PAAVAI ENGINEERING COLLEGE, NAMAKKAL – 637 018

(AUTONOMOUS)

B.Tech. CHEMICAL ENGINEERING

REGULATIONS 2016

CURRICULUM

SEMESTER V

S.No	Category	Course Code	Course Title	L	T	P	C
Theory							
1	BS	MA16501	Numerical Methods	3	2	0	4
2	PC	CM16501	Mass Transfer I	3	0	0	3
3	PC	CM16502	Chemical Engineering Thermodynamics I	3	0	0	3
4	PC	CM16503	Chemical Process Industries I	3	0	0	3
5	PC	CM16504	Chemical Process Plant Safety	3	0	0	3
6	PE	CM165*	Professional Elective I	3	0	0	3
Practicals							
1	PC	CM16505	Technical Analysis Laboratory	0	0	4	2
2	PC	CM16506	Heat Transfer Laboratory	0	0	4	2
3	EE	EN16501	Career Guidance Laboratory - I	0	0	2	1
			Total				**25**

SEMESTER VI

S.No	Category	Course Code	Course Title	L	T	P	C
Theory							
1	PC	CM16601	Chemical Reaction Engineering	3	0	0	3
2	PC	CM16602	Chemical Process Industries II	3	0	0	3
3	PC	CM16603	Mass Transfer II	3	2	0	4
4	PC	CM16604	Chemical Engineering Thermodynamics II	3	2	0	4
5	PC	CM16605	Process Plant Utilities	3	0	0	3
6	OE	CM169*	Open Elective I	3	0	0	3
Practicals							
1	PC	CM16606	Mass Transfer Laboratory	0	0	4	2
2	PC	CM16607	Process Equipment Design I	0	0	4	2
3	EE	EN16601	Career Guidance Laboratory - II	0	0	2	1
			Total				**25**

LIST OF ELECTIVES

ELECTIVE I

S.No	Category	Course Code	Course Title	L	T	P	C
1	PE	CM16511	Biochemical Engineering	3	0	0	3
2	PE	CM16512	Drugs and Pharmaceutical Technology	3	0	0	3
3	PE	CM16513	Pulp and Paper Technology	3	0	0	3
4	PE	CM16514	Fundamentals of Nano science	3	0	0	3

ELECTIVE II

S.No	Category	Course Code	Course Title	L	T	P	C
1	PE	CM16611	Solid Waste Management	3	0	0	3
2	PE	CM16612	Industrial Wastewater Treatment	3	0	0	3

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

(EEE, Chemical, CSE)

COURSE OBJECTIVES

To enable students to

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

UNIT I SOLUTION OF EQUATIONS AND EIGEN VALUE PROBLEMS 15

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

UNIT II INTERPOLATION AND APPROXIMATION 15

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

UNIT III NUMERICAL DIFFERENTIATION AND INTEGRATION 15

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

UNIT IV INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS 15

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

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

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

TOTAL PERIODS 75

COURSE OUTCOMES

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

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

TEXT BOOKS

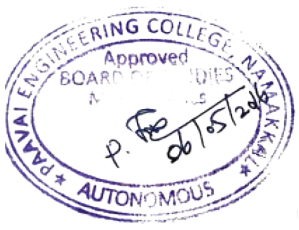
1. Erwin Kreyszig., "Advanced Engineering Mathematics" 10th edition, Wiley Publications, 2010.
2. T. Veerarajan. and T. Ramachandran, "Numerical Methods with programming in C", 2nd ed., Tata McGraw-Hill, 2006.

REFERENCES

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

CO/PO MAPPING

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



CM16501 MASS TRANSFER I 3 0 0 3

COURSE OBJECTIVES

To enable students to

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

UNIT I DIFFUSION 9

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

UNIT II INTERPHASE MASS TRANSFER 9

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

UNIT III HUMIDIFICATION 9

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

UNIT IV DRYING 9

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

UNIT V CRYSTALLIZATION 9

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

TOTAL PERIODS 45

COURSE OUTCOMES

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

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

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

TEXT BOOKS

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

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	-

CM16502 CHEMICAL ENGINEERING THERMODYNAMICS I 3 0 0 3

COURSE OBJECTIVES

To enable students to

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

UNIT I **9**

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

UNIT II **9**

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

UNIT III **9**

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

UNIT IV **9**

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

UNIT V **9**

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

TOTAL PERIODS 45

COURSE OUTCOMES

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

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

TEXT BOOKS

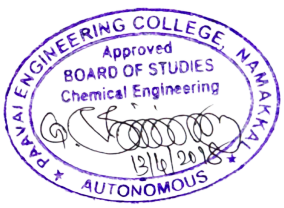
1. Smith, J.M., Van Ness, H.C and Abbot M.M "Introduction to Chemical Engineering Thermodynamics" McGraw Hill Publishers, VI edition, 2003
2. Narayanan, K.V. A Textbook of Chemical Engineering Thermodynamics Prentice Hall India, 2004

REFERENCES

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

CO/PO MAPPING

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



CM16503 CHEMICAL PROCESS INDUSTRIES I 3 0 0 3

COURSE OBJECTIVES

To enable students to

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

UNIT I INTRODUCTION AND CHLOR-ALKALI INDUSTRIES 9

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

UNIT II SULPHUR AND SULPHURIC ACID INDUSTRIES 9

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

UNIT III SILICATE INDUSTRIES 9

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

UNIT IV NITROGEN AND PHOSPORUS INDUSTRIES 9

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

UNIT V FERTILIZER INDUSTRIES 9

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

TOTAL PERIODS 45

COURSE OUTCOMES

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

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

TEXT BOOKS

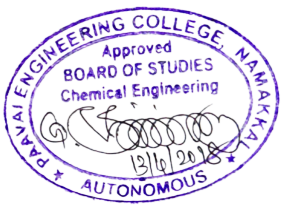
1. Austin G.T., ―Shreve's Chemical Process Industries‖, 5th Edition, McGraw-Hill International Book Company, Singapore, 2012.
2. Gopala Rao M. and Marshall Sittig, ― Dryden‘s Outlines of Chemical Technology, 3rd Edition, East-West Press, New Delhi, 2008.

REFERENCES

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

CO/PO MAPPING

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



CM16504 CHEMICAL PROCESS PLANT SAFETY 3 0 0 3

COURSE OBJECTIVES

To enable students to

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

UNIT I INTRODUCTION TO SAFETY PROGRAMMES 9

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

UNIT II PLANT HAZARDS 9

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

UNIT III INDUSTRIAL SAFETY 9

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

UNIT IV ACCIDENTS 9

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

UNIT V LEGAL ASPECTS 9

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

TOTAL PERIODS 45

COURSE OUTCOMES

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

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

TEXT BOOKS

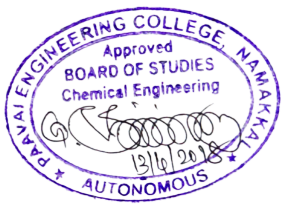
1. Fawcett H.H. and Wood W.S., ―Safety and Accident Prevention in Chemical Operation‖, 2nd Edition, Interscience, 1982.
2. D.B Dhone, Plant safety and maintenance, Nirali Prakashan Publication,1st edition, (2014).

REFERENCES

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

CO/PO MAPPING

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



CM16505 TECHNICAL ANALYSIS LABORATORY 0 0 4 2

COURSE OBJECTIVES

To enable students to

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

LIST OF EXPERIMENTS

I. Soap Analysis

a. Estimation of total fatty acid

b. Estimation of percentage alkali content

II. Oil Analysis

a. Estimation of free acid

b. Determination of Saponification value

c. Determination of iodine value

III. Cement Analysis

a. Estimation of Silica content

b. Estimation of mixed oxide content

c. Estimation of calcium oxide content

IV. Coal Analysis

a. Estimation of Sulphur present in coal

b. Ultimate analysis of coal

c. Proximate analysis of coal

V. Analysis of Bleaching Powder

a. Estimation of available chlorine

VI. Analysis of fuels

a. Flash point

b. Fire point

c. Cloud point

d. Pour point

e. Aniline point.

VI. Analysis of milk

a. Detection of adulterants in whole milk

TOTAL PERIODS 60

COURSE OUTCOMES

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

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

CO/PO MAPPING

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

CM16506 HEAT TRANSFER LABORATORY 0 0 4 2

COURSE OBJECTIVES

To enable students to

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

LIST OF EXPERIMENTS

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

TOTAL PERIODS 60

REFERENCES

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

COURSE OUTCOMES

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

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

CO/PO MAPPING

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

EN16501 CAREER GUIDANCE LABORATORY - I 0 0 2 1

COURSE OBJECTIVES

To enable students to

- help the students to understand their capabilities & enhance their Grooming and showcasing his/her Capabilities to a Prospective Employer provide Opportunity for the Students to become acquainted with Corporate Opportunities relevant to their Academic Learning
- enable students to articulate their thoughts on a given topic – in English and to make decent write ups in English on any given topic
- enable students prepare & score well in Aptitude tests conducted by Corporates/Prospective employers
- enable students to Prepare for any Group Discussion Evaluation or Presenting their credentials during a face-to-face interview leading to selection and employment
- help individuals become a knowledgeable person on the various evaluation processes leading to Employment.

UNIT I PERSONALITY DEVELOPMENT 1 06

Introduction – self explorations – character building – self-esteem- self-confidence- positive thinking - leadership qualities- time management.

UNIT II PERSONALITY DEVELOPMENT 2 06

Grooming- Role Play – Good Etiquettes - Extempore - Writing Skills: Email, Paragraph – Team Building- Body Language - Non Verbal Communication-Strategy – observer.

UNIT III QUANTITATIVE APTITUDE (QA) 1 06

Time , speed & distance -- simple interest & compound interest – percentage – height & distance – time & work – number systems – L.C.M & HCF – ratio proportion- area – directions.

UNIT IV LOGICAL REASONING (LR) 1 06

Analogies - letter & symbol series – number series – cause & effect – essential part – verbal reasoning.

UNIT V VERBAL REASONING (VR) 1 06

Blood relation – venn diagrams – analogy – character puzzles – logical sequence – classification – verification of truth – seating arrangement.

TOTAL PERIODS 30

COURSE OUTCOMES

- upon the completion of the course, students will be able to
- demonstrate Aptitude & Reasoning Skills
- enhance Verbal & Written Ability.
- improve his/her Grooming and Presentation Skills.
- interact effectively on any recent event/happenings/ current affairs.

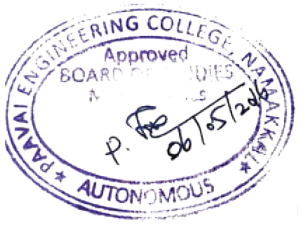
- be a knowledgeable person on the various evaluation processes leading to employment and face the same with Confidence.

REFERENCES

1. Agarwal, R.S, "A Modern Approach to Verbal & Non Verbal Reasoning", S.Chand & co ltd, NewDelhi.
2. Abhijit Guha, "Quantitative Aptitude", Tata-McGraw Hill.
3. Norman Lewis, "Word Power Made Easy", W.R. Goyal publications.
4. Johnson.D.W., Reaching Out – Interpersonal Effectiveness and Self-Actualization. Boston: Allyn and Bacon

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



CM16601 CHEMICAL REACTION ENGINEERING 3 2 0 4

COURSE OBJECTIVES

To enable students to

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

UNIT I ELEMENTS OF REACTION KINETICS 15

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

UNIT II IDEAL REACTORS 15

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

UNIT III DESIGN FOR SINGLE AND MULTIPLE REACTIONS 15

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

UNIT IV NON-IDEAL FLOW 15

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

UNIT V GAS-SOLID NON-CATALYTIC REACTORS 15

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

TOTAL PERIODS 75

COURSE OUTCOMES

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

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

TEXT BOOKS

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

REFERENCES

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

CO/PO MAPPING

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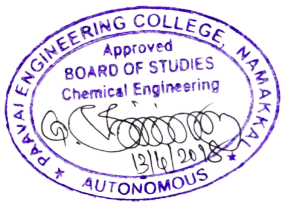
CO1	-	-	-	-	3	-	1	-	1	-	2	-	2	1
CO2	-	-	-	-	3	-	1	-	1	-	2	-	2	1
CO3	-	-	-	-	3	-	1	-	1	-	2	-	2	1
CO4	-	-	-	-	3	-	1	-	1	-	2	-	2	1
CO5	-	-	-	-	3	-	1	-	1	-	2	-	2	1



CM16602 CHEMICAL PROCESS INDUSTRIES II 3 0 0 3

COURSE OBJECTIVES

To enable students to

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

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

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

UNIT II OILS, FATS, INDUSTRIES 9

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

UNIT III PETROLEUM AND PETROCHEMICAL INDUSTRIES 9

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

UNIT IV RUBBER AND POLYMERS 9

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

UNIT V PAINT AND PIGMENTS 9

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

TOTAL PERIODS 45

COURSE OUTCOMES

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

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

TEXT BOOKS

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

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

REFERENCES

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

CO/PO MAPPING

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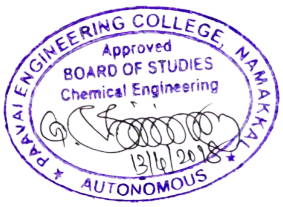
CO1	-	-	-	-	3	-	1	-	1	-	2	-	2	1
CO2	-	-	-	-	3	-	1	-	1	-	2	-	2	1
CO3	-	-	-	-	3	-	1	-	1	-	2	-	2	1
CO4	-	-	-	-	3	-	1	-	1	-	2	-	2	1
CO5	-	-	-	-	3	-	1	-	1	-	2	-	2	1



CM16603 MASS TRANSFER II 3 2 0 4

COURSE OBJECTIVES

To enable students to

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

UNIT I DISTILLATION 15

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

UNIT II CONTINOUS FRACTIONATION 15

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

UNIT III ABSORPTION 15

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

UNIT IV LEACHING AND EXTRACTION 15

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

UNIT V ADSORPTION 15

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

TOTAL PERIODS 75

COURSE OUTCOMES

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

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

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

TEXT BOOKS

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

REFERENCES

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

CO/PO MAPPING

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

CM16604 CHEMICAL ENGINEERING THERMODYNAMICS II 3 0 0 3

COURSE OBJECTIVES

To enable students to

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

UNIT I PROPERTIES OF SOLUTIONS 9

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

UNIT II PHASE EQUILIBRIA 9

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

UNIT III CORRELATION AND PREDICTION OF PHASE EQUILIBRIA 9

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

UNIT IV CHEMICAL REACTION EQUILIBRIA 9

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

UNIT V THERMODYNAMIC EQUILIBRIUM 9

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

TOTAL PERIODS 45

COURSE OUTCOMES

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

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

TEXT BOOKS

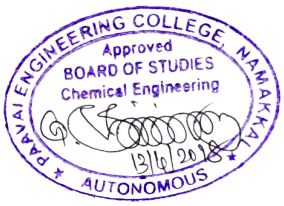
1. Narayanan, K.V. A Textbook of Chemical Engineering Thermodynamics Prentice Hall India, (2004).
2. Smith, J.M., Van Ness, H.C and Abbot M.M "Introduction to Chemical Engineering Thermodynamics ", McGraw Hill Publishers, VI edition, (2003).

REFERENCES

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

CO/PO MAPPING

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



CM16605 PROCESS PLANT UTILITIES 3 0 0 3

COURSE OBJECTIVES

To enable students to

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

UNIT I IMPORTANT OF UTILITIES 9

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

UNIT II STEAM AND STEAM GENERATION 9

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

UNIT III REFRIGERATION 9

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

UNIT IV COMPRESSED AIR 9

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

UNIT V FUEL AND WASTE DISPOSAL 9

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

TOTAL PERIODS 45

COURSE OUTCOMES

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

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

TEXT BOOKS

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

REFERENCES

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

CO/PO MAPPING

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

CM16606 MASS TRANSFER LABORATORY 0 0 4 2

COURSE OBJECTIVES

To train the students to

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

LIST OF EXPERIMENTS

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

TOTAL PERIODS 60

COURSE OUTCOMES

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

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

REFERENCES

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

CO/PO MAPPING

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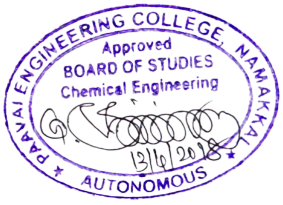
CO2	2	2	-	3	2	-	-	-	-	-	-	-	2	-
CO3	2	2	-	3	2	-	-	-	-	-	-	-	2	-
CO4	2	2	-	3	2	-	-	-	-	-	-	-	2	-



CM16607 PROCESS EQUIPMENT DESIGN I 0 0 4 2

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

COURSE OBJECTIVES

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

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

LIST OF EXPERIMENTS

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

TOTAL PERIODS 60

COURSE OUTCOMES

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

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

REFERENCES

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

CO/PO MAPPING

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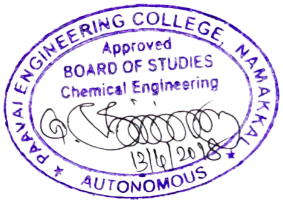


EN16601 CAREER GUIDANCE LABORATORY II 0 0 2 1

COURSE OBJECTIVES

To enable students to

- enhance career competency and employability skills
- demonstrate effective leadership and interpersonal skills
- improve professional capabilities through advanced study and researching current market strategy.
- develop problem solving and decision making capabilities

UNIT I CORPORATE READINESS 6

Business Communication – Inter and Intrapersonal skills – Business Etiquettes – Corporate ethics – Communication media Etiquette.

UNIT II INTERVIEW SKILLS 6

Resume building – Group discussions – Presentation skills – Entrepreneur skills – Psychometric assessment – Mock interview.

UNIT III QUANTITATIVE APTITUDE (QA) 2 6

Profit and Loss – Clock – Power and Square roots – Train – Boats and streams – Probability – Calendars – Permutations and Combinations - Partnership – Simplification – Pipes and Cisterns – Puzzles.

UNIT IV LOGICAL REASONING (LR) 2 6

Statements and Assumptions – Matching Definitions – Logical Games – Making judgments – Statements and conclusions – Verbal classifications.

UNIT V VERBAL REASONING (VR) 2 6

Syllogisms – Data sufficiency – Dice – Series completion – Character puzzles – cube and cuboids – Arithmetic Reasoning.

TOTAL PERIODS 30

COURSE OUTCOMES

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

- develop team work capabilities
- boost their problem solving skills
- enhance the transformation from college to corporate.
- be a knowledgeable person on the various evaluation processes leading to employment and face the same with Confidence.

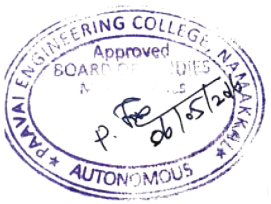
REFERENCES

1. Agarwal, R.S, “A Modern Approach to Verbal & Non Verbal Reasoning”, S.Chand & co ltd, NewDelhi.
2. Abhijit Guha, “Quantitative Aptitude”, Tata-McGraw Hill.
3. Norman Lewis, “Word Power Made Easy”, W.R. Goyal publications.
4. Johnson.D.W., Reaching Out – Interpersonal Effectiveness and Self-Actualization. Boston:

Allyn and Bacon

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



CM16511 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 kinetics.
- acquire the knowledge on cellular growth structure and their kinetics.
- know the techniques in gas-liquid mass transfer and their power requirements.
- familiarize about the membrane separation and purification methods.

UNIT I INTRODUCTION 9

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

UNIT II KINETICS OF ENZYME ACTION 9

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

UNIT III KINETICS OF MICROBIAL GROWTH 9

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

UNIT IV TRANSPORT PHENOMENA 9

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

UNIT V DOWN STREAM PROCESSING 9

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

TOTAL PERIODS 45

COURSE OUTCOMES

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

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

- sketch the steps in purification methods.

TEXT BOOKS

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

REFERENCES

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

CO/PO MAPPING

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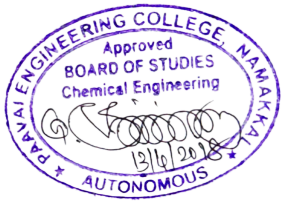
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1	-	2	-	3	1	-	-	-	-	2	-	2	1
CO2	1	-	2	-	3	1	-	-	-	-	2	-	2	1
CO3	1	-	2	-	3	1	-	-	-	-	2	-	2	1
CO4	1	-	2	-	3	1	-	-	-	-	2	-	2	1
CO5	1	-	2	-	3	1	-	-	-	-	2	-	2	1



CM16512 DRUGS AND PHARMACEUTICAL TECHNOLOGY 3 0 0 3

COURSE OBJECTIVES

To enable students to

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

UNIT I INTRODUCTION 9

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

UNIT II DRUG METABOLISM AND PHARMACO KINETICS 9

Drug metabolism; physic chemical principles; Pharma kinetics-action of drugs on human bodies. Antibiotics- gram positive, gram negative and broad-spectrum antibiotics; hormones

UNIT III IMPORTANT UNIT PROCESSES AND THEIR APPLICATION 9

Chemical conversion processes; alkylation; carboxylation; condensation and cyclisation; dehydration, Esterification, halogenation, oxidation, sulfonation; complex chemical conversions fermentation.

UNIT IV MANUFACTURING PRINCIPLES & PACKING AND QUALITY CONTROL 9

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

UNIT V PHARMACEUTICAL PRODUCTS & PHARMACEUTICAL ANALYSIS 9

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

TOTAL PERIODS 45

COURSE OUTCOMES

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

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

TEXT BOOKS

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

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

REFERENCES

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

CO/PO MAPPING

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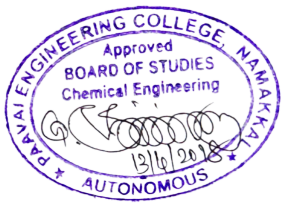
CO1	1	-	2	-	3	1	-	-	-	-	2	-	2	1
CO2	1	-	2	-	3	1	-	-	-	-	2	-	2	1
CO3	1	-	2	-	3	1	-	-	-	-	2	-	2	1
CO4	1	-	2	-	3	1	-	-	-	-	2	-	2	1
CO5	1	-	2	-	3	1	-	-	-	-	2	-	2	1



CM16513 PULP AND PAPER TECHNOLOGY 3 0 0 3

COURSE OBJECTIVES

To enable the students to

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

UNIT I INTRODUCTION 9

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

UNIT II WOODYARD OPERATION 9

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

UNIT III PAPER MACHINE 9

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

UNIT IV PAPER AND PAPERBOARD 9

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

UNIT V PROPERTIES AND TESTING OF PULP AND PAPER 9

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

TOTAL PERIODS 45

COURSE OUTCOMES

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

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

TEXT BOOKS

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

REFERENCES

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

CO/PO MAPPING

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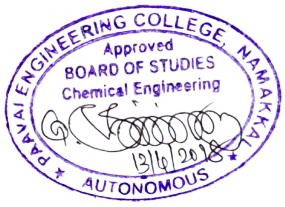

CM16514 FUNDAMENTALS OF NANOSCIENCE 3 0 0 3

COURSE OBJECTIVES

To enable students to

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

UNIT I INTRODUCTION 9

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

UNIT II GENERAL METHODS OF PREPARATION 9

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

UNIT III NANOMATERIALS 9

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

UNIT IV CHARACTERIZATION TECHNIQUES 9

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

UNIT V APPLICATIONS 9

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

TOTAL PERIODS 45

COURSE OUTCOMES

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

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

TEXT BOOKS

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

REFERENCES

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

CO/PO MAPPING

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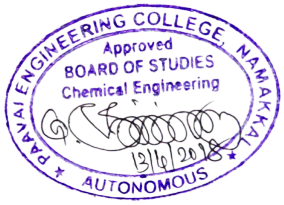
CO4	3	-	2	-	3	1	-	-	-	-	2	-	2	2
CO5	3	-	2	-	3	1	-	-	-	-	2	-	2	2



CM16901 SOLID WASTE MANAGEMENT 3 0 0 3

COURSE OBJECTIVES

To enable students to

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

UNIT I SOURCES AND TYPES **9**

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

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

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

UNIT III COLLECTION AND TRANSFER **9**

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

UNIT IV OFF-SITE PROCESSING **9**

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

UNIT V DISPOSAL **9**

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

TOTAL PERIODS 45

COURSE OUTCOMES

Upon completing the course

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

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

TEXTBOOKS

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

REFERENCES

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

CO/PO MAPPING

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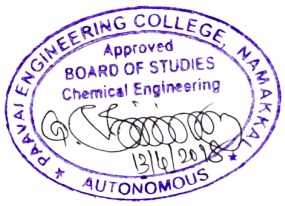
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	-	-	-	-	-	2	1	1	-	-	-	-	-	-
CO2	-	-	-	-	-	2	1	1	-	-	-	-	-	-
CO3	-	-	-	-	-	2	1	1	-	-	-	-	-	-
CO4	-	-	-	-	-	2	1	1	-	-	-	-	-	-
CO5	-	-	-	-	-	2	1	1	-	-	-	-	-	-



CM16902 INDUSTRIAL WASTEWATER 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 WASTEWATER TREATMENT AN OVERVIEW 9

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

UNIT II PROCESS ANALYSIS AND SELECTION 9

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

UNIT III CHEMICAL UNIT PROCESSES 9

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

UNIT IV BIOLOGICAL TREATMENT 9

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

UNIT V ADVANCED WASTEWATER TREATMENT 9

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

TOTAL PERIODS 45

COURSE OUTCOMES

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

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

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

TEXT BOOKS

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

REFERENCES

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

CO/PO MAPPING

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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