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

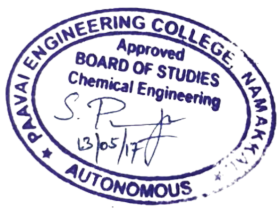
1. http:// www.nptel.ac.in
2. http:// www.msubbu.in
3. http://www.unitoperation.com

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

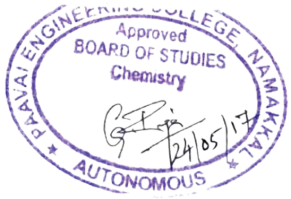
1. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad India,2010 .
2. S. Divan, Environmental Law and Policy in India, Oxford University Press, New Delhi, 2001.
3. K.D. Wager, Environmental Management, W.B. Saunders Co., Philadelphia, USA, 1998.
4. W.P. Cunningham, Environmental 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

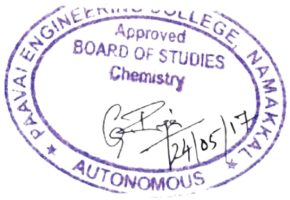
1. Chemistry in Engineering and Technology, Vol.2, TMH Publishing Co Ltd.,New Delhi, 1994.
2. I L Finar "Organic Chemistry" ELBS (1994).
3. Rajbir Singh,"Physical Organic Chemistry",Mittal Publications, 2012.
4. Fleix A.Carroll, "Perspective on Structure and Mechanism in Organic Chemsitry",John Wiley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

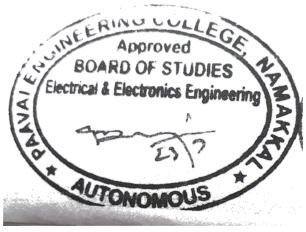
1. https://en.wikipedia.org/wiki/DC_motor
2. https://en.wikipedia.org/wiki/AC_motor
3. http://www.electrical4u.com/control-of-electrical-drives/http://www.kbelectronics.com/Variable_Speed_DC_Drives.html

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

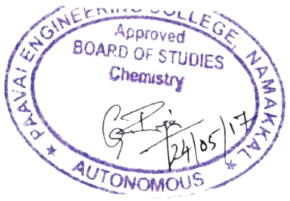
1. Vogels's Text Book of Practical Organic Chemistry, Fifth Edition, Longman,Singapore Publishers Pte. Ltd., Singapore (1989).
2. Organic Chemistry Lab Manual, Chemistry Division, Chemical Engineering Departemnt, A.C. Tech, Anna University (2007).

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

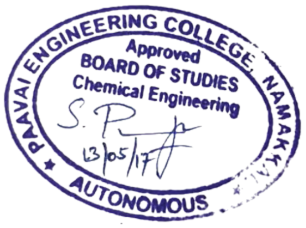
1. McCabe, W.L, Smith J.C and Harriot, P., “Unit Operations in Chemical Engineering”, McGraw-Hill, Fourth Edition, 1984.

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

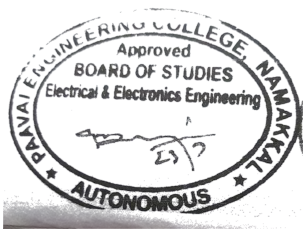
- summarize the characteristics and speed control of electrical machines
- predict the performance characteristics of transducers
- conduct load tests
- Determine starter performance

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	-



CM15501 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.

REFERENCES

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

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	-

CM15502 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

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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

CM15503 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

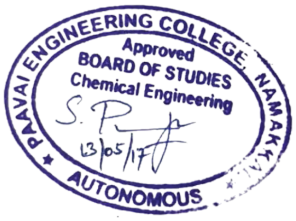
1. Austin G.T., ―Shreve's Chemical Process Industries‖, 5th Edition, McGraw-Hill International Book Company, Singapore, 2012.
2. Gopala Rao M. and Marshall Sittig, ― Dryden‘s Outlines of Chemical Technology, 3rd Edition, East-West Press, New Delhi, 2008.

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



CM15512 BIOCHEMICAL ENGINEERING 3 0 0 3

COURSE OBJECTIVES

To enable students to

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

UNIT I INTRODUCTION 9

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

UNIT II KINETICS OF ENZYME ACTION 9

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

UNIT III KINETICS OF MICROBIAL GROWTH 9

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

UNIT IV TRANSPORT PHENOMENA 9

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

UNIT V DOWN STREAM PROCESSING 9

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

TOTAL PERIODS 45

COURSE OUTCOMES

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

- comprehend microbes and microbial kinetics and immobilization techniques
- understand enzymes and enzyme kinetics for application in batch and continuous process
- understand the sterilization and fermentation process
- apply theories of mass transfer to microbial systems
- gain knowledge of industrial bio reactors and downstream processing

TEXT BOOKS

1. .J.E.Bailey and D.F.Ollis, Biochemical engineering fundamentals 2nd ed, 1986, McGraw Hill.
2. Michael L. Shuler and Fikret Kargi, Bioprocess Engineering 2nd edition, Pearson education.
3. Aiba, S; Humphrey, A.E., Milli, N.R., Biochemical Engineering 2nd ed., Academic Press, 1973.

REFERENCES

1. Biochemical engineering by James M.Lee – Prentice-Hall-1992.
2. Bioprocess engineering principles, Pauline M. Doran, Academic Press.
3. Biochemical Engineering, H.W. Blanch and D.S. Clark, Marcel Dekker, 1997.

WEB LINKS

1. **www.elsevier.com/wps/find/journaldescription.../authorinstructions**
2. www.sciencedirect.com/science/journal/1369703X
3. www.britannica.com/EBchecked/topic/.../**biochemical-engineering**

CO/PO MAPPING:

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

CM15505 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	-	-	-	-	-	-	-	-	-	-	-	-	-	-

CM15506 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).

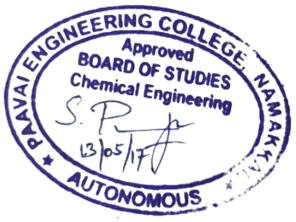
COURSE OUTCOMES

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



CM15601 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

CM15602 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

CM15603 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	-

CM15604 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

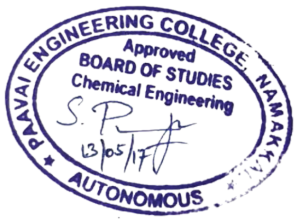
1. Narayanan, K.V. A Textbook of Chemical Engineering Thermodynamics Prentice Hall India, (2004).
2. Smith, J.M., Van Ness, H.C and Abbot M.M "Introduction to Chemical Engineering Thermodynamics ", McGraw Hill Publishers, VI edition, (2003).

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



CM15504 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

CM15611 INDUSTRIAL WASTE WATER TREATMENT 3 0 0 3

COURSE OBJECTIVES

To enable students to

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

UNIT I WASTE WATER TREATMENT AN OVERVIEW 9

Terminology – Regulations – Health and Environment Concerns in waste water management– Constituents in waste water inorganic– Organic and metallic constituents.

UNIT II PROCESS ANALYSIS AND SELECTION 9

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

UNIT III CHEMICAL UNIT PROCESSES 9

Role of unit processes in waste water treatment chemical coagulation – Chemical precipitation for improved

plant performance chemical oxidation –Neutralization – Chemical Storage.

UNIT IV BIOLOGICAL TREATMENT 9

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

UNIT V ADVANCED WASTE WATER TREATMENT 9

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

TOTAL PERIODS 45

COURSE OUTCOMES

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

- Define the quality parameters typically used to characterize wastewater and explain the different classes of treated wastewater.
- Describe various types of process units used for preliminary, primary and secondary treatment and explain how they achieve the target level of treatment.
- Recognize and discuss emerging technologies for advanced wastewater treatment and water recycling.
- Discuss water and wastewater treatment solid wastes management
- Propose a treatment system for a given wastewater to achieve a specified end use

TEXT BOOKS

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

REFERENCES

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

WEB LINKS

1. http:// www.nptel.ac.in
2. https://www.environmental-expert.com/books/keyword-industrial-wastewater-treatme...
3. https://www.elsevier.com Waste Management and Disposal › Industrial Waste

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	-	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

CM15607 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

CM15511 **FOOD TECHNOLOGY** **3 0 0 3**

COURSE OBJECTIVES

To enable students to

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

UNIT I AN OVERVIEW **9**

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

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

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

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

Preliminary processing methods; conversion and preservation operations.

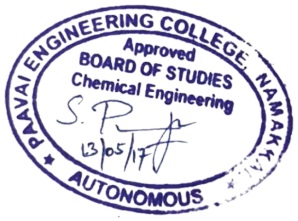
UNIT IV FOOD PRESERVATION METHODS **9**

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

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

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

TOTAL PERIODS 45



COURSE OUTCOMES

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

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

TEXT BOOKS

1. Jowitt R., ―Hygienic Design and Operation of Food Plant‖, AVI Pvt. Co., West Port, 1980.
2. Head man D.R. and Singh R.P., ―Food Processing Technology‖, AVI Pvt. Co., West Port, 1981.
3. Heid J.L. Joslyn M.A., Fundamentals of Food Processing Operation, The AVI publishing Co., West port 1967.

REFERENCES

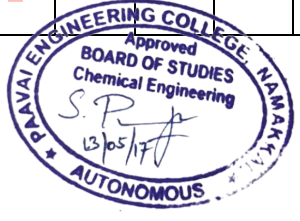
1. Brennan J., Butters G.J.R., Cowell, N.D. and AEV Lilly, ―Food Engineering Operations‖, 3rd Edition,
2. Applied Scientific Publishers, London, 1990.
3. Ronald H. Schmidt and Gary E. Rodrick, ―Food Safety Handbook‖, John Wiley and Sons, New Jersey, 2005.
4. Charm S.E., The Fundamentals of Foods Engineering,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

WEB LINKS

1. http://www.nzifst.org.nz/unitoperations/contents.htm
2. www.nal.usda.gov/fnic/pubs/bibs/gen/foodcomp.**pdf**
3. www.elsevier.com/wps/find/journaldescription.cws.../622910?...true

CO/PO MAPPING:

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



CM15513 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 uses and economics

UNIT II DRUG METABOLISM AND PHARMACO KINETICS 9

Drug metabolism; physico 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; packing techniques; qualitycontrol.

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, pHmetry.

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).
- ellaborate the concepts and mechanism behind the different types of separation techniques.

TEXT BOOKS

1. McCabe, W.L, Smith J.C and Harriot, P., "Unit Operations in Chemical Engineering", McGraw-Hill, Fourth Edition, 1984.
2. Rawlines, E.A.; " Bentleys Text book 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.

WEB LINKS

1. http:// www.nptel.ac.in
2. https://www.crcpress.com/Drugs-and-the-Pharmaceutical.../book.../IHCDRUPHASCI
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														
	Programme Outcome (POs)													
Cos	**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

CM15514 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 nanoscience,
- 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 nanomaterials currently in use or under investigation.
- understand the current and potential applications of these materials in the various areas of biomedicine, biotechnology, materials science, electronics, photonics, agriculture, energy production, enhanced catalysis

UNIT I INTRODUCTION 9

Nanoscale 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, Ultrasonication, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy,Atomic Layer Epitaxy, MOMBE.

UNIT III NANOMATERIALS 9

Nanoforms of Carbon - Buckminster fullerene- graphene 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- Nanometal oxides-ZnO, TiO2,MgO,ZrO2, NiO, nanoalumina, CaO, AgTiO2, Ferrites, Nanoclays 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 Nanoindentation.

UNIT V APPLICATIONS **9**

NanoInfoTech: Information storage- nanocomputer, molecular switch, super chip, nanocrystal, Nanobiotechlogy: nanoprobes in medical diagnostics and biotechnology, Nano medicines, Targetted drug delivery, Bioimaging –Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical Systems (NEMS)- Nanosensors,nano crystalline silver for bacterial inhibition, Nanoparticles for sunbarrier products - In Photostat, printing, solarcell, 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 apllications 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, “Nanoscale charecterisation 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.

WEB LINKS

1. www.nanoscience.com/applications/education/overview/
2. https://en.wikipedia.org/wiki/Nanotechnology
3. https://www.sciencelearn.org.nz/resources/1640-nanoscience-explained

CM15612 INDUSTRIAL INSTRUMENTATION 3 0 0 3

COURSE OBJECTIVES

To enable students to

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

UNIT I BASICS OF INSTRUMENTATION 9

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

UNIT II MEASUREMENT SYSYTEM 9

Process Variables Measurement–Temperature systems– Thermocouples, Thermo resistive system, Filled-system thermometers, Radiation thermometry, Location of temperature measuring devices in equipments, Pressure system – Mechanical pressure elements Pressure Transducers and Transmitters, Vacuum measurement, Resonant wire pressure Transducer, Flow system – Differential producers, Variable area flow meters, Velocity, vortex,mass, ultrasonic & other flow meters, positive displacement flow meters, Open – channel flow measurements, Force systems, Strain gauges Humidity Moisture system, Humidity Measurement, Moisture measurement system, Rheological system, Viscosity measurement, Radiation system, Nuclear radiation instrumentation.

UNIT III ANALYTICAL INSTRUMENTATION AND CHROMOTOGRAPHY 9

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

UNIT IV PROCES CONTROL 9

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

UNIT V FLOW CONTROL 9

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

TOTAL PERIODS 45

COURSE OUTCOMES

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

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

TEXT BOOKS

1. Fribance, "Industrial Instrumentation Fundamentals" ,Mc Graw Hill Co. Inc. New York 1985
2. Eckman D.P. "Industrial Instrumentation", Wiley Eastern Ltd., 1989.
3. Considine D M and Considine G D "Process Instruments Controls" Handbook 3rd Edition, McGraw – Hill Book Co., NY, 1990.

REFERENCES

1. Marlin, T. E., " Process Control ", 2nd Edn, McGraw Hill, New York, 2000.
2. Smith, C. A. and Corripio, A. B., "Principles and Practice of Automatic Process Control", 2nd Edn., John Wiley, New York, 1997
3. Jason L. Speyer,Walter H.Chung,"Stochastic Processes,Estimation, and Control",PHI Ltd (2013).

WEB LINKS

1. https://doc.lagout.org/.../Fundamentals%20of%20Industrial%20Instrumentation
2. https://www.nicet.org/default/assets/File/inst.pdf.

CO/PO MAPPING:

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

CM15613 FERMENTATION ENGINEERING 3 0 0 3

COURSE OBJECTIVES

To enable students to

- have a knowledge on microbes ,biomass and transformation process
- study the instruments involved in fermentation technology
- learn the microbial removal and different separation methods
- understand the different effluent treatment methods and disposal techniques
- have knowledge on different pretreatment techniques and cost optimization

UNIT I INTRODUCTION TO FERMENTATION PROCESSES 9

Microbial biomass – Microbial Enzymes – Microbial metabolites – Recombinant products – Transformation Process – Microbial growth binetus – Isolation and preservation and improvement of industrially important micro organism.

UNIT II INSTRUMENTATION AND CONTROL. 9

Measurement of process variables – Temperature and its control – Flow measurement and control – Gases and Liquids – Pressure measurement and control – Cenline analysis – Control System – Combination of Control Systems – Computer application in fermentation technology.

UNIT III RECOVERY AND PURIFICATION OF FERMENTATION PRODUCTS 9

Removal of Microbial cells – Foam Separation – Precipitation Filtration – Different Filtration process –extraction Centifugation – Different centrifuge cell description – Different methods – Solvent recovery – Superfluid – Chromatography – Membrane processes – Drying – Crystallization – Whole growth processing.

UNIT IV EFFLUENT TREATMENT 9

Strength of fermentation effluent – Treatment and disposal – Treatment Processes – Physical, chemical and biological – Aerobic process – Anareobic treatment.

UNIT V FERMENTATION ECONOMICS 9

Introduction – Isolation of micro organisms of industrial interest – Strain improvement – Market potential – Plant and equipment – Media – Air sterilization – Heating and cooling – Recovery costs.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- gain knowledge on microbial activities and digestion on biomass
- acquire knowledge on primary instruments and control system in fermentation industries
- understand and suggest different operations involving microbs
- know different treatment techniques in effluents using microorganisms
- inoculate on the economic balances with cost optimization and sterlization

TEXT BOOKS

1. Principles of fermentation Technology P.Stanbury Buttuworth Hanman – 1999.
2. Fermentation and Biochemical Engineering Handbook – C.C Haber. William Andrew II Edition 2007.

REFERENCES

1. Bioprocess Engineering Hydersen B.K Nancy A.dela K.L.Nelsen Wiley Interscience,1994.
2. Stanbury, P.E. and Whitaker, A., Principles of Fermentation Technology (1984), Pergamon Press.

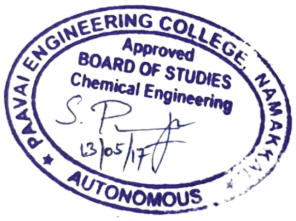
WEB LINKS

1.https://edurev.in/.../Fermentation...Notes.../e95a7ddc-d703-44d8-a637-a925200802c...

2. nptel.ac.in/courses/103107082/

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



CM15614 GREEN CHEMISTRY AND ENGINEERING 3 0 0 3

COURSE OBJECTIVES

To enable students to

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

UNIT I QUALITY ISSUES AND RISK ASSESMENT 9

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

UNIT II ENVIORNMENTAL EXPOSURE 9

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

UNIT III POLLUTION PREVENTION 9

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

UNIT IV PROCESS AND ESTIMATION INTEGRATION 9

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

UNIT V COST AND LIFE CYCLE ASSESMENT 9

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

TOTAL PERIODS 45

COURSE OUTCOMES

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

- Understand the issues in quality and risk assessment tools
- Suggest the environment friendly techniques to reduce effluents
- Acquire the knowledge in preventing pollution by following green chemistry principles
- Estimate the energy balance sheet and predict the future
- Assess the magnitude of product and optimize the cost

TEXT BOOKS

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

REFERENCES

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

WEB LINKS

1. http:// www.nptel.ac.in
2. https://www.slideshare.net/Santachem/green-chemistry-15990119
3. https://mospace.umsystem.edu/.../24/Principles%20of%20Green%20Chemistry.ppt?.

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	-	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