFE CYCLE ASSESMENT**9**

Magnitudes of Environmental Costs-A Framework for Evaluating Environmental Costs-Hidden Environmental Costs. Liability Costs-Internal Intangible **Costs-External Intangible Costs**-Introduction to Product Life Cycle Concepts-Life- Cycle Assessment. Life-Cycle Impact Assessments- Streamlined Life-Cycle Assessments.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- understand the issues in quality and risk assessment tools
- suggest the environment friendly techniques to reduce effluents
- acquire the knowledge in preventing pollution by following green chemistry principles
- estimate the energy balance sheet and predict the future
- assess the magnitude of product and optimize the cost

TEXT BOOKS

1. Allen, D.T., Shonnard, D.R, Green Engineering: Environmentally Conscious Design of Chemical Processes. Prentice Hall PTR 2002.
2. MukeshDoble and Anil Kumar Kruthiventi, Green Chemistry and Engineering, Elsevier,Burlington,USA, 2007

REFERENCES

1. Rao, C.S Environmental Pollution Control Engineering, Wiley- Eastern Ltd.1991.
2. Rao M.N and H.V.N. Rao. "Air pollution", Tata McGraw Hill Publishing Co.Ltd.1989
- 3.
- 4.

CO/PO MAPPING

Mapping of course outcomes with programme outcomes (1/2/3 indicates strength of correlation)3-Strong, 2-Medium, 1- Weak														
Programme Outcome (POs)														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	3	-	-	3	-	-	2	-	2	2
CO2	-	-	-	-	3	-	-	3	-	-	2	-	2	2
CO3	-	-	-	-	3	-	-	3	-	-	2	-	2	2
CO4	-	-	-	-	3	-	-	3	-	-	2	-	2	2
CO5	-	-	-	-	3	-	-	3	-	-	2	-	2	2



COURSE OBJECTIVES

To enable students

- to learn about different types of corrosion
- to make the students aware coating and protection methods
- to learn about corrosion in specific environments
- to control pollution with technological achievement and economic viability.
- to study the corrosion protection management with principle

UNIT I TYPES OF CORROSION AND TESTING METHODS 9

Basic principles of corrosion and its control – Forms of corrosion, uniform, Galvanic, Crevice, pitting, selective leaching, erosion, stress - corrosion, cracking Cavitation phenomena and their effects – Corrosion testing – Field testing – **Electrochemical techniques for measurement of corrosion rates**, corrosion detection and components examination – Accelerated salt - spray testing.

UNIT II CORROSION PROTECTION METHODS 9

Corrosion inhibitors, electroplated coatings, conversion coatings, anodizing, hot dipping, spray metal coatings, zinc coating by alloying, electrophoretic coatings and electro painting, powder coating, electrical methods of corrosion protection, composite materials in corrosion minimization – **Cathodic and Anodic protections.**

UNIT III CORROSION IN SPECIFIC ENVIRONMENTS 9

Corrosion damage to concrete in industrial and marine environments and its protection; **biological corrosion, halogen corrosion of metals**, environmental degradation of materials, corrosion and inspection managements in chemical processing and petrochemical industries.

UNIT IV CORROSION IN SPECIFIC CASES AND CONTROL 9

Corrosion in structure – corrosion of stainless steels – corrosion in power equipments, corrosion in electrical and electronic industry – **corrosion and selection of materials of pulp and paper plants** – corrosion aspects in nuclear power plants – corrosion of surgical implants and prosthetic devices.

UNIT V CORROSION AND COUNTRY'S ECONOMY 9

Corrosion protection management – process maintenance procedures under corrosion Environments.

TOTAL PERIODS 45

COURSE OUTCOMES

Upon the completion of the course- students will be able to

- have an insight into all aspects of corrosion and testing methods
- apply the principles of corrosion inhibition for protection of process equipments
- develop knowledge of corrosion inspection and management in chemical industries
- control corrosion and select materials for different applications
- comprehend the impact of corrosion on nations economy

TEXT BOOKS

1. Fontana M.G., Corrosion Engineering, Tata McGraw Hill, 2005.
2. Jones D.A., Principles and Protection of Corrosion, Prentice-Hall, 1996

REFERENCES

1. Pierre R. Roberge, Corrosion Engineering: Principles and Practice, McGraw-Hill, 2008.
2. Sastri V.S., Ghali E. And Elboudjaini M., Corrosion Prevention and Protection: Practical Solutions, John Wiley and Sons, 2007.

CO/PO MAPPING

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CO4	3	2	2	2	1	1	1	-	-	1	-	2	2	3
CO5	2	2	1	1	1	2	2	-	-	-	1	2	2	3



COURSE OBJECTIVES

To enable the students to

- understand the purpose of instrumentation in Industrial processes.
- learn the working of different types of temperature measuring instruments like RTD, Thermistor, and thermocouple.
- have a sound knowledge about analytical instrument and chromatography.
- have an idea about the fundamental of process control and programmable controllers.
- have an adequate knowledge on pressure, level and flow controllers with types of valves.

UNIT I BASICS OF INSTRUMENTATION**5**

Introduction – Variables, Units & standards of measurement, Measurement terms – characteristic. Data Analysis.

UNIT II MEASUREMENT SYSTEM**12**

Process Variables Measurement–Temperature systems– Thermocouples, Thermo resistive system, Filled-system thermometers, Radiation thermometry, Location of temperature measuring devices in equipments, Pressure system – Mechanical pressure elements Pressure Transducers and Transmitters, Vacuum measurement, Resonant wire pressure Transducer, Flow system – Differential producers, Variable area flow meters, Velocity, vortex, mass, ultrasonic & other flow meters, positive displacement flow meters

UNIT III ANALYTICAL INSTRUMENTATION**12**

Analytical instrumentation – Analysis instruments, Sample conditioning for process analyzers, X-ray Analytical methods, Quadrupole mass spectrometry, Ultra violet Absorption Analysis, Infra-red process analyzers, Photometric reaction product analysers Oxygen analyzers, Oxidation – reduction potential measurements, pH measuring systems, Electrical conductivity and Resistivity measurements, Thermal conductivity, gas analysis, Combustible, Total hydro carbon, and CO analyzer,

UNIT IV PROCESS CONTROL**9**

Fundamentals of Automatic process control – Control algorithms-Automatic controllers – Electronic controllers -Electric controllers (Traditional) – Hydraulic controllers – Fluidics - Programmable controllers.

UNIT V TRANSMITTERS AND CONTROL VALVES**7**

Sensors, Transmitters and control valves - Pressure, Flow, Level, Temperature and Composition sensors, Transmitters, Pneumatic and electronic control valves, Types, Actuator, accessories, Instrumentation symbols and Labels.

TOTAL PERIODS**45****COURSE OUTCOMES**

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

- explain the purpose of instrumentation in Industrial processes

- know the working of different types of temperature measuring instruments like RTD, Thermistor, and Thermocouple.
- apply the knowledge on chromatography techniques.
- explain the types and fundamentals of controllers.
- Know the various flow and level measurement devices used for industrial purposes.

TEXT BOOKS

1. Fribance, “Industrial Instrumentation Fundamentals”, McGraw Hill Co. Inc. New York 1985
2. Considine D M and Considine G D “Process Instruments Controls” Handbook 3rd Edition, McGraw – Hill Book Co., NY, 1990.

REFERENCES

1. Marlin, T. E., “Process Control “, 2nd Edn, McGraw Hill, New York, 2000.
2. Smith, C. A. and Corripio, A. B., “Principles and Practice of Automatic Process Control”, 2nd Edn., John Wiley, New York, 1997
3. Jason L. Speyer, Walter H.Chung, “Stochastic Processes, Estimation, and Control”, PHI Ltd
4. Eckman D.P. “Industrial Instrumentation”, Wiley Eastern Ltd., 1989.

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CO2	-	-	-	-	3	-	1	-	1	-	2	-	2	1
CO3	-	-	-	-	3	-	1	-	1	-	2	-	2	1
CO4	-	-	-	-	3	-	1	-	1	-	2	-	2	1
CO5	-	-	-	-	3	-	1	-	1	-	2	-	2	1



COURSE OBJECTIVES

To enable students to

- develop an understanding of the basic concepts of fertilizer technology
- study about various types of fertilizers
- learn about the manufacturing techniques of fertilizer.
- understand the design of the equipments in fertilizer industry
- apply the methodology in real life.

UNIT I NITROGENOUS FERTILISERS 9

Methods of production of nitrogenous fertilizer - ammonium sulphate - nitrate - urea and calcium ammonium nitrate; Ammonium chloride and their methods of production - characteristics and specifications - **storage and handling.**

UNIT II PHOSPHATIC FERTILISERS 9

Raw materials; phosphate rock - sulphur; pyrites etc. - processes for the production of sulphuric and phosphoric acids; phosphates fertilizers - ground rock phosphate; bone meal - single superphosphate - triple superphosphate - triple superphosphate - **thermal phosphates and their methods of production - characteristics and specifications.**

UNIT III POTASSIC FERTILISERS 9

Methods of production of potassium chloride - **potassium schoenite - their characteristics and specifications.**

UNIT IV COMPLEX AND NPK FERTILISERS 9

Methods of production of ammonium phosphate - sulphate diammonium phosphate - nitro phosphates - urea - ammonium phosphate - mono - ammonium phosphate and various grades of **NPK fertilizers** produced in country

UNIT V MISCELLANEOUS FERTILISERS 9

Mixed fertilizers and granulated mixtures; **biofertilisers** - nutrients - secondary nutrients and micro nutrients; fluid fertilizers - controlled release fertilizers - controlled release fertilizers.

TOTAL PERIODS 45

COURSE OUTCOMES

Upon the completion of the course students would be able to

- develop an understanding of the basic concepts of fertilizer technology
- study about various types of fertilizers
- learn about the manufacturing techniques of fertilizer.
- understand the design of the equipments in fertilizer industry
- apply the methodology and techniques in real life.

TEXT BOOKS

1. GopalaRao M. and Marshall Sittig “Dryden’s Outlines of Chemical Technology”, 3rd Edition East- West Press, New Delhi- 2008.
2. Menno- M.G.; “Fertilizer Industry - An Introductory Survey” Higginbotham’s Pvt. Ltd.- 1973.

REFERENCES

1. “Handbook of fertilizer technology” Association of India, New Delhi- 1977.
2. Sauchelli- V.; “The Chemistry and Technology of Fertilizers” ACS MONOGRAPH No. 148- Reinhold Publishing Cor. New York- 1980.
3. Fertilizer Manual- “United Nations Industrial Development Organization” United Nations, New York- 1967.
4. Slack- A.V.; “Chemistry and Technology of Fertilizers” Interscience, New York- 1966.

CO/PO MAPPING

Mapping of Course Outcome (CO's) with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
CO's	Programme Outcomes (PO's)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	1	1	1	-	-	-	2	1	2	3
CO2	2	2	2	1	1	2	2	-	1	-	-	2	2	3
CO3	3	1	1	2	1	2	2	-	1	1	2	2	2	3
CO4	3	1	2	2	1	1	1	-	-	1	-	2	2	3
CO5	2	2	1	1	1	2	2	-	-	-	1	2	2	3



2. Seinfeld- J.H.; Lapidus- L; “Process Modelling- Estimation and Identification”, Prentice Hall- Englewood Cliffs- New Jersey- 1974.
3. Beveridge- C.S.; Schechter- R.S.; “Optimization: Theory and Practice”, McGraw-Hill.- New York.
4. Enrique del Castillo, “Process Optimization: A Statistical Approach”, springer-2007

CO/PO MAPPING

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CO1	2	2	1	1	1	1	1	-	-	-	-	1	2	3
CO2	1	2	1	2	1	-	-	-	1	-	-	2	2	1
CO3	1	2	1	2	1	-	-	-	1	1	-	2	2	2
CO4	2	1	2	2	1	-	-	-	-	1	-	2	2	2
CO5	2	2	1	1	1	-	-	-	-	-	1	2	2	3



COURSE OBJECTIVE

To enable students to

- demonstrate competence in setting up computational fluid dynamics models.
- understand the computational fluid models
- enable technical competence in building and conducting CFD simulations.
- understand the basic fluid operation analogies.
- perform grid generation for models

UNIT I CONSERVATION LAWS AND TURBULENCE MODELS 9

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 Stokes equations - turbulence models - one and two equation- Reynolds stress - **LES and DNS**

UNIT II FINITE DIFFERENCE APPROXIMATION 9

Mathematical behavior of PDE - finite difference operators - **basic aspects of discretization by FDM** - explicit and implicit methods - **error and stability analysis.**

UNIT III FINITE VOLUME METHOD 9

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

UNIT IV FLOW FIELD COMPUTATION 9

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

UNIT V GRID GENERATION 9

Physical aspects - simple and multiple connected regions - grid generation by PDE solution - grid generation by algebraic mapping. Growth and growth coefficients - Calculations involving material and energy balances - **Methods based on super saturation and industrial equipment.**

TOTAL PERIODS 45

COURSE OUTCOME

Upon completing the course, the students would have learnt about

- hands-on experience with a commercial CFD program.
- understand the computational fluid models
- enable technical competence in building and conducting CFD simulations.
- understand the basic fluid operation analogies.
- perform grid generation for models

TEXT BOOKS

1. Anderson- J. D., “Computational Fluid Dynamics: The Basics with Applications”- McGraw-Hill- 1995.

- Fletcher- C. A. J., “Computational Techniques for Fluid Dynamics”- Springer Verlag- 1997.

REFERENCES

- Chung T.J “Computational Fluid Dynamics” Cambridge University Press- 2003.
- Muralidhar. K. and Sundararajan. T., “Computational Fluid Flow and Heat Transfer”, Narosa Publishing House- New Delhi- 2001.
- Subas- V. Patankar “Numerical heat transfer fluid flow”- Hemisphere Publishing Corporation- 1980.
- Taylor. C and Hughes. J.B. “Finite Element Programming of the Navier Stock Equation”, Pineridge Press Limited- U.K. 1981.

CO/PO MAPPING

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CO2	3	2	2	1	1	-	2	1	1	-	3	2	2	3
CO3	3	3	1	2	1	-	-	-	1	1	2	2	2	3
CO4	3	2	3	2	1	-	1	1	-	1	2	2	2	3
CO5	2	2	1	1	1	-	-	-	-	-	1	2	2	3



COURSE OBJECTIVES

To enable students to

- to understand the concept of piping generic design
- to learn the fundamental principles of fluid flow phenomena
- to perform the design of pipeline systems for air and water systems
- to perform the design of pipeline system for refrigeration and slurry systems
- to apply operation and maintenance techniques to ensure safety operations

UNIT I PIPING FUNDAMENTALS 9

Equations of flow for Newtonian and Non-Newtonian fluids - losses in pipes and fittings - Types of pipes and Fittings. **Piping standards and codes.**

UNIT II PIPING GENERIC DESIGN 9

Piping layout - series and parallel pipes - Pipe network. **Stress analysis and design of pipe supports.**

UNIT III PIPING DESIGN-I 9

Design of pipeline system - Air- Water - Steam and Oil.

UNIT IV PIPING DESIGN- II 9

Design of pipeline system - Gases - Refrigeration and Slurry. Continuous drying - Drying equipment: tray - Rotary drum - spray dryer and their applications.

UNIT V OPERATION AND MAINTENANCE 9

Coating- cleaning; freeze prevention- leak detection- corrosion and protection. Pipeline failures - Piping insulation and heat tracing- repair techniques; Pipeline economics.

TOTAL PERIODS 45

COURSE OUTCOMES

On completion of the course the students will be able to

- understand the concept of piping generic design
- familiarize the fundamental principles of fluid flow phenomena
- perform the design of pipeline systems for air and water systems
- perform the design of pipeline system for refrigeration and slurry systems
- apply operation and maintenance techniques to ensure safety operations

TEXT BOOKS

1. John J Mcketta, "Piping Handbook", 3rd Edition, Marcel Dekker Publication- 1992.
2. Henry Liu, "Pipeline Engineering", 2nd Edition- Lewis Publishers- 2003.

REFERENCES

1. Mohinder L. Nayyar, "Piping Handbook", 7th Edition- McGraw Hill- 2000.
2. George A. Antaki- "Piping and Pipeline Engineering: Design- Construction- Maintenance- Integrity and Repair", Marcel Dekker Publications- 2003.

CO/PO MAPPING

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CO2	2	2	2	1	1	-	-	-	1	-	-	2	2	3
CO3	3	2	1	2	1	-	-	-	1	1	-	2	2	3
CO4	3	2	2	2	1	-	-	-	-	1	-	2	2	3
CO5	2	2	1	1	1	-	-	-	-	-	1	2	2	3



COURSE OBJECTIVES

To enable students to

- to give an overview of various method of process modeling
- to understand the development of process models based on conservation principles
- to learn Process data and computational techniques to solve the process models.
- to study different computational techniques for simulation.
- to learn the fundamental principles of steady and unsteady state models.

UNIT I INTRODUCTION**9**

Introduction to modeling and simulation- **classification of mathematical models**-conservation equations and auxiliary relations.

UNIT II STEADY STATE LUMPED SYSTEMS**9**

Degree of freedom analysis- single and network of process units- systems yielding linear and non-linear algebraic equations- flow sheeting – sequential modular and equation oriented approach- tearing-partitioning and precedence ordering- solution of linear and non-linear algebraic equations.

UNIT III UNSTEADY STATE LUMPED SYSTEMS**9**

Analysis of liquid level tank- gravity flow tank- jacketed stirred tank heater- reactors- flash and distillation column- solution of ODE initial value problems- **matrix differential equations- simulation of closed loop systems.**

UNIT IV STEADY STATE DISTRIBUTED SYSTEM**9**

Analysis of compressible flow- heat exchanger- packed columns- plug flow reactor **-solution of ODE boundary value problems.**

UNIT V CRYSTALLIZATION**9**

Analysis laminar flow in pipe-sedimentation - boundary layer flow - conduction - heat exchanger - heat transfer in packed bed – diffusion - packed bed adsorption - plug flow reactor - hierarchy in model development - Classification and solution of partial differential equations. **Empirical modeling-parameter estimation - Population balance and stochastic modeling.**

TOTAL PERIODS 45**COURSE OUTCOMES**

Upon completing the course

- the student should have understood the development of process models based on conservation principles
- process data and computational techniques to solve the process models.
- overview of various method of Process modeling
- different computational techniques for simulation.
- the fundamental principles of steady and unsteady state models.

TEXT BOOKS

1. Ramirez- W.; “Computational Methods in Process Simulation “- 2nd Edn. Butterworths Publishers - New York- 2000.
2. Luyben- W.L. “ Process Modelling Simulation and Control”, 2nd Edn- McGraw-Hill Book Co.- 1990

REFERENCES

1. Felder R. M. and Rousseau R. W. “Elementary Principles of Chemical Processes”, John Wiley- 2000.
2. Franks- R. G. E.- “ Mathematical Modelling in Chemical Engineering”, John Wiley- 1967
3. Amiya K. Jana “Process Simulation and Control Using ASPEN”, PHI Learning Ltd (2012).
4. Amiya K. Jana “Chemical Process Modelling and Computer Simulation”, PHI Learning Ltd- (2012).

CO/PO MAPPING

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CO3	2	2	1	2	1	-	-	-	1	1	-	2	2	3
CO4	3	2	2	2	1	-	-	-	-	1	-	2	2	3
CO5	2	2	1	1	1	-	-	-	-	-	1	2	2	3



COURSE OBJECTIVES

To enable students to

- give an overview of various separation process
- understand the types of membrane and reactors
- learn adsorption technique for separation
- study different equipments involved in inorganic separation
- know the various techniques used for separation

UNIT I BASICS OF SEPARATION PROCESS 9

Review of Conventional Processes, Recent advances in Separation Techniques based on size, surface properties, ionic properties and other special characteristics of substances, Process concept, Theory and Equipment used in cross flow Filtration, cross flow Electro Filtration, Surface based solid – liquid separations involving a second liquid.

UNIT II MEMBRANE SEPARATIONS 9

Types and choice of Membranes, Plate and Frame, tubular, spiral wound and hollow fiber Membrane Reactors and their relative merits, commercial, Pilot Plant and Laboratory Membrane permeators involving Dialysis, Reverse Osmosis, Nanofiltration, Ultra filtration and Micro filtration, Ceramic-Hybrid process and Biological Membranes.

UNIT III SEPARATION BY ADSORPTION 9

Types and choice of Adsorbents, Adsorption Techniques, Dehumidification Techniques, Affinity Chromatography and Immuno Chromatography, Recent Trends in Adsorption

UNIT IV INORGANIC SEPARATIONS 9

Controlling factors, Applications, Types of Equipment employed for Electrophoresis, Dielectrophoresis, Ion Exchange Chromatography and Eletrodialysis, EDR, Bipolar Membranes

UNIT V OTHER TECHNIQUES 9

Separation involving Lyophilisation, Pervaporation and Permeation Techniques for solids, liquids and gases, zone melting, Adductive Crystallization, other Separation Processes, Supercritical fluid Extraction, Oil spill Management, Industrial Effluent Treatment by Modern Techniques.

TOTAL PERIODS 45

COURSE OUTCOMES

Upon completing the course

- the student should have understood the development of process models based on conservation principles
- process data and computational techniques to solve the process models.
- overview of various method of Process modeling
- different computational techniques for simulation.
- the fundamental principles of steady and unsteady state models.

TEXT BOOKS

1. King, C. J., "Separation Processes", Tata McGraw Hill, 1982.
2. Nakagawal, O. V., "Membrane Science and Technology" Marcel Dekkar, 1992.

REFERENCES

1. Felder R. M. and Rousseau R. W. "Elementary Principles of Chemical Processes", John Wiley-2000.
2. Roussel, R. W., "Handbook of Separation Process Technology", John Wiley, New York, 1987.

CO/PO MAPPING

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CO3	2	2	1	2	2	-	-	-	1	-	-	2	2	2
CO4	2	3	2	2	2	-	2	-	-	-	-	2	2	2
CO5	2	2	1	1	1	-	-	-	-	-	1	2	2	3

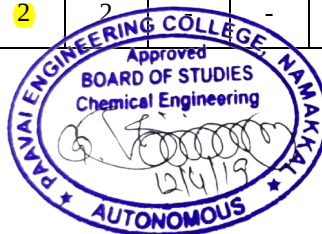


1. Watkins R.N. "Petroleum Refinery Distillation"- 2nd Edition- Gulf Publishing Company- Texas- 1979.

2. Hobson G. D. "Modern Petroleum Technology"- Part 1&2 5th Edition- Wiley Publishers- 1984.
3. Mohamed A. Fahim- Taher A. Al-Sahhaf- Amal Elkilani "Fundamentals of Petroleum Refining" Elsevier-2010
4. Surinder Parkash "Refining Processes Handbook"- Gulf Professional publishing-2003

CO/PO MAPPING

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CO3	2	1	1	2	1	2	2	-	1	1	2	2	1	3
CO4	3	1	2	2	1	1	1	-	-	1	-	2	2	3
CO5	2	2	1	1	1	2	2	-	-	-	1	2	2	3



COURSE OBJECTIVES

To enable the students to,

- understand the difference between engineer and technology
- know the value of science in chemical engineering
- gain the knowledge on equipments and its role in industry
- understand the multi-disciplinary role by chemical engineers
- predict the future innovations based on market demands

UNIT I INTRODUCTION TO CHEMICAL TECHNOLOGY 9

Chemistry, Chemical Engineering and Chemical Technology; Chemical process industries: History and their role in Society; Role of Chemical Engineer; History and Personalities of Chemical Engineering; Greatest achievements of Chemical Engineering.

UNIT II ROLE OF SCIENCE IN CHEMICAL ENGINEERING 9

Components of Chemical Engineering: Role of Mathematics, Physics, Chemistry and Biology; Thermodynamics, Transport Phenomena, Chemical Kinetics and Process dynamics, design and control.

UNIT III INSIGHT TO PROCESS INDUSTRY 9

Concept of Unit Processes and Unit Operations; Description of different Unit Processes and Unit Operations; Designing of equipments; Flow sheet representation of process plants, Evolution of an Industry – Sulphuric acid and Soda ash manufacture. Demonstration of simple chemical engineering experiments; Plant visit to a chemical industry.

UNIT IV ROLE IN INTERDISCIPLINARY 9

Role of Computer in Chemical Engineering; Chemical Engineering Software; Visit to ProcessSimulation Lab; Relation between Chemical Engineering and other engineering disciplines; Traditional vs. modern Chemical Engineering; Versatility of Chemical Engineering; Role of Chemical Engineers in the area of Food, Medical, Energy, Environmental, Biochemical, Electronics etc. Plant visit to an allied industry.

UNIT V FUTURE TRENDS IN CHEMICAL ENGINEERING 9

Paradigm shifts in Chemical Engineering; Range of scales in Chemical Engineering; Opportunities for Chemical Engineers; Future of Chemical Engineering.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- characterize the difference between science and technology
- gain knowledge in fluid behavior and solid properties.

- understand the concept of chemical engineering principles
- understand the role of Chemical Engineers in the area of Food, Medical, Energy, Environmental, Biochemical
- analyze and predict the market demands and opportunities

TEXT BOOKS

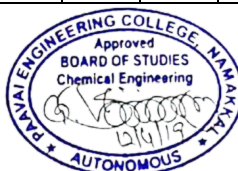
1. Salil K. Ghosal, Siddhartha Datta, "Introduction to Chemical Engineering", Tata McGraw-Hill Education (2006)
2. Badger W.L. and Banchero J.T., "Introduction to Chemical Engineering", 6th Edition, Tata McGraw Hill, (1997).

REFERENCES

1. Finlayson, B. A., "Introduction to Chemical Engineering Computing", John Wiley & Sons, New Jersey, (2006).
2. McCabe, W.L., Smith, J. C. and Harriot, P. "Unit operations in Chemical Engineering", McGraw Hill, 7th Edition, (2001).
3. Dryden, C.E., "Outlines of Chemicals Technology", Edited and Revised by Gopala Rao, M. and M. Sitting, 3rd Edition, Affiliated East-West press, (1997).
4. Randolph Norris Shreve, George T. Austin, "Shreve's Chemical Process Industries", 5th edition, McGraw Hill, 2001

CO/PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's)														
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
CO's	Programme Outcomes (PO's)													
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CO3	2		2	3	2	-	-	-	-	-	-	-	2	3
CO4	1	3	2	2	2	-	-	2	-	-	-	-	3	2
CO5	3	3	3	3	2	-	-	-	-	-	-	-	3	2



COURSE OBJECTIVES

To enable the students to

- develop their knowledge in basic civil engineering practices such as plumbing, carpentry and its tool usages.
- practice some of mechanical basics such as welding, basic machining, sheet metal work, fitting.
- experience with basic electrical wiring circuits
- know about the electronic components, color coding signal generation, soldering practice..

GROUP A (CIVIL AND MECHANICAL)**I CIVIL ENGINEERING PRACTICE****BUILDINGS**

- Study of plumbing and carpentry components of residential and industrial buildings. Safety aspects.

PLUMBING WORKS

- Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, elbows inhousehold fittings.
- Study of pipe connections requirements for pumps and turbines.
- Preparation of plumbing line sketches for water supply and sewage works.
- Hands-on-exercise:
- Basic pipe connections – Mixed pipe material connection – Pipe connections with different joiningcomponents. (e) Demonstration of plumbing requirements of high-rise buildings.

CARPENTRY USING POWER TOOLS ONLY

- a) Study of the joints in roofs, doors, windows and furniture.
- b) Hands-on-exercise:
Wood work, joints by sawing, planing and cutting.

II MECHANICAL ENGINEERING PRACTICE**WELDING**

- Preparation of arc welding of butt joints, lap joints and tee joints.
- Gas welding practice

BASIC MACHINING

- Simple Turning, Facing, Thread cutting and Taper turning
- Drilling Practice

SHEET METAL WORK

- Model making – Trays, funnels, etc.
- Different type of joints.

FITTING

- Square fitting
- Vee – fitting models

DEMONSTRATION ON

- (a) Smithy operations, upsetting, swaging, setting down and bending. Example –
Exercise –Production of hexagonal headed bolt.
- (b) Foundry operations like mould preparation for gear and step cone pulley.

TOTAL: 30 PERIODS

GROUP B (ELECTRICAL AND ELECTRONICS)

III ELECTRICAL ENGINEERING PRACTICE

1. Study of electrical tools and safety measures
2. Basic wiring practices - Stair-case wiring, Fluorescent lamp wiring and Residential house wiring
3. Measurement of electrical parameters such as voltage, current, power & power factor in RLC circuit.
4. Measurement of energy using single phase energy meter.
5. Earthing Practices & Measurement of earth resistance using megger.
6. Study of electrical equipments such as iron box, induction heater.

IV ELECTRONICS ENGINEERING PRACTICE

1. Study of Electronic components and equipments – Resistor, color coding measurement of AC signalparameter (Peak-Peak, RMS, Period, and Frequency) using CRO.
2. Study of logic gates AND, OR, Ex-OR and NOT.
3. Generation of Clock Signal.
4. Soldering practice – Components Devices and Circuits – Using general purpose PCB.
5. Measurement of ripple factor of HWR.
6. Construction and verification of half adder circuit.
7. Construction and verification of half subtractor circuit.
8. Study of Telephone, F.M Radio and Cell Phone.

TOTAL: 30 PERIODS

COURSE OUTCOMES

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

- use the tools for plumbing and carpentry works
- prepare models by -welding, machining, sheet metal and fitting
- construct electrical wiring circuit and demonstrate practically
- analyse the signal generation, solder the electronic components based on the circuits

CO - PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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CO4	2	2	2	2	2	-	-	-	1	-	-	1	2	3



COURSE OBJECTIVES

To enable students to

- learn information on various material properties, selection for design and manufacture.
- understand heat treatment techniques for the materials related to ferrous materials.
- familiarize polymers, composites and ceramics based on specific application.
- introduce the structures using organic and inorganic materials.
- study detailed information on types of corrosion and its prevention

UNIT I INTRODUCTION**9**

Selection criteria and processes: General criteria of selection of materials in process industries. Environmental considerations and recycling Properties: Mechanical, Thermal, Chemical, Electrical, Magnetic and Technological properties. Processing of metals and alloys - Casting-hot and cold rolling – forging – extrusion - deep drawing. **Plastic deformation of metal** - Recovery and recrystallization of plastically deformed metals.

UNIT II FERROUS AND NON-FERROUS METALS**9**

Pure iron, cast iron, mild steel, stainless steels, special alloy steels- iron and iron carbide phase diagram- heat treatment of plain-carbon steels. Manufacturing methods of Lead, Tin and Magnesium. Properties and applications in process industries

UNIT III POLYMERS, CERAMICS, GLASSES**9**

Industrial polymerization methods, crystallinity and stereo isomers- Thermosetting and Thermo plastics. FRP- Fiber Reinforced Plastics (FRP), different types of manufacturing methods; Ceramic crystal and silicate structures - **processing of ceramics-glasses-enamels-properties.**

UNIT IV INORGANIC MATERIALS**9**

Manufacture of cement and its properties – Special cement – Cement concrete – Reinforced and prestressed concrete – **Properties and applications** – Mixing and curing. Flyash, Gypsum and Gypsum Plaster.

UNIT V CORROSION AND PREVENTION**9**

Definition of corrosion-Basic theories and mechanism of corrosion-Types of corrosion Anti-Corrosion methods- **Organic paints and coatings metal, varnishes, distempers, ceramic coatings.**

TOTAL PERIODS 45**COURSE OUTCOMES**

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

- choose appropriate material for process equipment with advanced properties and its processing method depending on type of application.
- gain knowledge on different types of materials, properties and applications in process industries
- acquire the knowledge about industrial polymerization methods, glass processing and properties of ceramics.

- understand and build reinforced structures by knowing the special properties of cement.
- gain knowledge about different types of corrossions and suggest preventive methods.

TEXT BOOKS

1. Khanna O P, “Material Science and metallurgy” Dhnapat Rai Publications (1995).
2. Er.R.K. Rajput “Engineering Materials” S.Chand Publications, 2014.

REFERENCES

1. Agarwal B.K., —Introduction to Engineering Materials, Tata McGraw Hill, 1988.
2. Budinsky K G and Budinsky K M “ Engineering materials- Properties and Selection” Prentice Hall of India (2002).

WEB LINKS

1. <https://www.youtube.com/watch?v=Y75IQksBb0M>
2. <https://www.youtube.com/watch?v=XTU0Z-FkhtU>
3. <https://www.youtube.com/watch?v=z-OP4EihGWI>

CO/PO MAPPING:														
Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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CO4	2	3	2	1	3	1	-	-	-	-	1	3	2	2
CO5	2	2	3	2	2	2	-	-	-	-	2	2	2	2



COURSE OBJECTIVES

To enable students to

- use different systems of units and convert one system of unit to another system.
- learn what material balance are, how to formulate, apply and solve them.
- know how to use the psychrometric chart for determining humidity.
- learn the basics of thermo chemistry and thermo physics calculations.
- relate the air requirement for combustion calculations of fuels.

UNIT I BASIC CHEMICAL CALCULATIONS**15**

Units and Dimensions – Fundamental and derived units – conversions – Basis of calculations – Methods of gas expression – Compositions of mixture and solutions. Ideal and real gas laws – Gas constant – Calculations of pressure, volume and temperature using ideal gas law – Use of partial pressure and pure component volume in calculations – Applications of real gas relationship in gas calculation.

UNIT II MATERIAL BALANCE (Without chemical reaction)**15**

Law of conservation of mass – Application of material balance to unit operations like distillation, Evaporation– absorption, extraction, crystallisation, drying and mixing/blending. Psychrometry – Properties of atmospheric air – Humidity of air – Calculation of absolute, molal, relative and percentage humidity– Use of Psychrometric chart.

UNIT III MATERIAL BALANCE (With chemical reaction)**15**

Stoichiometric Principles - Material balance with chemical reaction – Limiting and excess reactants– percent excess– Conversion, yield and selectivity – Recycle – Bypass and purging.

UNIT IV ENERGY BALANCE**15****Thermo Physics**

Heat capacity of solids, liquids, gases and solutions – Use of mean heat capacity in heat calculations – Problems involving sensible heat and latent heats – Evaluation of enthalpy.

Thermo Chemistry

Standard heat of reaction, heats of formation, combustion, solution, mixing etc. – Calculation of standard heat of reaction – Effect of pressure and temperature on heat of reaction – Energy balance for systems with and without chemical reaction.

UNIT V FUELS AND COMBUSTION**15**

Combustion calculations Calorific value of solid, liquid and gas fuels – GCV and NCV. Analysis of coal – orsat, Proximate, Ultimate - Air requirement Theoretical oxygen and air– Calculation of excess air – Theoretical flame temperature.

TOTAL PERIODS 75**COURSE OUTCOMES**

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

- understand various types of units and dimensions, basic laws about behaviour of fluids and solid.

- formulate material and energy balances with or without chemical reactions and apply them for a given process.
- experiment and solve material balance problems involving chemical reactions.
- learn what energy balances are, and how to apply them and finally, to learn how to deal with the complexity of larger problems.
- calculate flue gas composition from fuel composition and vice versa.

TEXT BOOKS

1. K.A. Gavhane, "Stoichiometry" Nirali Prakashan Publications, (2015).
2. Himmelblau, D., "Basic Principles and Calculations in Chemical Engineering", 6th Edition, Prentice Hall of India (P) Ltd.,(2000).

REFERENCES

1. Venkataramani, V. and Anantharaman, N., "Process calculations", Prentice Hall of India (P) Ltd., 2003.
2. K.V.Narayanan, B.Lakshmipathy,"Stoichiometry and Process Calculation", PHI Learning Ltd.(2013).
3. Bhatt, B.I. and Vora, S. M., "Stoichiometry", 4th Edition, Tata McGraw Hill Publishers Ltd., (2005).

WEB LINKS

1. [http:// www.nptel.ac.in](http://www.nptel.ac.in)
2. [http:// www.msubbu.in](http://www.msubbu.in)
3. <http://www.unitoperation.com>

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CO2	3	3	2	-	-	-	-	-	-	-	-	1	2	2
CO3	3	3	2	-	-	-	-	-	1	-	-	2	2	2
CO4	3	3	2	2	-	2	2	-	1	-	1	2	2	2
CO5	3	3	-	3	2	3	3	-	1	-	1	2	2	2



COURSE OBJECTIVES

To enable students to

- understand the Characteristics of particulate solids, and storage of solids.
- be in a position to decide the best suitable size reduction equipment needed for a particular process industry.
- acquire knowledge in separating solids from solids, solids from liquids.
- familiarize mechanism of filtration and equipment's involved in process.
- impact knowledge on mixing of solid-solid, liquid – liquid components.

UNIT I PROPERTIES AND STORAGE OF SOLIDS**9**

Characterization of solid particles: Particle size and shape, Mean particle sizes and number of particle in a mixture, **Particle size measurement** Methods - screen analysis Cumulative and Differential. Properties of particulate masses. **Storage of solids** - Bulk and Bin – Conveyors – Belt, Chain, Screw and Pneumatic conveying.

UNIT II SIZE REDUCTION**9**

Mechanism of size reduction – Choice of size reduction equipments – Energy and Power requirements in size Reduction – **Laws of size reduction Size reduction equipments**. Principles of comminution.

UNIT III MECHANICAL SEPARATIONS**9**

Screening and types of Screening equipment – **material balance over the screen** – screen capacity – effectiveness of screens – Concept of gravity settling – sedimentation – thickening – electrostatic and magnetic separator – Froth floatation – centrifugal separation - **Cyclone separator**.

UNIT IV FILTRATION**9**

Theory and mechanism of filtration- cake filter - principles – pressure drop – constant pressure and rate filtration – **Batch and continuous filters Equipment for filtration** – Filter media and aids – **Fundamentals and introduction to membrane, bio, micro filtration.**

UNIT V MIXING AND AGITATION**9**

Equipment for agitation – **impeller and their characteristics** – flow patterns - power for agitation – correlations. Mixing of solids and pastes: equipments for solid mixing, kneading and dispersions.

TOTAL PERIODS 45**COURSE OUTCOMES**

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

- explain the various types of mechanical operations and its importance in industries.
- decide the best type of operation needed for a specific industry by analyzing, interpreting and evaluating data.
- select and design various types of fluid-solid separation equipment based on the behaviour and properties of materials used in industries
- explain about filtration and their mechanism.

- evaluate their processing operation by effective agitation and mixing of fluids.

TEXT BOOKS

1. Kiran D Patil, “Mechanical Operations” 3rd Edition, Nirali Publication. (2015).
2. Foust, A. S., Wenzel, L.A., Clump, C.W., Naus, L., and Anderson, L.B., “Principles of Unit Operations”, 2nd Edn., John Wiley & Sons, (1994).

REFERENCES

1. Coulson, J.M. and Richardson, J.F., “Chemical Engineering” Vol. I, 4th Edn., Asian Books Pvt. Ltd., India, (1998).
2. Anup K Swain, Hemlata Patra, G K Roy, “Mechanical Operations”, Tata McGraw Hill Education Private Limited, (2011)
3. McCabe, W.L, Smith J.C and Harriot, P., “Unit Operations in Chemical Engineering”, McGraw-Hill, Fourth Edition, (1984).

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CO2	3	2	1	2	1	1		-	-	-	-	2	2	2
CO3	3	2	2	2	1	1	2	-	-	-	-	3	2	2
CO4	3	2	2	2	1	-	-	-	-	-	-	3	2	2
CO5	3	3	1	3	1	-	1	-	-	-	-	3	2	2



COURSE OBJECTIVES

To enable students to

- familiarize in the field of chemical kinetics.
- know the basic of catalysis and bio-catalysis reactions.
- understand the various types of photochemical reactions.
- acquire knowledge in the field of electrochemistry, solubility behaviour.
- understand the importance of physical chemistry towards different applications.

UNIT I CHEMICAL KINETICS**9**

Rate of a reaction-Order of a reaction – Examples and rate equations for Zero order, First order, Second order and Third order reactions –Molecularity of a reaction – Unimolecular and Bimolecular reactions – Half life period– **Kinetics of parallel and opposing reactions** – Activation energy – Arrhenius equation – Collision theory of reaction rates – **Theory of absolute reaction rates** – Michalis Menton kinetics of enzyme catalyzed reactions- **Effect of temperature on enzyme catalysis**

UNIT II CATALYSIS AND SURFACE CHEMISTRY**9**

General characteristics of catalytic reactions- Acid-Base catalysis-Heterogeneous catalysis-.Surface reactions- Kinetics of surface reactions-**Unimolecular surface reactions**-Bimolecular surface reactions- Effect of temperature on surface reactions-Auto catalysis and **Oscillatory reactions**.

UNIT III PHOTOCHEMISTRY**9**

Laws of Photochemistry, **Beer-Lambert's law**- Grothus & Drapper's law- Stark Einstein's law- Quantum efficiency– Reason for difference in quantum efficiency –Method of determination of quantum yield. Photochemical reactions, Actinometry – Uranyl oxalate method only – Kinetics and mechanism of Hydrogen – Bromine reaction, Hydrogen – Chlorine reaction – **Photosensitization**- Photo inhibitor- **Chemiluminescence**.

UNIT IV COLLOIDS**9**

Introduction to colloids – properties of colloids – coagulation of solutions – Origin of charge on colloidal particles – Determination of size of colloidal particles – Donnan Membrane equilibrium – Emulsions – Gels – Applications of colloids – **Nanoparticles (Au, Ag, Pt) – Preparation** – Characterization – Properties – Application in catalysis and drug delivery systems.

UNIT V THE DISTRIBUTION LAW**9**

Distribution co-efficient - Distribution Law — Conditions for the validity of the Distribution law- I2– CCl₄ – H₂O System – Nature of interaction of the solute with one of the solvents Dissociation- Association – **Applications of Distribution law – Process of Extraction**.

TOTAL PERIODS 45**COURSE OUTCOMES**

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

- explain the chemical kinetics, electrochemical equilibria in different applications.
- demonstrate the catalysis and bio-catalysis reaction

- list the biochemical reactions equilibria towards different applications.
- comprehend the knowledge about industrial chemical reactions such as production of soaps, colloids.
- develop the basic concepts of chemical reaction and mechanism in large scale production

TEXT BOOKS

1. Kund and Jain, “Physical Chemistry”, S.Chand and Company, New Delhi (2011).
2. Puri B.H. Sharma L.R. and M.S.Prathama, “Principles of Physical Chemistry”, S.Chand and Company, New Delhi (2012).
3. B.S.Bahl, Arun Bahl and G.D.Tuli, “Essentials of Physical Chemistry”, S.Chand and Company, New Delhi (2015).

REFERENCES

1. Gordon M. Barrow, “Physical Chemistry”, Eight Edition, Tata McGraw Hill (2013).
2. Peter Atkins & Julio de Paula, Atkins, “Physical Chemistry”, 9th Edition, Oxford university press. (2012).
3. Gurudeep Raj (2011), “Advanced Physical chemistry”, 34th edition, Goel Publishing House, Krishna Prakashan Media (P) Ltd.
4. Laidler, J (2012): “Chemical Kinetics”, 4th edition, Harper & Row.
5. Glasstone, S (2014) : “An Introduction to Electrochemistry”, Affiliated East West press, New Delhi.

WEB LINKS

1. www.chemresources.com
2. www.library.njit.edu/research/helpdesk/subjectguides/chemistry.php

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CO1	2	2	2	2	2	2	2	2	-	-	2	2	2	2
CO2	2	2	2	1	2	2	2		2		1	2	2	1
CO3	2	1	2	2	1	2	1	2	-	3	1	2	2	2
CO4	2	1	3	2	2	1	2	-	2	-	1	2	1	2
CO5	2	2	3	1	2	2	2	2	2	3	2	2	2	2



COURSE OBJECTIVES

To enable students to

- improve the practical knowledge on the properties and characteristics of solvents and mixtures.
- understand the rate of reaction and its mechanism.
- analyse the physical nature of chemical reactions.
- Determine rate constant for reactions

LIST OF EXPERIMENTS

1. Determination of molecular weight of a polymer by viscosity method.
2. Determination of partition co-efficient of iodine between two immiscible solvents
3. Determination of partition co-efficient of benzoic acid between two immiscible solvents
4. Determination of K_a of the weak acid.
5. Conductometric experiments- Verification of Oswald's Dilution Law.
6. Titration of Strong Acid Vs Strong Base- Conductometric experiments.
7. Titration of mixture of Strong Acid & Weak Acid Vs Strong Base- Conductometric experiments.
8. Titration of Weak Acid Vs Weak Base- Conductometric experiments.
9. Determination of Rate Constant (K)-Ester Hydrolysis.
10. Determination of Activation Energy (ΔE).
11. Estimation of Ferrous ion concentration by Potentiometric Titration.
12. Determination of standard electrode potential (Zn).
13. Determination of pH metric titration of Strong Acid Vs Strong Base.
14. Enzyme catalytic reaction by varying pH.
15. Application of Phase Rule to Phenol-Water system.

TOTAL PERIODS 45

COURSE OUTCOMES

The student is able to

- determine the properties and characteristics of solvents and mixtures.
- analyse experimentally the various properties of acids & bases.
- determine the kinetics of various simple chemical reaction.
- Calculate the rate constants of a reaction

REFERENCES

1. Physical Chemistry experiments by Alexander Findley, McGraw-Hill IV Edition, (1976).
2. Shoemaker D.P., and Gardad C.W., Experiments in Physical Chemistry, McGraw-Hill, London, 2011.

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CO2	3	1	-	3	-	-	-	-	-	-	-	3	1	2
CO3	2	1	1	1	-	-	-	-	-	-	-	2	2	1
CO4	1	2	1	2	-	-	-	-	-	-	-	2	1	1



COURSE OBJECTIVES

To enable students to

- accuire a sound working knowledge on different types of crushing equipments
- learn separation characteristics of different mechanical operation separators.
- perform experiments to study the performance of various size reduction equipments
- determine mixing index

LIST OF EXPERIMENTS

1. Sieve analysis
2. Batch filtration studies using a Leaf filter
3. Batch filtration studies using a Plate and Frame Filter press
4. Characteristics of batch Sedimentation
5. Reduction ratio in Jaw Crusher
6. Reduction ratio in Ball mill
7. Reduction ratio of Roll Crusher
8. Separation characteristics of fine particles using Cyclone separator
9. Separation characteristics of Elutriator
10. Reduction ratio of Drop weight crusher
11. Mixing apparatus

TOTAL PERIODS 60

COURSE OUTCOMES

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

- carry out experiments as a team to study the performance of various size reduction equipments.
- analyze and interpret the experimental data for solid handling to provide valid results.
- select suitable equipment needed for a specific mechanical operation.
- calculate mixing index

REFERENCES

1. McCabe, W.L, Smith J.C and Harriot, P., “Unit Operations in Chemical Engineering”, McGraw-Hill, Fourth Edition, (1984).

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CO2	3	2	1	2	1	1	-	-	-	-	-	2	2	2
CO3	3	2	2	2	1	1	2	-	-	-	-	3	2	2
CO4	2	3	3	1	-	-	-	-	-	-	-	2	1	1



COURSE OBJECTIVES

To enable students to

- discriminate between different radiation frequencies through the use of filters and prisms.
- measure the concentration of a solute in a solution using beer's law.
- identify the atomic configurations in molecules
- study the chromatographic behavior and hplc of solutes.
- know the static and transient methods of analyzing the samples.

UNIT I INTRODUCTION OF SPECTROMETRY 9

Properties of electromagnetic radiation- wave properties – components of optical instruments – Sources of signal radiation – wavelength selectors – sample containers – radiation transducers – Signal process and read outs to noise ratio - sources of noise – Enhancement of signal to noise - types of optical instruments – Principle of Fourier Transform optical Measurements.

UNIT II MOLECULAR SPECTROSCOPY 9

Molecular absorption spectrometry – Measurement of Transmittance and Absorbance – Beer's law – Theory of Instrumentation - Applications -Theory of fluorescence and Phosphorescence – Instrumentation – Applications – Infrared absorption spectrometry – IR instrumentation - Applications – Theory of Raman spectroscopy – Instrumentation – applications.

UNIT III MAGNETIC RESONANCE SPECTROSCOPY AND MASS SPECTROMETRY 9

Theory of NMR – environmental effects on NMR spectra – chemical shift- NMR spectrometers – applications of ^1H and ^{13}C NMR- Molecular mass spectra – ion sources – Mass spectrometer. Applications of molecular mass – Electron paramagnetic resonance- g values – instrumentation.

UNIT IV SEPARATION METHODS 9

General description of chromatography – Band broadening and optimization of column performance- Liquid chromatography – Partition chromatography - Adsorption chromatography – Ion exchange chromatography -size exclusion chromatography- Affinity chromatography-principles of GC and applications – HPLC- Capillary electrophoresis – Applications.

UNIT V ELECTRO ANALYSIS AND SURFACE MICROSCOPY 9

Electrochemical cells- Electrode potential cell potentials – potentiometry reference electrode – ion selective and molecular selective electrodes – Instrument for potentiometric studies – Voltametry – Cyclic and pulse voltametry- Applications of voltametry . Study of surfaces – Scanning probe microscopes – AFM and STM.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- know the role of analytical instrumentation in the production and evaluation of new products.
- Interpretate electromagnetic radiation absorbed, scattered, or emitted by atoms.
- identify unknown or confirming the presence of suspected compounds in materials.
- operate and analyze the samples using chromatographic and HPLC techniques.
- improve the selectivity and sensitivity of the sample and its detection.

TEXT BOOKS

1. Willard “Instrumental Methods of Analysis” 7 edition edition , CBS Publishers & Distributors (2004).
2. H.Kumar, “Instrumental Methods of Chemical Analysis” Pragati Prakashan; Latest Edition edition (2015)

REFERENCES

1. D.A.Skoog, F. J. Holler, Stanky, R.Crouch,” Instrumental Methods of Analysis” Cengage Learning (2007).
2. Gurdeep R Chatwal Sham K Anand, “Instrumental Methods Of Chemical Analysis”, 1 st edition, Himalaya publishing house (2015).

WEB LINKS

1. <https://www.youtube.com/watch?v=jA9RKqT74AU>
2. <https://www.youtube.com/watch?v=g5voLRKi4fA>
3. <https://www.youtube.com/watch?v=dkARLSQWHH8>

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CO3	3	2	2	2	3	-	-	-	-	-	-	-	2	2
CO4	3	3	2	2	3	-	-	-	-	-	-	-	1	2
CO5	3	3	2	3	3	-	-	-	-	-	-	-	1	2



COURSE OBJECTIVES

To enable students to

- study various modes of heat transfer and their fundamental relations.
- understand properties of insulation and critical thickness of insulation.
- understand the phenomenon of radiation, radiation shields and estimation of emissivity.
- understand the working of heat exchangers and to learn design of double pipe, shell and tube heat exchangers.
- study the performance and types of evaporators.

UNIT I CONDUCTION 9

Modes of heat transfer – Steady state heat conduction – Fourier's law - heat conduction for flat plate, hollow Cylinder. **Critical insulation thickness**– Transient heat conduction – Lumped heat parameter model.

UNIT II CONVECTION 9

Concept of heat transfer by convection – Natural and forced convection — Application of dimensional analysis for natural and forced convection– Empirical Equations for natural and forced convection - Reynolds and Colburn analogy – jH factor — **Local and Overall heat transfer coefficient**

UNIT III RADIATION 9

Concept of thermal radiations – Black body concept – Stefan Boltzman's, Kirchhoff's, Planck's and Wien laws; Emissive power – Black body radiation – Emissivity – **Planck's law** – Radiation between black surfaces – **Grey surfaces – Radiation shields.**

UNIT IV HEAT EXCHANGERS 9

Heat exchanger types – Parallel and counter flow heat exchangers – Overall heat transfer coefficient – Log mean temperature difference for single pass – Correction factor for multi pass heat exchangers – Heat exchanger Effectiveness – Number of transfer units – **Chart for different configurations** – Dirt factor.

UNIT V EVAPORATORS 9

Introduction to Boiling and Condensation - Evaporation – Single effect and multiple effect evaporation – **Boiling point elevation** – Capacity, surface area and Economy of single and multiple effect evaporators - Evaporation equipments

TOTAL PERIODS 45

COURSE OUTCOMES

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

- derive equations for the calculation of heat flux and estimation of intermediate temperatures in multilayer systems.
- application for various correlations of convective heat transfer to different problems.

- explain radiation in different type of solids and estimate emissivity.
- students gain knowledge in various heat transfer methodology in process engineering and to design heat transfer equipments heat exchangers and evaporation
- design of single and multiple effect evaporators and can calculate the economy and capacity of evaporators.

TEXT BOOKS

1. Rajput “Process Heat Transfer “, McGraw-Hill, (1999).
2. K.A. Gavhane, “Heat Transfer”, Eighteenth Edition, Niralai Publication (2015).

REFERENCES

1. Coulson, J.M. and Richardson, J.F., “Chemical Engineering “ Vol. I, 4th Edn., Asian Books Pvt. Ltd., India, (1998).
2. Yunus A. Cengel, “ Heat Transfer: A Practical Approach” 2nd Edition, Mcgraw Hill Education (2011).

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CO4	3	2	1	2	1	-	1	-	-	-	1	3	2	2
CO5	3	3	2	1	1	-	1	-	-	-	1	3	2	2



COURSE OBJECTIVES

To enable students to

- have a knowledge on fundamental concepts, fluid properties and fluid statics.
- impart the student knowledge on dynamic characteristics for through pipes and porous medium, flow measurement
- help the students to have knowledge on fluid properties characteristics while static, during flow through ducts, pipes and other channels.
- Knowledge on several machineries used to transport the fluid and their performance are assessed.

UNIT I FLUID PROPERTIES AND STATICS**15**

Physical properties of fluids – Classification of fluids – Pressure measurement – Manometers – Simple and Differential – Concept of buoyancy – Fluid statics and its applications. **Dimensional homogeneity, Rayleigh and Buckingham- π method** – Significance of different dimensionless numbers.

UNIT II FLOW OF COMPRESSIBLE AND INCOMPRESSIBLE FLUIDS**15**

Types of fluid flow – Boundary layer concepts – Navier-Stokes' equation – Continuity Equation – Mass balance in a flowing fluid – Bernoulli's equation – **Euler's equation of motion** – Friction factor chart – **Darcy weisbach Equation** – Flow of incompressible fluids in pipes – Laminar and turbulent flow through closed conduits – Velocity profile and friction factor for smooth and rough pipes – **Hagen-Poiseuille equation.**

UNIT III FLOW OF FLUIDS THROUGH SOLIDS**15**

Form drag – Skin drag – Drag co-efficient – Flow around solids and packed beds – Friction factor for packed beds – Ergun's Equation – Motion of particles through fluids – **Terminal settling velocity – Fluidization – Types – Advantages – Applications.**

UNIT IV TRANSPORTATION**15**

Measurement of fluid flow – construction, working and equation for variable head and variable area meters: Orifice meter – **Venturimeter – Pitot tube – Rotameter** – determination of discharge and discharge coefficient – Weirs and notches – **Major and minor losses.**

UNIT V METERING**15**

Transportation of fluids – Performance curves and characteristics – **Efficiency of Centrifugal pump,** working principle of Positive displacement, **Rotary and Reciprocating pumps** – Introduction to Fans, blowers and Compressors.

TOTAL PERIODS 75**COURSE OUTCOMES**

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

- understand the fundamental concepts of physical properties of fluids and its importance in fluid flow operations.

- treat problems in the movement of fluids through all kinds of process equipment and use dimensional analysis for scaling experimental results
- understand the fluid flow through packed and fluidized beds
- deal with the important engineering tasks of moving fluid through process equipment and of measuring and controlling fluids in flow.
- analyse pipe flows as well as fluid machineries used to transport the fluid and their performance

TEXT BOOKS

1. R.K. Bansal, "Fluid Mechanics and Hydraulic Machines", Revised Ninth Edition, Laxmi Publications (p) limited, (2014).
2. A.P. Kulkarni, "Fluid Mechanics for Chemical Engineers" Nirali Prakshan Publication (2015).

REFERENCES

1. McCabe W.L, Smith, J C and Harriot. P "Unit operations in Chemical Engineering", McGraw Hill, VII Edition, (2005).
2. Noel de Nevers, "Fluid Mechanics for Chemical Engineers ", Second Edition, McGraw-Hill, (1991).

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CO4	3	2	1	1	-	-	-	-	-	-	-	-	2	-
CO5	3	2	1	1	-	-	-	-	-	-	-	-	2	-



COURSE OBJECTIVES

To enable students to

- learn the types of carbohydrates and their importance in daily usages.
- comprehend simple heterocyclic compounds and their properties.
- acquire the knowledge on the various types of dyes and their applications.
- know the fundamental and analysis of proteins.
- understand synthesis of important medicinal compounds and their applications.

UNIT I CARBOHYDRATES 9

Introduction – various definitions and classifications of carbohydrates –Preparation, Physical & Chemical properties, Structure and Uses of Monosaccharides (Glucose & Fructose) Interconversions – Aldo pentose to aldo hexose–Aldo hexose to aldo pentose- aldose to isomeric Ketose – Ketose to isomeric Aldose – Aldose to epimer.

UNIT II HETEROCYCLIC COMPOUNDS 9

Preparation, Physical & Chemical properties and Uses of Pyrrole, Furan, Furfural, TetrahydroFuran, Thiophene, Indole, Pyridine, Quinoline and Isoquinoline.

UNIT III DYES 9

Witt's theory and modern theory of colors – Synthesis, properties and uses of Methyl red, Methyl orange, Congo red, Malachite green, para-rosaniline, phenolphthalein, fluorescence, Eosin dyes

UNIT IV AMINOACIDS AND PROTEINS 9

Amino acids and proteins-Classification-synthesis of amino acids- reaction of carboxyl group and amino group-peptide linkage-structure of protein-end group analysis-colour reaction of proteins-denaturation.

UNIT V PHARMACEUTICAL CHEMISTRY 9

Synthesis, properties and uses of Antimalarial drugs – isopentaquine and chloroquine Synthesis, properties and uses of Antibacterial drugs – Sulphanilamide and Sulphapyridine, Pencillin and erythromycin.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- explain on various reaction preparations of organic compounds and their properties.
- comprehend synthesis of different type of organic compounds.
- understand synthesis of amino acids and proteins.
- develop the knowledge about organic reactions.
- study as a precursor on chemical reaction engineering.

TEXT BOOKS

1. R.T. Morrison and R.N. Boyd "Organic Chemistry" VI Edition Prentice Hall Inc (1996) USA.
2. K.S. Tiwari, N.K. Vishnoi and S.N. Malhotra "A text book of Organic Chemistry" Second Edition, Vikas Publishing House Pvt. Ltd. (1998), New Delhi.
3. P.L.Soni, A text book of Organic Chemistry, S Chand Publishers, (2001), New Delhi.

REFERENCES

1. Chemistry in Engineering and Technology, Vol.2, TMH Publishing Co Ltd., New Delhi, 1994.
2. I L Finar "Organic Chemistry" ELBS (1994).
3. Rajbir Singh, "Physical Organic Chemistry", Mittal Publications, 2012.
4. Fleix A. Carroll, "Perspective on Structure and Mechanism in Organic Chemistry", John Wiley and Sons, 2012.
5. Eric V. Anslyn and Dennis A. Dougherty, "Modern Physical Organic Chemistry", University Science Books, 2010.

CO/PO MAPPING:														
Mapping of Course Outcomes with Programme Outcomes														
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
	Programmes Outcomes(POs)													
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	2	1	-	-	1	-	3	-	3	1	2
CO2	3	2	-	2	1	-	-	1	-	3	-	3	1	2
CO3	3	2	-	2	1	-	-	1	-	3	-	3	2	1
CO4	3	2	-	2	1	-	-	1	-	3	-	3	2	1
CO5	3	2	-	2	1	-	-	1	-	3	-	3	2	2



COURSE OBJECTIVES

To enable students to

- understand the Fundamentals of energy conversion, construction and principle of operation.
- perform characterization of electrical machines and various drives.
- realize the concept of starting methods and speed control of electrical machines.
- study the fundamentals of Sensors application.
- acquire knowledge on the operation of solid state speed control of D.C. and A.C. drives

UNIT I DC MACHINES**9**

DC Generator-Construction and Principle of operation, EMF Equation, types, OCC and External characteristics curves and Efficiency. DC Motors-Principle of operation, types, Characteristics of motor and Starters.

UNIT II AC MOTOR**9**

Three phase Induction motors, Construction, types, principle of operation, torque-slip characteristics and starting methods, Single Phase Induction Motor-Construction and working principle of operation.

UNIT III FUNDAMENTALS OF ELECTRIC DRIVES**9**

Basic Elements – Types of Electric Drives – factors are influencing the choice of electrical drives – heating and cooling curves – Loading conditions and classes of duty – Selection of power rating for drive motors -Load variation factors.

UNIT IV TRANSDUCERS AND SENSORS**9**

Introduction to transducers – LVDT, Piezoelectric transducer, Temperature transducer, Pressure transducers. Introduction to sensors-Signal Conditioning of Sensors-Position Sensors: Inductive Position Sensors, Inductive Proximity Sensors, Rotary Encoders, Temperature Sensors, Light Sensors.

UNIT V SOLID STATE SPEED CONTROL OF D.C. AND A.C DRIVES USING CONVENTIONAL METHODS**9**

Speed control of DC series and shunt motors – Armature and field control, Ward- Leonard control system - using controlled rectifiers (Single phase Half & Full wave)–Speed control of three phase induction motor – Voltage control, voltage / frequency control, slip power recovery scheme – Inverters and AC voltage regulators – applications.

TOTAL PERIODS 45**COURSE OUTCOMES**

On Completion this course, the student will be able to

- select and utilize various of dc machines.

- employ effective control techniques to electrical motors.
- ability to understand concept applied in Electric drives.
- select appropriate Sensors for engineering applications.
- able to apply solid state speed control of D.C. and A.C. drives.

TEXT BOOKS

1. Nagrath .I.J. & Kothari .D.P, “Electrical Machines”, Tata McGraw-Hill, 2004.
2. VedamSubrahmaniam, “Electric Drives (concepts and applications)”, Tata McGraw- Hill, 2001.
3. D. Patranabi, “Sensors and Transducers”, PHI Learning Pvt. Ltd., 2003.

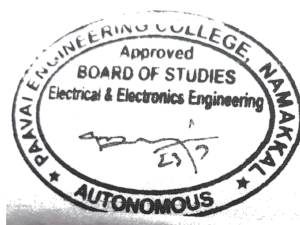
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1. Theraja B.L and therajaA.K., ‘A Text book of Electrical Technology ‘, volume – II, S,Chand& Co., 2007.
2. M.D.Singh, K.B.Khanchandani, “Power Electronics”, Tata McGraw-Hill, 1998.
3. Ian.R.Sinclair, “Sensors and Transducers”, BSP Publication, 2001
4. Bimal K Bose, “Modern Power Electronics and AC Drives”, Prentice-Hall of India Pvt. Ltd., New Delhi, 2003.
5. Muhammad H. Rashid, “Power Electronics: Circuits, Devices and Applications”, Pearson Education, Third Edition, 2004.

WEBLINKS

1. https://en.wikipedia.org/wiki/DC_motor
2. https://en.wikipedia.org/wiki/AC_motor
3. http://www.electrical4u.com/control-of-electrical-drives/http://www.kbelectronics.com/Variable_Speed_DC_Drives.html

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CO2	3	3	-	-	-	-	-	-	-	-	-	-	3	3
CO3	3	3	-	-	-	-	-	-	-	-	-	-	3	3
CO4	3	3	-	-	-	-	-	-	-	-	-	-	3	3
CO5	3	3	-	-	-	-	-	-	-	-	-	-	3	3



COURSE OBJECTIVES

To enable students to

- identify what distinguishes a strong and weak nucleophile and recall the rules of reactions
 - analyzes a list of compounds and determines their reactivity
 - Know about synthesis of organic compounds
 - identify and characterize various functional groups
1. Quantitative analysis of organic compounds – Identification of aliphatic/aromatic, saturated/unsaturated compounds.
 2. Identification and characterization of various functional groups by their characteristic reactions:
a) alcohol, b) aldehyde, c) ketone, d) carboxylic acid, e) phenol, f) ester, g) primary, secondary and tertiary amines h) imide i) nitro compounds.
 3. Analysis of an unknown organic compound and preparation of suitable solid derivatives.
 4. Analysis of carbohydrates.
 5. Analysis of proteins.
 6. Methodology of filtration and recrystallization.
 7. Introduction to organic synthetic procedures:
 - i. Acetylation – Preparation of acetanilide from aniline.
 - ii. Hydrolysis – Preparation of salicylic acid from methyl salicylate.
 - iii. Substitution – Conversion of acetone to iodoform.
 - iv. Nitration – Preparation of m-dinitrobenzene from nitrobenzene.
 - v. Oxidation – Preparation of benzoic acid from benzaldehyde/ benzyl alcohol.

TOTAL PERIODS 45

COURSE OUTCOMES

The student is able to

- identify what distinguishes a strong and weak nucleophile and recall the rules of reactions..
- shows their mastery of nomenclature.
- analyzes a list of compounds and determines their reactivity
- identify and characterize various functional groups.

REFERENCES

1. Vogels's Text Book of Practical Organic Chemistry, Fifth Edition, Longman, Singapore Publishers Pte. Ltd., Singapore (1989).
2. Organic Chemistry Lab Manual, Chemistry Division, Chemical Engineering Departemnt, A.C. Tech, Anna University (2007).

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CO2	3	3	3	-	-	-	-	-	-	-	-	-	2	-
CO3	3	3	3	-	-	-	-	-	-	-	-	-	2	-
CO4	3	2	2	-	-	-	-	-	-	-	-	-	2	1



COURSE OBJECTIVES

To enable students to

- calibrate flow meters, find pressure loss for fluid flows and determine pump characteristics.
- Find discharge coefficients of fluid
- Understand the pump characteristics
- Calculate pressure drop

LIST OF EXPERIMENTS

1. Discharge coefficient of constant and variable head meters
2. Calibration of weirs and notches
3. Open drum orifice and draining time
4. Flow through straight pipe
5. Flow through annular pipe
6. Flow through helical coil and spiral coil
7. Losses in pipe fittings and valves
8. Characteristic curves of pumps (Centrifugal, Reciprocating)
9. Pressure drop studies in packed column
10. Pressure drop studies in Fluidized bed
11. Viscosity measurement
12. Calibration of Rotameter

TOTAL PERIODS 60

COURSE OUTCOMES

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

- understand the fundamental fluid flow properties and its measurements
- Find discharge coefficients of fluid
- draw the pump characteristics
- Calculate pressure drop of fluids

REFERENCES

1. McCabe, W.L, Smith J.C and Harriot, P., “Unit Operations in Chemical Engineering”, McGraw-Hill, Fourth Edition, 1984.

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CO2	3	3	3	-	-	-	-	-	-	-	-	-	2	-
CO3	3	3	3	-	-	-	-	-	-	-	-	-	2	-
CO4	1	2	2	-	-	-	-	-	-	-	-	-	1	1

