EE16202 **ELECTRIC CIRCUITS LABORATORY** **0 0 21**

(COMMON TO EEE / CHEMICAL)

COURSE OBJECTIVES

- Understand basic laws
- Know basic theorems
- develop the practical knowledge through the simulation of electrical circuits,
- design of filters andverifying circuit theorems.

LIST OF EXPERIMENTS

1. Verification of Ohms law
2. Verification of Kirchoff's laws
3. Verification of Thevenin's & Norton's Theorem
4. Verification of Superposition theorem
5. Verification of Maximum Power Transfer theorem
6. Power measurement in 3 phase circuits
7. Design and simulation of Resonance circuits
8. Circuit Analysis using CRO
9. Digital simulation of Circuit Transients using PSpice /PSIM
10. Digital simulation of Network theorems using PSpice /PSIM

TOTAL: 30 PERIODS

COURSE OUTCOMES

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

- implement basic laws
- identify basic theorems
- develop the practical knowledge through the simulation of electrical circuits,
- design of filters andverifying circuit theorems

CO-PO MAPPING

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

CO's	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	-	-	-	-	-	3	1	2
CO2	3	3	3	3	-	-	-	-	-	-	-	3	1	2
CO3	3	3	3	3	-	-	-	-	-	-	-	3	1	2
CO4	3	3	3	3	-	-	-	-	-	-	-	3	1	2

CM16301 **MATERIAL TECHNOLOGY** **3 0 0 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 corrosions 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

	Programmes Outcomes (POs)													
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	2	2	2	1	-	-	-	-	2	2	2	2
CO2	2	3	3		3	2	-	-	-	-	1	1	2	2
CO3	2	2	1	3	2	1	-	-	-	-	2	2	2	2
CO4	2	3	2	1	3	1	-	-	-	-	1	3	2	2
CO5	2	2	3	2	2	2	-	-	-	-	2	2	2	2

CM16302 CHEMICAL PROCESS CALCULATIONS 3 2 0 4

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 Pubications, (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,”Stochiometry 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

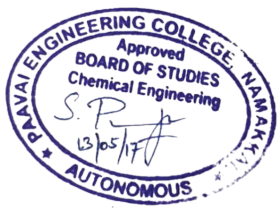
1. http:// www.nptel.ac.in
2. http:// www.msubbu.in
3. http://www.unitoperation.com

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



CM16303 **MECHANICAL OPERATIONS** **3 0 0 3**

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).

WEB LINKS

1. http:// www.nptel.ac.in
2. http://www.msubbu.in/sp/mo/
3. http://www.unitoperation.com

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**	**PO 12**	**PSO1**	**PSO2**
CO1	3	3	3	1	1	1	1	-	-	-	1	3	2	2
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

CH16301 ENVIRONMENTAL SCIENCE AND ENGINEERING 3 0 0 3

(Common to CSE, EEE, CHE, Civil & IT branches)

COURSE OBJECTIVES

To enable students to

- know the constituents of the environment and the precious resources in the environment.
- conserve all biological resources.
- understand the role of human being in maintaining a clean environment and useful environment or the future generations
- acquire knowledge about ecological balance and preserve bio-diversity.
- understand the role of government and non-government organizations in environment management.

UNIT I INTRODUCTION TO ENVIRONMENTAL STUDIES AND NATURAL RESOURCES 9

Environment: Definition- scope - importance – need for public awareness. Forest resources: Use –over exploitation- deforestation - case studies- mining - effects on forests and tribal people. Water resources: Use – over utilization of surface and ground water- floods – drought - conflicts over water. Mineral resources-Use – exploitation - environmental effects of extracting and using mineral resources – case studies. Food resources: World food problems - changes caused by agriculture and overgrazing – effects of modern agriculture- fertilizer-pesticide problems - water logging - salinity -case studies. Energy resources-Growing energy needs - renewable and non renewable energy sources. Role of an individual in conservation of natural resources.

UNIT II ECOSYSTEMS AND BIODIVERSITY 9

Concept of an ecosystem: Structure and function of an ecosystem – producers - consumers – decomposers– energy flow in the ecosystem – ecological succession – food chains - food webs and ecological pyramids. Types of ecosystem: Introduction - characteristic features - forest ecosystem – grassland ecosystem – desert ecosystem - aquatic ecosystems (lakes, rivers, oceans, estuaries).

Biodiversity: Introduction– definition (genetic - species –ecosystem) diversity. Value of biodiversity: Consumptive use - productive use – social values – ethical values - aesthetic values. Biodiversity level: Global - national - local levels- India as a mega diversity nation- hotspots of biodiversity. Threats to biodiversity Habitat loss - poaching of wildlife – man wildlife conflicts – endangered and endemic species of India. Conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.

UNIT III POLLUTION 9

Pollution: Definition –air pollution - water pollution - soil pollution - marine pollution - noise pollution -thermal pollution – nuclearhazards. Solid waste management: Causes - effects - control measures of urban and industrial wastes. Role of an individual in prevention of pollution - Disaster management: Floods – earthquake - cyclone- landslides. Electronic waste-Sources-Causes and its effects.

UNIT IV SOCIAL ISSUES AND ENVIRONMENT 9

Sustainable development: Unsustainable to sustainable development – urban problems related to energy. Water conservation - rain water harvesting - watershed management. Resettlement and rehabilitation of people. Environmental ethics: Issues - possible solutions – climate change - global warming and its effects on flora and fauna - acid rain - ozone layer depletion - nuclear accidents - nuclear holocaust. Environment protection act: Air (Prevention and Control of Pollution) act– water (Prevention and control of Pollution) act – wildlife protection act – forest conservation act – issues involved in enforcement of environmental legislation.

UNIT V HUMAN POPULATION AND ENVIRONMENT 9

Human population: Population growth - variation among nations – population explosion – family welfare programme and family planning – environment and human health– Human rights – value education – HIV/ AIDS –Swine flu – women and child welfare. Role of information technology in environment and human health.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- explain the relationship between the human population and environment.
- elaborate the basic concepts of environment studies and natural resources.
- gain the knowledge about ecosystem and biodiversity.
- have knowledge about causes, effects and control measures of various types of pollution.
- understand the social issues and various environmental acts.

TEXT BOOKS

1. Raman Sivakumar, Introduction to Environmental Science and Engineering, 2nd Edn, Tata McGraw Hill Education Private Limited, New Delhi,(2010).
2. Benny Joseph, "Environmental Science and Engineering", Tata McGraw Hill, (2010).

REFERENCES

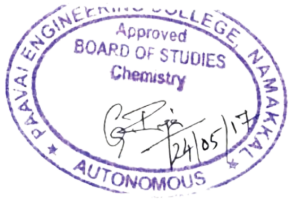
1. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad India,2010 .
2. S. Divan, Environmental Law and Policy in India, Oxford University Press, New Delhi, 2001.
3. K.D. Wager, Environmental Management, W.B. Saunders Co., Philadelphia, USA, 1998.
4. W.P. Cunningham, Environmental Encyclopedia, Jaico Publising House, Mumbai, 2004.
5. Clair Nathan Sawyer, Perry L. McCarty, Gene F. Parkin, "Chemistry for Environmental"

CO/PO MAPPING:

Mapping of Course Outcomes with Programme Outcomes

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO	Programmes Outcomes(POs)													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	2	2	2	1	-	-	-	-	2	2	2	2
CO2	2	1	1		3	1	-	-	-	-	1	1	2	2
CO3	3	3	2	1	2	2	-	-	-	-	2	2	2	2
CO4	2	2	2	2	2	1	-	-	-	-	1	3	2	2
CO5	2	2	3	1	1	1	-	-	-	-	2	2	2	2



CM16304 MECHANICAL OPERATIONS LABORATORY 0 0 4 2

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).

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

CM16401 INSTRUMENTAL METHODS OF ANALYSIS 3 0 0 3

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 13C 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" 7edition 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

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

CM16402 PROCESS HEAT TRANSFER 3 0 0 3

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 calclulate 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).

WEB LINKS

1. http:// www.nptel.ac.in
2. http://www.msubbu.in/sp/mo/
3. http://www.unitoperation.com

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

CM16403 **FLUID FLOW OPERATIONS** **3 2 0 4**

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-Poisuelle 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).

WEB LINKS

1. http:// www.nptel.ac.in
2. http:// www.msubbu.in
3. http://www.unitoperation.com

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

CH16401 **ORGANIC CHEMISTRY** **3 0 0 3**

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, propoerties and uses of Antibacterial drugs – Sulphaniliamide 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 35 Chemistry" Second Edition, Vikas Publishing House Pvt. Ltd. (1998), New Delhi.
3. P.L.Soni,Atext book of Organic Chemistry,S Chand Publishers,(2001), New Delhi.

REFERENCES

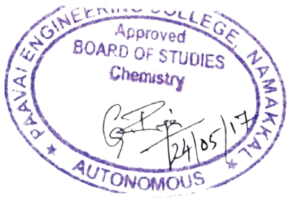
1. Chemistry in Engineering and Technology, Vol.2, TMH Publishing Co Ltd.,New Delhi, 1994.
2. I L Finar "Organic Chemistry" ELBS (1994).
3. Rajbir Singh,"Physical Organic Chemistry",Mittal Publications, 2012.
4. Fleix A.Carroll, "Perspective on Structure and Mechanism in Organic Chemsitry",John Wiley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



EE16408 ELECTRICAL MACHINE DRIVES AND SENSORS 3 0 0 3

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 TRANSDUCERSANDSENSORS 9

Introduction to transducers – LVDT, Piezoelectric transducer, Temperature transducer, Pressure transducers. Introduction to sensors-Signal Conditioning of Sensors-Position Sensors: InductivePosition 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.

REFERENCES

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

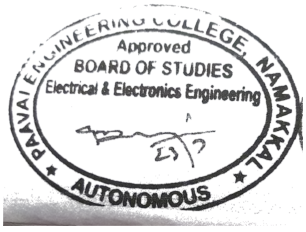
1. https://en.wikipedia.org/wiki/DC_motor
2. https://en.wikipedia.org/wiki/AC_motor
3. http://www.electrical4u.com/control-of-electrical-drives/http://www.kbelectronics.com/Variable_Speed_DC_Drives.html

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



CH16402 **ORGANIC CHEMISTRY LABORATORY** **0 0 4 2**

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 salycilic acid from methyl salyciliate.
    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

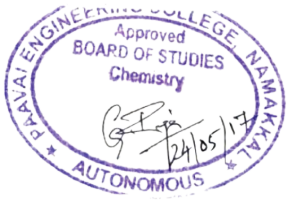
1. Vogels's Text Book of Practical Organic Chemistry, Fifth Edition, Longman,Singapore Publishers Pte. Ltd., Singapore (1989).
2. Organic Chemistry Lab Manual, Chemistry Division, Chemical Engineering Departemnt, A.C. Tech, Anna University (2007).

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



CM16404 **FLUID MECHANICS LABORATORY** **0 0 4 2**

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

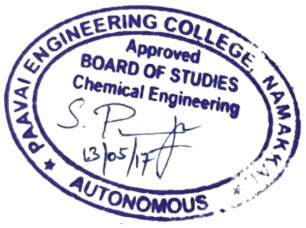
1. McCabe, W.L, Smith J.C and Harriot, P., “Unit Operations in Chemical Engineering”, McGraw-Hill, Fourth Edition, 1984.

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



EE16409 **ELECTRICAL ENGINEERING LABORATORY** **0 0 4 2**

COURSE OBJECTIVES

To enable students to

- conduct various experiments on electrical machines analyze their performance.
- determining the performance characteristics of transducers
- perform load tests
- know about the performance of starters

LIST OF EXPERIMENTS

1. Load test on DC shunt motor and DC Series motor.
2. Open circuit characteristics and load characteristics of DC shunt
3. Speed Control of DC Shunt Motor (Armature and Field control)
4. Swinburne's test.
5. Load test on three phase squirrel cage induction motor
6. Speed control of three phase squirrel cage induction motor.
7. Load test on single phase induction motor.
8. Study of DC &AC Starters.
9. Study of displacement transducer - LVDT
10. Study of pressure transducer

TOTAL PERIODS 60

COURSE OUTCOMES

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

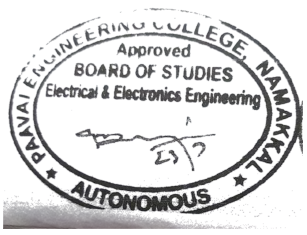
- summarize the characteristics and speed control of electrical machines
- predict the performance characteristics of transducers
- conduct load tests
- Determine starter performance

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



MA16501 **NUMERICAL METHODS** **3 2 0 4**

(EEE, Chemical, CSE)

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 conventionalmethod.
- apply finite element method to increase the accuracy of second order differentialequations

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

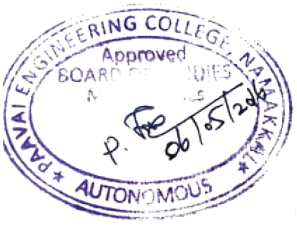
1. P. Kandasamy, K. Thilagavathy and K. Gunavathy, "Numerical Methods", S.Chand Co. Ltd., New Delhi, 2003
2. Gerald C.F. and Wheatley, P.O., "Applied Numerical Analysis" 6th Edition, Pearson Education Asia, New Delhi, 2002.
3. M.K.Jain , S.R.K. Iyangar , R.K.Jain , "Numerical Methods For Scientific & 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)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
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



CM16501 MASS TRANSFER I 3 0 0 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 co-efficient - 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-psychometric 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 Practice‖, Prentice Hall of India, New Delhi, 2011.
2. Treybal Robert E., ―Mass Transfer Operations, 3rd Edition, McGraw-Hill Book Company, 1980.

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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.

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	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**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	-

CM16502 CHEMICAL ENGINEERING THERMODYNAMICS I 3 0 0 3

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 Cp and Cv- 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

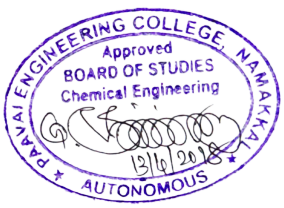
1. Smith, J.M., Van Ness, H.C and Abbot M.M "Introduction to Chemical Engineering Thermodynamics" McGraw Hill Publishers, VI edition, 2003
2. Narayanan, K.V. A Textbook of Chemical Engineering Thermodynamics Prentice Hall India, 2004

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).

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



CM16503 CHEMICAL PROCESS INDUSTRIES I 3 0 0 3

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 PHOSPORUS 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

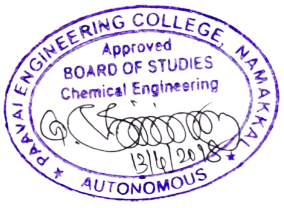
1. Austin G.T., ―Shreve's Chemical Process Industries‖, 5th Edition, McGraw-Hill International Book Company, Singapore, 2012.
2. Gopala Rao M. and Marshall Sittig, ― Dryden‘s Outlines of Chemical Technology, 3rd Edition, East-West Press, New Delhi, 2008.

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

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



CM16504 CHEMICAL PROCESS PLANT SAFETY 3 0 0 3

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

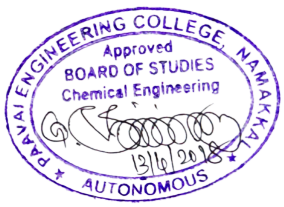
1. Fawcett H.H. and Wood W.S., ―Safety and Accident Prevention in Chemical Operation‖, 2nd Edition, Interscience, 1982.
2. D.B Dhone, Plant safety and maintenance, Nirali Prakashan Publication,1st edition, (2014).

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. Crowl, 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

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



CM16505 TECHNICAL ANALYSIS LABORATORY 0 0 4 2

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

TOTAL PERIODS 60

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

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

CM16506 HEAT TRANSFER LABORATORY 0 0 4 2

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.

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)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	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	2	-	-	-	1	1	-	2	2	3
CO5	2	2	1	1	1	-	-	-	-	-	1	2	2	3

CM16601 CHEMICAL REACTION ENGINEERING 3 2 0 4

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

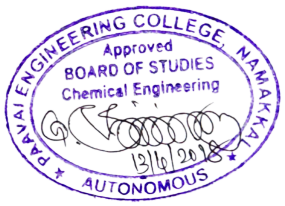
1. Levenspiel O., ―Chemical Reaction Engineering‖, 4th Edition, Wiley India Pvt. Ltd., New Delhi, (2009).
2. K.A. Gavhane, Chemical Reaction Engineering I & II", Nirali Prakashan Publication, (2015).

REFERENCES

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.

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



CM16602 CHEMICAL PROCESS INDUSTRIES II 3 0 0 3

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.

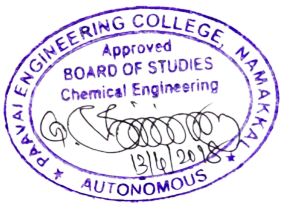
2. Gopala Rao M. and Marshall Sittig, ― Dryden's Outlines of Chemical Technology‖, 3rd Edition, East- West Press, New Delhi, 2008.

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

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



CM16603 **MASS TRANSFER II** **3 2 0 4**

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 CONTINOUS 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

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	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	-

CM16604 CHEMICAL ENGINEERING THERMODYNAMICS II 3 0 0 3

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

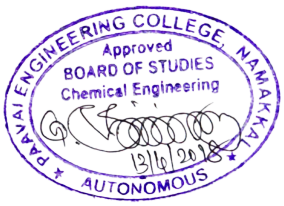
1. Narayanan, K.V. A Textbook of Chemical Engineering Thermodynamics Prentice Hall India, (2004).
2. Smith, J.M., Van Ness, H.C and Abbot M.M "Introduction to Chemical Engineering Thermodynamics ", McGraw Hill Publishers, VI edition, (2003).

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

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



CM16605 PROCESS PLANT UTILITIES 3 0 0 3

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 Monochlorodifluro Methane, Chlorofluro 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

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

CM16606 MASS TRANSFER LABORATORY 0 0 4 2

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

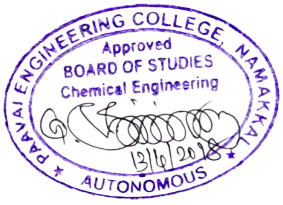
- determine important data for the design of process equipment like distillation
- determine important data for operation of extractor
- evaluate the data for diffusivity and drying
- understand the mass transfer principles which are having wide applications in various industries

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

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



CM16607 PROCESS EQUIPMENT DESIGN I 0 0 4 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

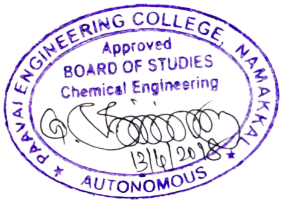
- have skill to design and install process equipment like cyclone separator
- have skill in design and drawing of filters and centrifuge
- have skill in design and drawing of different vessels such as agitated and jacketed
- have skill in design and drawing considerations in nut, bolts and screws

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.

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	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



SEMESTER VII

CM15701 TRANSPORT PHENOMENA 3 2 0 4

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+6

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+6

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 MASS BALANCE DISTRIBUTION IN LAMINAR FLOW 9+6

Flow of Newtonian fluids in planes - slits and annulus heat flux and temperature distribution for heat sources such as electrical - nuclear viscous and chemical - forced and free convection - mass flux and concentration profile for diffusion in stagnant gas - Falling Liquid Film (Gas Absorption) - Diffusion and Chemical Reaction inside a Porous Catalyst.

UNIT IV TRANSPORT IN TURBULENT AND BOUNDARY LAYER FLOW 9+6

Turbulent phenomena - phenomenological relations for transfer fluxes - time smoothed equations of change and their applications for turbulent flow in pipes - boundary layer theory – laminar - turbulent Hydrodynamics - Thermal and concentration boundary layer and their thicknesses - analysis of flow over flat Surface.

UNIT V ANALOGIES BETWEEN TRANSPORT PROCESSES 9+6

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

TOTAL PERIODS 75

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
- determine the shell mass balance and concentration distributions in systems involving diffusion and reactions
- develop steady and time dependent solutions along with their boundary conditions
- analyze the analogy between the transports processes of heat- momentum and mass transfer

TEXT BOOKS

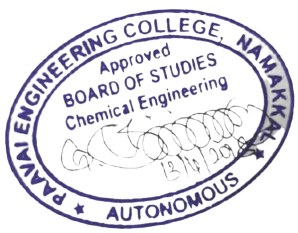
1. R.B. Bird- W.E. Stewart and E.W. Lightfoot, “Transport Phenomena”, John Wiley II Edition 2006.
2. Robert- S Brodkey- Harry C. Hershey, “Transport Phenomena A Unified Approach ”, Brodkey Publishing 2003

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. J.R. Welty- R.W. Wilson- and C.W.Wicks Rorer G.E- Wilson R.W. “Fundamentals of Momentum
4. “Heat and Mass Transfer” V Edition. John Wiley- New York- 2007.
5. 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														
Programme Outcome (POs)														
COs	**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	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



CM15702 PROCESS INSTRUMENTATION DYNAMICS AND CONTROL 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- introduce about various instrument and their principle.
- 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 INSTRUMENTATION 9

Principles of measurements and classification of process instruments - measurement of temperature – pressure - fluid flow - liquid weight and weight flow rate – viscosity - pH - concentration - electrical and thermal conductivity humidity of gases.

UNIT II OPEN LOOP SYSTEMS 9

Laplace transformation and its application in process control. First order systems and their transient response for standard input functions- first order systems in series - linearization and its application in systems and their dynamics - transportation lag.

UNIT III CLOSED LOOP SYSTEMS 10

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

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

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 45

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
- Design the controllers

TEXT BOOKS

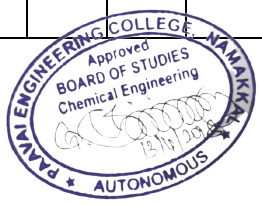
1. Stephanopoulos. G. “Chemical Process Control”, Prentice Hall of India- 2003
2. Donald R Coughnowr “Process Systems Analysis and Control”, 3rd Edition. McGraw Hill- New York- 2008

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-1964

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



CM15703 PROCESS PLANT UTILITIES 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- understand effective use of chemical industry utilities.
- know various trouble shooting in industries
- study various optimization techniques in refrigeration industry
- optimize various parameters in cooling industries to improve efficiency
- gain knowledge on different techniques utilized in waste disposal

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 Mono chlorodifluro Methane - Chlorofluro 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

- understand effective use of chemical industries utilities
- knowledge about Steam- power- water- air are extensively used in process industries
- understand its efficient operation methods in refrigeration industries.
- safe operation for the survival of industries
- understand the importance of health- safety and the environment during waste disposal.

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- 2007.
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

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	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

CM15704 ENERGY MANAGEMENT 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- know the basic 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 ENERY 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 Vezirog- "Alternate Energy Sources"- IT- McGraw Hill- New York
2. El. Wakil- "Power Plant Technology"- Tata McGraw Hill- New York- 2002.
3. Sukhatme. S.P.- "Solar Enery - Thermal Collection and Storage"- Tata McGraw hill- New Delhi- 1981.
4. Albert Thumann- P.E.- C.E.M & William J Younger C.E.M- "Handbook of Energy Audit by 7th edition" Faiment Press 2008
5. 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														
Programme Outcome (POs)														
COs	**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	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

CM15353 FERTILIZER TECHNOLOGY 3 0 0 3

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 diamSmonium 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

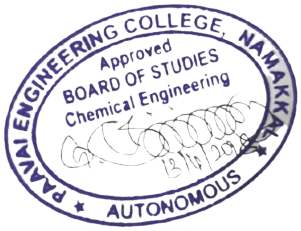
1. GopalaRao M. and Marshall Sittig "Dryden's Outlines of Chemical Technology", 3rd Edition East- West Press, New Delhi- 2008.
2. Menno- M.G.; "Fertilizer Industry - An Introductory Survey" Higginbotham's Pvt. Ltd.- 1973.

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



CM15452 **CORROSION ENGINEERING** **3 0 0 3**

COURSE OBJECTIVES

To enable the students 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

UNIT I TYPES OF CORROSION AND TESTING METHODS 9

Basic principles of corrosion and its control – Forms of corrosion – uniform – Galvanic – Crevis – 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 – electro photeric 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

At the end of this course- the student would 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

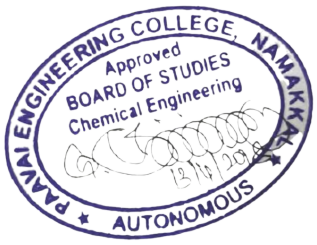
1. Fontana M.G, “Corrosion Engineering”, Tata McGraw Hill- 2005.
2. Jones D.A. “Principal and Protection of Corrosion”, Prentice-Hall- 1996

REFERENCES

1. Pierre R. Roberge, “Corrosion Engineering: Principles and Practice”, McGraw-Hill- 2008.
2. Sastri V.S. Ghali E. And Elboujdaini M.“Corrosion Prevention and Protection: Practical Solutions”, John Wiley and Sons- 2007.
3. Pierre R. Roberge “Handbook of Corrosion Engineering” 2nd edition, McGraw-Hill- 2012.
4. Zaki Ahmad “ Principles of Corrosion Engineering and corrosion control” Butterworth- 2006

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	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



CM15705 PROCESS CONTROL LABORATORY 0 0 4 2

(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

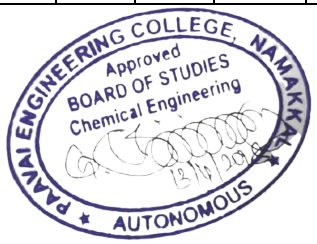
1. Stephanopoulos- G. "Chemical Process Control"- Prentice Hall of India, 2003.
2. Coughnowr. D "Process Systems Analysis and Control", 3rd Edn.- McGraw Hill- New York- 2008

REFERENCES

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

CO/PO MAPPING

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	2	1	1	2	1	1	-	1	-	-	1	2	3
CO2	3	2	2	2	1	-	-	-	1	-	-	2	2	3
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



CM15706 CHEMICAL PROCESS EQUIPMENT DESIGN II 0 0 4 2

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

COURSE OBJECTIVES

To develop skill for design and install process equipment's like

- Basic drawing for cooling tower- drier – evaporator
- Basic drawing for heat exchanger
- 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

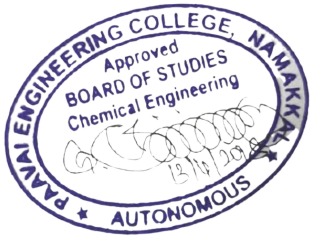
1. McCabe- W.L- Smith J.C and Harriott- P.- "Unit Operations in Chemical Engineering"- McGraw-Hill Fourth Edition- 1984.
2. J.M. Coulson and J.Richardson- "Chemical Engineering"- vol. 6- Asian Books Printers Ltd.

REFERENCES

1. R.H. Perry- "Chemical Engineers' Handbook"- McGraw-Hill
2. Robert Treybal- "Mass Transfer Operations"- McGraw-Hill.
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														
Programme Outcome (POs)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	1	1	2	1	1	-	1	-	-	1	2	3
CO2	3	2	2	2	1	-	-	-	1	-	-	2	2	3
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



CM15707 MASS TRANSFER LABORATORY 0 0 4 2

COURSE OBJECTIVES

To train the students to develop sound working knowledge on different types of equipment's

- 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. Demonstration 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

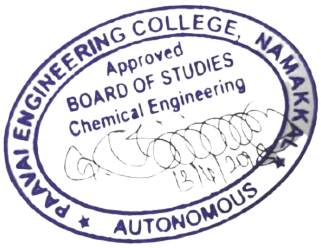
- determine important data for the design of process equipment like distillation
- determine important data for operation of extractor
- evaluate the data for diffusivity and drying
- understand the mass transfer principles which are having wide applications in various industries

TEXT BOOKS

1. McCabe- W.L- Smith J.C and Harriott- 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.

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



PROGRAMME ELECTIVE V

CM15551 AIR POLLUTION AND CONTROL 3 0 0 3

COURSE OBJECTIVES

To enable students to

- learn about Air Pollution regulations
- make the students aware of effects of air pollution- Global effects-
- learn the of Sampling of pollutants-
- control pollution with technological achievement and economic viability.
- study the Meteorology and air pollution- Atmospheric stability- and Prediction of air quality.

UNIT I INTRODUCTION 9

Air Pollution Regulatory Framework History - Air Pollution Regulatory - Framework - Regulatory System - Laws and Regulations - Clean air Act - Provisions for Recent Developments.

UNIT II AIR POLLUTION GASES 9

Measurement fundamentals - chemicals and physical properties – Phase - Incinerators - Design and Performance - Operation and Maintenance - Absorbers - Design operation and improving performances

UNIT III PARTICULATE AIR POLLUTION 9

Particle collection mechanism - fluid particle - dynamic - particle size - Distribution - Efficiency - Gravity Settling chambers Cyclones - Electrostatic precipitators

UNIT IV HYBRID SYSTEM 9

Heat electrostatic precipitation - Genizing Heat Scrubbers - Dry Scrubbers - Electrostatically Augmented Fabric Filtration

UNIT V AIR POLLUTION CONTROL EQUIPMENT 9

Introduction - Installation - Cost Model.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- understand the evolution of air pollution regulation and different laws related to air pollution and control
- know the effects of air pollution and its adverse impact on Global scenario
- assess the performance of absorbers and understand the different particle collection mechanisms
- understand the concepts involved in hybrid systems and its cost Modelling
- learn to control the pollution with technological equipment and attain economic viability.

TEXT BOOKS

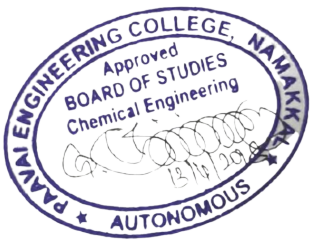
1. Louis Theodore, "Air Pollution Control Equipment", Springer- 2011
2. Cooper C.D. and Alley F.C. "Air Pollution Control-A Design Approach"- 4th Edition- Waveland Pr Inc. 2010.

REFERENCES

1. Noel de Nevers, "Air Pollution Control Engineering"- 2nd Edition- Waveland Pr Inc.- 2010.
2. Rao M.N. and Rao H.V.N. "Air Pollution"- 1st Edition- McGraw Hill India Pvt. Ltd.- 2001.
3. Norman C.Pereira, "Air Pollution control Engineering", Springer science- 2004
4. Paul N. Cheremisinoff, "Air Pollution Control and Design for Industry", Marcel Dekker INC- New york- 1993

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



CM15653 PETROLEUM REFINING ENGINEERING 3 0 0 3

COURSE OBJECTIVES

On completion of the course the students will be able to

- study the formation and composition of petroleum
- learn with properties and testing methods for crude and petroleum products
- learn the various treatment techniques of petroleum
- familiarize with upgrading process of petroleum products
- understand the material and energy balance

UNIT I FORMATION AND COMPOSITION OF PETROLEUM 9

Origin and formation of petroleum; composition; types and classification; Petroleum reserves.

UNIT II PROPERTIES AND TESTING METHODS 9

Physical properties and testing methods - crude and petroleum products;

UNIT III TREATMENT TECHNIQUES 9

Desalting of crudes- dehydration and fractionation methods; Thermal and catalytic cracking processes vis- Breaking - Dubbs two coil process - coking- FCC- Hydro cracking processes.

UNIT IV UPGRADING PROCESSES 9

Solvent extraction; hydro treatment processes; Reforming and Alkylation; Isomerization; polymerization; Finishing and purification processes.

UNIT V MATERIAL AND ENERGY BALANCES 9

Material and Energy balances calculation; controlling hydrocarbon losses in refinery; application of pollution Control techniques.

TOTAL PERIODS 45

COURSE OUTCOMES

On completion of the course the students will be able to

- understand the formation and composition of petroleum
- familiarize with properties and testing methods for crude and petroleum products
- understand the various treatment techniques of petroleum
- familiarize with upgrading process of petroleum products
- demonstrate the material and energy balance

TEXT BOOKS

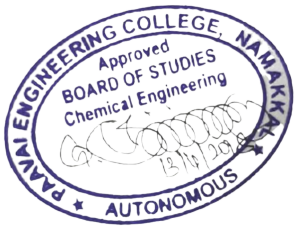
1. Bhaskara Rao B.K. "Modern Petroleum Refining Processes", 5th Edition- Oxford and IBH Publishing Company- New Delhi- 2008.
2. Nelson W.L. “Petroleum Refinery Engineering”, 4th Edition- McGraw Hill Publishing Company Limited- 1958.

REFERENCES

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

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	2	1	1	1	1	1	-	-	-	2	1	1	3
CO2	2	2	2	1	1	2	2	-	1	-	-	2	2	3
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



SEMESTER VIII

CM15801	**PROJECT WORK**	**0**	**0**	**12**	**6**

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 weightage 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 has to 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 have to 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 has to 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

TOTAL PERIODS 180

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

PROGRAMME ELECTIVE III

CM15351 OIL AND NATURAL GAS ENGINEERING 3 0 0 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														
Programme Outcome (POs)														
COs	**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

CM15352 ELECTROCHEMICAL ENGINEERING 3 0 0 3

COURSE OBJECTIVES

To enable students to

- obtain the principles of electrochemical cells
- solve problems related to the production- storage- distribution of electrochemical energy
- understand utilization of electrochemical energy and the associated environmental issues
- understand the impact of these factors on global energy issues
- integrate professional- ethical and environmental factors in electrochemical engineering design

UNIT I REVIEW BASICS OF ELECTROCHEMISTRY 9

Review basics of electrochemistry - Faraday's law - Nernst potential - Galvanic cells - Polarography - The electrical double layer - It's role in electrochemical processes - Electro capillary curve Helmoltz layer – Guoy - Steven's layer - fields at the interface.

UNIT II MASS TRANSFER IN ELECTROCHEMICAL SYSTEMS: 9

Mass transfer in electrochemical systems: diffusion controlled electrochemical reaction the importance of convention and the concept of limiting current. over potential - primary secondary current distribution rotating disc electrode.

UNIT III INTRODUCTION TO CORROSION 10

Introduction to corrosion - series - corrosion theories derivation of potential - current relations of activities controlled and diffusion controlled corrosion process. Potential - pH diagram - Forms of corrosion - definition - factors and control methods of various forms of corrosion - corrosion control measures - industrial boiler water corrosion Control protective coatings Vapor phase inhibitors - cathodic protection - sacrificial anodes - paint removers.

UNIT IV ELECTROCHEMICAL CELLS 8

Electro deposition - electro refining - electroforming - electro polishing - anodizing Selective solar coatings - Primary and secondary batteries - types of batteries - Fuel cells.

UNIT V ELECTRODES USED IN ELECTROCHEMICAL INDUSTRIES 9

Electrodes used in different electrochemical industries: Metals - Graphite - Lead dioxide Titanium substrate Insoluble electrodes - Iron oxide - semi conducting type - Metal finishing - cell design. types of electrochemical reactors - batch cell - fluidized bed electrochemical reactor - filter press cell - Swiss roll cell - plug flow cell - design Equation figures of merits of different type of electrochemical reactors.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- obtain the principles of electrochemical cells
- solve problems related to the production- storage- distribution of electrochemical energy
- understand utilization of electrochemical energy and the associated environmental issues
- understand the impact of these factors on global energy issues
- integrate professional- ethical and environmental factors in electrochemical engineering design

TEXT BOOKS

1. Picket “Electrochemical Engineering” Prentice Hall-1977
2. Newman. J. S. “ Electrochemical systems” Prentice Hall-1973

REFERENCES

1. Barak M. and Stevenge U. K. “ Electrochemical Power Sources - Primary and Secondary Batteries” 1980
2. Mantell C. “Electrochemical Engineering” McGraw Hill-1972.
3. H.Wendt, G.Kreysa “ Electrochemical Engineering Science and Technology in chemical and other industries”, Springer-1999
4. Fumio Hine “Electrode Processes and Electrochemical Engineering” Plenum Press- New York-1985

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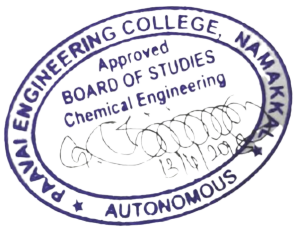
CO2	2	2	2	1	1	2	2	-	1	-	-	2	2	3
CO3	3	1	1	2	1	2	2	-	1	1	2	2	2	3
CO4	3	2	2	2	1	1	1	-	-	1	-	2	2	3
CO5	2	2	1	1	1	2	2	-	-	-	1	2	2	3



CM15354 POLYMER TECHNOLOGY 3 0 0 3

COURSE OBJECTIVES

To enable the students to

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

UNIT I INTRODUCTION 6

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 12

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 - Tg - 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

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Programme Outcome (POs)														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
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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

PROGRAMME ELECTIVE IV

CM15451 PULP AND PAPER TECHNOLOGY 3 0 0 3

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. Kenneth W. Brittt, "Handbook of Pulp and Paper Technology", 2nd Revised Edition- John Wiley & Sons- 1971.
2. Smook G.A. "Handbook for Pulp & Paper Technologists", 3rd Edition- Angus Wilde Publications Incorporation- 2003.

REFERENCES

1. Austin- G.T. "Shreve's Chemical Process Industries"- 5th Edition- McGraw-Hill International Book Company- Singapore- 1984.
2. Kent J.A.- Riggel's Hand Book of Industrial Chemistry‖- Van Nostrant Reinhold- 1974.
3. Monica ER Monica- Goran Gellerstcdt- "Pulp and paper chemistry and Technology"- Gneyter 2009.
4. Pratima Bajpai- "Pulp and Paper Industry-Energy Conservation"- Elsevier 2016

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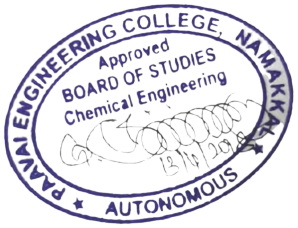
CO2	2	2	2	1	1	2	2	-	1	-	-	2	2	3
CO3	3	1	2	2	1	2	2	-	1	1	2	2	2	3
CO4	2	2	2	2	1	1	1	-	-	1	-	2	2	3
CO5	2	2	1	1	1	2	2	-	-	-	1	2	2	3



CM15453 ENZYME ENGINEERING 3 0 0 3

COURSE OBJECTIVES

To enable students to

- gain knowledge on microorganism and culture growth of enzyme
- learn about different classification of enzymes
- study about the enzyme kinetics using gas-liquid transports
- know the purifying techniques in enzyme production and its application
- study about different types of bioreactor operation and design.

UNIT I INTRODUCTION 9

Types of Microorganism: Structure and function of microbial cells - Fundamentals of microbial growth - Batch and continuous culture. Isolation and purification of enzymes from cells. Cell and Enzyme Immobilization.

UNIT II ENZYME KINETICS 9

Fermentation - Types of mechanisms- Continuous fermentation - aeration and agitation- kinetics of fermentation - Processes

UNIT III TRANSPORT PHENOMENA 9

Introduction of Bioreactor design: Continuously stirred aerated tank bioreactors. Mixing power correlation determination of volumetric mass transfer rate of oxygen from air bubbles and effect of mechanical mixing and aeration on oxygen transfer rate- heat transfer and power.

UNIT IV PURIFICATION OF ENZYMES 9

Introduction to Biochemistry- Function and applications. Nature and function of enzyme. Coenzyme / Cofactor. Classification of enzymes. Assay methods and units. Examples of applications of enzymes in industry- analytical technique medicine and Pharmaceuticals

UNIT V ENZYME BIOREACTORS 9

Industrial Bioreactors Utilizing Isolated enzymes and biosensors development and applications. designs of Reactor- Batch and continue type; analysis for immobilized enzyme reactors. Sterile and non-sterile Operations; reactors in series with and without recycle.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- classify enzymes and gain knowledge on immobilization- extraction and purification of enzymes and biosensors
- determine the Enzyme rate for the reaction with kinetics
- emphasis on reactor operation and design with respect to transfer rate
- purify the enzymes and the analytical techniques employed for it
- understand the function of industrial bio reactors and can study the effect of sterilization.

TEXT BOOKS

1. "Technological Applications of Bio-catalysts"- BIOTOL series- Butter worth- 1995.
2. Cornish. A -Bowden- "Analysis of Enzyme Kinetic Data"- Oxford University Press- 1996.

REFERENCES

1. Wiseman. A and Blake borough N and Dunnill P "Enzymic and nonenzymic catalysis"- Vol.5 Ellis and Harwood- U.K. (1981).
2. Wiseman A (Ed.) "Topics in enzyme and fermentation Bio-technology"- Ellis and Harwood- U.K. Vol-5.
3. James C. Samuelson "Enzyme Engineering**:** Methods and Protocols"- Humana Press- 2016
4. Peter Gemeiner,"Enzyme engineering**:** immobilized bio systems", E. Horwood- 1992

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**
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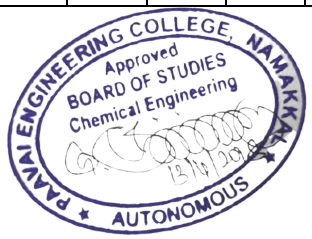
CO4	3	2	2			1	1					2	2	2
CO5	3	3	3			2	2					2	2	2



CM15552 **PROCESSES OPTIMIZATION** **3 0 0 3**

COURSE OBJECTIVE

To enable students to

- study the systems of equations for attaining optimum
- expose the students with basic function and interpretation of quadratic
- perform functional concepts using various mathematical methods
- study about unconstrained multivariable optimization methods
- expose the students in linear programming

UNIT I DEVELOPING MODELS FOR OPTIMIZATION **9**

Scope and hierarchy of optimization - Essential features of Optimization problems - Classification of Models - building a model - Factorial experimental designs- Degree of freedom

UNIT II BASIC CONCEPTS **9**

Formation of objective function - continuity of functions - NLP problem statement- convexity and applications - Interpretation of objective function based on its Quadratic approximation

UNIT III OPTIMIZATION OF UNCONSTRAINED FUNCTIONS **9**

Methods for one dimensional search- Newton‘s method and Quasi - Newton methods for uni-dimensional search. Polynomial approximation methods

UNIT IV UNCONSTRAINED MULTIVARIABLE OPTIMIZATION **9**

Methods using function value only - methods using first derivative - Newton‘s method- Quasi - Newton methods.

UNIT V LINEAR PROGRAMMING **9**

Simplex method - Barrier method - sensitivity analysis - Linear mixed integer programs - Examples

TOTAL PERIODS 45

COURSE OUTCOMES

Through this course- the students would have learnt about

- designing experiments and formulate optimization models of chemical processes/equipment
- knowledge on the basic concepts of process optimization techniques
- solving different uni-dimensional search methods and polynomial approximations
- understanding the principles of unconstrained multivariable Optimization techniques
- familiarizing the methods of linear programming

TEXT BOOKS

1. Edgar- T.F, Himmelblau, D.M. "Optimization of Chemical Processes", McGraw-Hill- 2001.
2. Kalyanmoy Deb "Optimization for Engineering Design: Algorithms and Examples", Prentice Hall of India- New Delhi- 2005.

REFERENCES

1. Biles- W.E.- Swain- J.J, "Optimization and Industrial Experimentation", Inter Science- New York- 19
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

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	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
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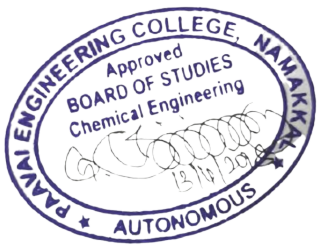

CM15553 COMPUTATIONAL FLUID DYNAMICS 3 0 0 3

COURSE OBJECTIVE

To enable students to

- make the 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 Strokes equations - turbulence models - one and two equation- Reynolds stress - LES and DNS

UNIT II FINITE DIFFERNCE 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 15

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 6

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

UNIT V GRID GENERATION 6

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.
2. Fletcher- C. A. J., "Computational Techniques for Fluid Dynamics"- Springer Verlag- 1997.

REFERENCES

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

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**
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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
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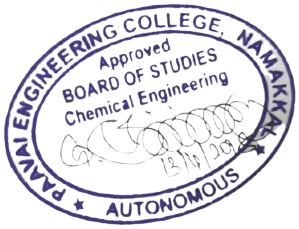


CM15554 **PIPING ENGINEERING** **3 0 0 3**

COURSE OBJECTIVES

To enable students to

- understand the concept of piping generic design
- learn 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

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

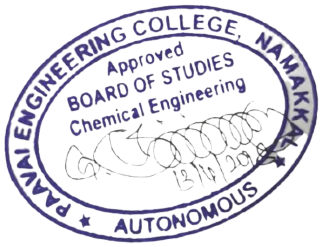
1. John J Mcketta, "Piping Handbook", 3rd Edition, Marcel Dekker Publication- 1992.
2. Henry Liu, "Pipeline Engineering", 2nd Edition- Lewis Publishers- 2003.

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

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



PROGRAMME ELECTIVE VI

CM15651 PROCESS MODELLING AND SIMULATION 3 0 0 3

COURSE OBJECTIVES

To enable students to

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

UNIT I INTRODUCTION 7

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 7

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

UNIT V CRYSTALLIZATION 13

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

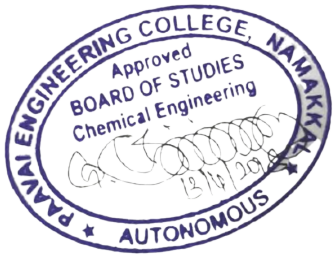
1. Ramirez- W.; "Computational Methods in Process Simulation "- 2nd Edn. Butterworths Publishers - New York- 2000.
2. Luyben- W.L. " Process Modelling Simulation and Control", 2nd Edn- McGraw-Hill Book Co.- 1990

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

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	2	1	1	1	1	1	-	-	-	-	1	2	3
CO2	2	1	2	1	2	-	-	-	1	-	-	2	2	3
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



CM15652 SOLID WASTE MANAGEMENT 3 0 0 3

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 8

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 8

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 III COLLECTION AND TRANSFER 8

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 12

Objectives of waste processing – Physical Processing techniques- 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

On completion of the course the students will be able to

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

TEXTBOOKS:

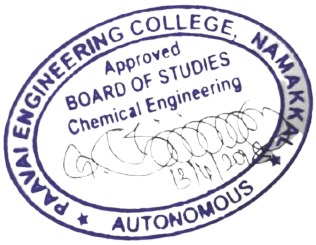
1. Tchobanoglous- G. Theisen H. M. and Eliassen- R. "Solid. Wastes: Engineering Principles and Management Issues", McGraw Hill- New York- 1993.
2. Paul T Willams, "Waste Treatment and Disposal"- John Wiley and Sons-2000

REFERENCES:

1. Bhide A.D. and Sundaresan. B.B. "Solid Waste Management Collection Processing and Disposal", Indian National Scientific Documentation Centre - 1983
2. George Tchobanoglous and Frank Kreith, "Handbook of Solid waste Management", McGraw Hill, New York- 2002
3. Marc J. Rogoff, "Solid Waste Recycling and Processing", Elsevier-2014
4. Sunil Kumar, "Municipal Solid Waste Management in Developing Countries", CRC press-2016

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	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



CM15654 CHEMICAL PROCESS DESIGN 3 0 0 3

COURSOBJECTIVES

On completion of the course the students will be able to

- apply the skill in thermal design of heat transfer equipments like condensers and reboilers
- understand the design parameters of reactors
- perform the process design of distillation column
- apply the skill in design of absorption column
- study the concepts involved in design of dryers

UNIT I INTRODUCTION 9

The Hierarchy of Chemical process Design - Overall process Design - approaches to design

UNIT II CHOICE OF REACTORS AND SEPARATOR 9

Reaction path - reactor performance - practical reactors - Separation of Heterogeneous and homogeneous fluid mixtures.

UNIT III SYNTHESIS OF REACTION - SEPARATION SYSTEMS 9

Process recycle - Batch processes - process yield

UNIT IV DISTILLATION SEQUENCING 9

Using simple columns - using columns with more than two products - Distillation Sequencing Using thermal coupling.

UNIT V HEAT EXCHANGER NETWORK UTILITIES - ENERGY TARGETS 9

Heat recovery pinch - The Problem table Algorithm - Utilities Selection - Energy targets capital total Cost targets - Number of Heat Exchanger Units - Area Targets - Number of Shells Targets - Capital Cost Targets

TOTAL PERIODS 45

COURSE OUTCOMES

On completion of the course the students will be able to

- apply the skill in thermal design of heat transfer equipments like condensers and reboilers
- estimate the design parameters of reactors
- perform the process design of distillation column
- apply the skill in design of absorption column
- understand the concepts involved in design of dryers

TEXT BOOKS

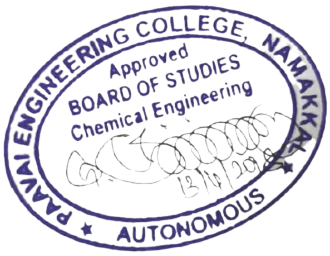
1. Walas- Stanley M. "Chemical Process Equipment Selection and Design" Butterworth - Heinemann
2. Lloyd E. Brownell and Edwin H. Young "Process Equipment Design" John Wiley and Sons

REFERENCES

1. Smith- R. "Chemical Process Design"- McGraw Hill, New York- 1995.
2. Douglas- J.M. "Conceptual Design of Chemical Process" McGraw Hill- New York- 1988.

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



CM16512 DRUGS AND PHARMACEUTICAL TECHNOLOGY 3 0 0 3

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; physic chemical principles; Pharma kinetics-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; parential 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.

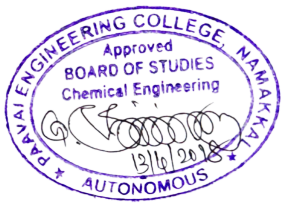
2. Rawlines, E.A.; “Bentleys Textbook of Pharmaceutics “, III Edition, Bailliere Tindall, London, 1977

REFERENCES

1. Yalkonsky, S.H.; Swarbick. 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.

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



CM16513 PULP AND PAPER TECHNOLOGY 3 0 0 3

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

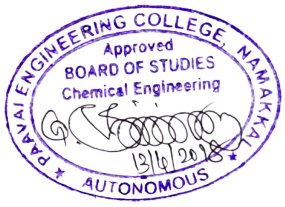
1. Pulp and paper chemistry and Technology Monica ER Monica, Goran Gellerstcdt Gunnar Hennksson De Gneyter 2009.
2. Smook G.A., ―Handbook for Pulp & Paper Technologists‖, 3rd Edition, Angus Wilde Publications, Incorporation, 2003.

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 Nostrant 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



CM16514 FUNDAMENTALS OF NANOSCIENCE 3 0 0 3

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

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**
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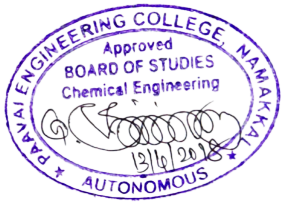

CM16901 **SOLID WASTE MANAGEMENT** **3 0 0 3**

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 III COLLECTION AND TRANSFER **9**

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

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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

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