PAAVAI ENGINEERING COLLEGE, NAMAKKAL – 637 018

(AUTONOMOUS)

B.Tech. CHEMICAL ENGINEERING

REGULATIONS 2015

CURRICULUM

SEMESTER V

COURSE CODE	COURSE TITLE	L	T	P	C
MA15501	Numerical Methods	3	2	0	4
CM15501	Instrumental Method of Analysis	3	0	0	3
CM15502	Mass Transfer I	3	0	0	3
CM15503	Chemical Engineering Thermodynamics II	3	2	0	4
CM15504	Chemical Process Industries I	3	0	0	3
CM1515*	Elective I	3	0	0	3
CM15506	Technical Analysis Laboratory	0	0	4	2
CM15507	Heat Transfer Laboratory	0	0	4	2
EN15501	Career Development Laboratory I	0	0	2	1

SEMESTER VI

COURSE CODE	COURSE TITLE	L	T	P	C
CM15601	Chemical Reaction Engineering	3	2	0	4
CM15602	Chemical Process Industries II	3	0	0	3
CM15603	Mass Transfer II	3	2	0	4
CM15604	Process Economics and Management	3	0	0	3
CM15605	Chemical Process Plant Safety	3	0	0	3
CM1525*	Elective II	3	0	0	3
CM15606	Chemical Reaction Engineering Laboratory	0	0	4	2
CM15607	Chemical Process Equipment Design I	0	0	4	2
EN15601	Career Development Laboratory II	0	0	2	1

LIST OF ELECTIVES

ELECTIVE I

COURSE CODE	COURSE TITLE	L	T	P	C
CM15151	Food Technology	3	0	0	3
CM15152	Biochemical Engineering	3	0	0	3
CM15153	Drugs and Pharmaceutical Technology	3	0	0	3
CM15154	Fundamentals of Nano science	3	0	0	3

ELECTIVE II

COURSE CODE	COURSE TITLE	L	T	P	C
CM15251	Industrial Wastewater Treatment	3	0	0	3
CM15252	Industrial Instrumentation	3	0	0	3
CM15253	Fermentation Engineering	3	0	0	3
CM15254	Green Chemistry and Engineering	3	0	0	3

SEMESTER V

MA15501 **NUMERICAL METHODS** **3 2 0 4**

(COMMON TO CSE,EEE & CHE)

COURSE OBJECTIVES

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

UNIT I SOLUTION OF EQUATIONS AND EIGEN VALUE PROBLEMS 15

Solution of equation –Iteration method : Newton Raphson method – Solution of linear system by Gaussianelimination and Gauss - Jordon method – Iterative method – Gauss-Seidel method – Inverse of a matrix by Gauss Jordon method – Eigenvalue 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

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

- comprehend the basics of linear equations.
- apply the interpolation methods for constructing approximate polynomials
- demonstrate the knowledge of numerical differential equations in computational and simulation process
- utilize the concept of initial value problems in the field of science and engineering
- describe the computational procedure of the amount of heat emitted or transferred from an object

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.
3. Sankar Rao K " Numerical Methods For Scientisits And Engineers –3rd Edition Princtice Hall of India Private, New Delhi, 2007.

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.

WEB LINKS

1. https://www.youtube.com/watch?v=QTQ8bO1F-Dg
2. https://www.youtube.com/watch?v=AT7Olelic8U
3. https://www.youtube.com/watch?v=TH06N7Q7FJw
4. https://www.youtube.com/watch?v=DnBJLpdVHCY
5. https://www.youtube.com/watch?v=5TccPEz2nB8

CM15501 INSTRUMENTAL METHODS OF ANALYSIS 3 0 0 3

COURSE OBJECTIVES

- To discriminate between different radiation frequencies through the use of filters and prisms.
- To measure the concentration of a solute in a solution using Beer's law.
- To identify the atomic configurations in molecules
- To study the chromatographic behavior and HPLC of solutes.
- To 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- NMRspectrometers – 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 9

Electrochemical cells- Electrode potential cell potentials – potentiometryreference electrode – ion selective and molecular selective electrodes – Instrument for potentiometric studies – Voltametry – Cyclic and pulse voltametry- Applications of voltametry .

TOTAL PERIODS 45

COURSE OUTCOMES

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

- know the role of analytical instrumentation in the production and evaluation of new products.
- interpret ate 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. Gurdeep R Chatwal Sham K Anand, “Instrumental Methods Of Chemical Analysis”, 1 st edition, Himalaya publishing house (2015).
2. Willard “Instrumental Methods of Analysis” 7edition edition ,CBS Publishers & Distributors (2004).

REFERENCES

1. D.A.Skoog, F. J. Holler, Stanky, R.Crouch,” Instrumental Methods of Analysis” Cengage Learning (2007).
2. H.Kumar, “Instrumental Methods of Chemical Analysis”PragatiPrakashan; Latest Edition edition (2016)

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

CM15502 **MASS TRANSFER I** **3 0 0 3**

COURSE OBJECTIVES

- To know the mechanism of molecular diffusion of gases and liquids
- To understand the mass transfer between two insoluble phases
- To familiar with interface simultaneous transfer of mass and energy
- To express equilibrium moisture content of a substance and drying methods.
- To 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

At the end of this 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 oftransfer 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 equipment.
- find the yield and purity of the commercial crystallization.

TEXT BOOKS

1. Anantharaman N. and MeeraSheriffa 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.

WEB LINKS

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

CM15503 CHEMICAL ENGINEERING THERMODYNAMICS II 3 2 0 4

COURSE OBJECTIVES

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

UNIT I PROPERTIES OF SOLUTIONS 15

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

UNIT II PHASE EQUILIBRIA 15

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, azeotropes.

UNIT III CORRELATION AND PREDICTION OF PHASE EQUILIBRIA 15

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 15

Chemical Reaction Equilibria: Criteria of equilibrium; standard free energy change and reactionequilibrium constant; effect of temperature and pressure on reaction equilibrium constant; homogeneous chemical reactions - thermodynamic analysis and prediction of equilibrium, Compositions.

UNIT V REFRIGERATION 15

Principles of refrigeration, methods of producing refrigeration, liquefaction process, co-efficient of performance, evaluation of the performance of vapor compression and Absorption cycles.

TOTAL PERIODS 75

COURSE OUTCOMES

At the end of this 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., (1999).
2. Rao, Y.V.C., "Chemical Engineering Thermodynamics" Universities Press, (2005).
3. GopinathHalder," Introduction to Chemical Engineering Thermodynamics", PHI Learning Ltd (2009).
4. K.A. Gavhane, "Chemical Engineering Thermodynamics II", NiraliPrakashan, (2010).

WEB LINKS

1. https://www.khanacademy.org/science/chemistry/thermodynamics-chemistry.
2. http://web.mit.edu/16.unified/www/FALL/thermodynamics/notes/node5.html.
3. http://www.nptelvideos.in/2012/12/basic-thermodynamics.html.

CM15504 CHEMICAL PROCESS INDUSTRIES I 3 0 0 3

COURSE OBJECTIVES

- To comprehend the unit operations/ processes in chloro alkali industries
- To understand the practical methods of production sulphur and its byproducts in a chemicalfactory.
- To know the various operations involved in cements and glass manufacture
- To have knowledge on Industrial manufacture of ammonia and nitrogen
- To gain knowledge on nitrogen industriesin 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 sodiumbicarbonate,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 trioxidesodium sulphate, sodiumthiosulphate.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

At the end of this 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. GopalaRao M. and Marshall Sittig, ― Dryden‘s Outlines of Chemical Technology‖, 3rd Edition, East-West Press, New Delhi, 2008.

REFERENCES

1. SrikumarKoyikkal,"Chemical Process Technology and Simulation",PHILearning Ltd (2013).
2. W.V. Mark & S.C. Bhatia, "Chemical process Industries Volume I" CBS Publishers & Distributors limited.
3. W Smith, R Chapman, "Chemical Process Industries : Inorganic Chemicals and Allied Industries Volume 1", CBS Publishers & Distributors limited.

WEB LINKS

1. https://www.youtube.com/watch?v=RjZJjneJ5fk
2. http://nptel.ac.in/courses/103107081/
3. http://nptel.ac.in/courses/103106108/21

CM15506 TECHNICAL ANALYSIS LABORATORY 0 0 4 2

COURSE OBJECTIVES

- To enable the students to estimate the chemical contents present in the given sample and their separation methods.

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

d. Estimation of calcium oxide by rapid method

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.

TOTAL PERIODS 60

COURSE OUTCOMES

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

- have a thorough understanding on the estimation and analysis of chemical compounds.

CM15507 **HEAT TRANSFER LABORATORY** **0 0 4 2**

COURSE OBJECTIVES

- To acquire fundamental and industrial knowledge about modes of heat transfer, like conduction, convection andradiation, and their application.

LIST OF EXPERIMENTS

1. Composite wall
2. Natural and Forced Convection
3. Stefan Boltzman 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

COURSE OUTCOMES

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

- calculate overall heat transfer co-efficient in different modes of heat transfer operations.

EN15501 CAREER DEVELOPMENT LABORATORY I 0 0 2 1

COURSE OBJECTIVES

- To help the students to understand their capabilities and enhance their grooming and showcasing his/her capabilities to a prospective employer.
- To provide opportunity for the students to become acquainted with corporate opportunities relevant to their academic learning
- To enable students to articulate their thoughts on a given topic – in english and also to make decent write ups in English on any given topic
- To enable students prepare and score well in Aptitude tests conducted by corporates/prospective employers
- To enable students to prepare for any group discussion evaluation or presenting their credentials during a face-to-face interview leading to selection and employment
- To help individuals become a knowledgeable person on the various evaluation processes leading to Employment.

UNIT I PERSONALITY DEVELOPMENT 1 6

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

UNIT II PERSONALITY DEVELOPMENT 2 6

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

UNIT III QUANTITATIVE APTITUDE (QA) 1 6

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

UNIT IV LOGICAL REASONING (LR) 1 6

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

UNIT V VERBAL REASONING (VR) 1 6

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

TOTAL PERIODS 30

COURSE OUTCOMES

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

- demonstrate aptitude and reasoning skills
- enhance verbal and 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. AbhijitGuha, "Quantitative Aptitude ", tata-mcgraw hill.
3. word power made easy by normanlewis ,wr.goyal publications.
4. Johnson, d.w. reaching out – interpersonal effectiveness and self-actualization. boston: allyn and bacon

SEMESTER VI

CM15601 CHEMICAL REACTION ENGINEERING 3 2 0 4

COURSE OBJECTIVES

- To understand the principles and analysis the rate equation for reactors.
- To have knowledge about various reactors and their performance equation.
- To evaluate selectivity and yield for parallel and mixed reactions.
- To have sound knowledge on RTD and various types of models.
- To have knowledge on 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 INTRODUCTION TO HETEROGENEOUS REACTIONS 15

Catalysts- types, preparation and deactivation; Industrial reactors-fixed, fluidized, trickle bed and air lift reactors.

TOTAL PERIODS 75

COURSE OUTCOMES

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

- apply the principles of reaction kinetics and formulate rate equations and analyse 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 particular 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. K.A. Gavhane, Chemical Reaction Engineering I & II", NiraliPrakashan Publication, (2015).
2. Levenspiel O., ―Chemical Reaction Engineering‖, 4th Edition, Wiley India Pvt. Ltd., New Delhi, (2009).

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).

WEBLINKS

1. http://www.nptel.ac.in

CM15602 **CHEMICAL PROCESS INDUSTRIES II** **3 0 0 3**

COURSE OBJECTIVES

- To attain knowledge on advances and challenges in paper and pulp industries.
- To know the various operations involved in extraction of oil and manufacture of soap/detergents.
- To identify the types of petroleum and its processing methods.
- To classify the types and methods by which elastomers and polymers are made.
- To 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-Oil, fats and their extraction methods-Hydrogenation of oils- Soaps and detergents.

UNIT II OILS, FATS, SOAPS AND DETERGENT INDUSTRIES 9

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

UNIT III PETROLEUM AND PETROCHEMICAL INDUSTRIES 9

Petroleum refining-Physical and chemical conversion products- lubricating oils,petrochemical precursors, methane, olefines, 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 ALCOHOL AND PAINT 9

Raw material and production of ethyl alcohol by corn and molasses, acetic acid from acetaldehyde, butanol by Oxo process, Properties of paint and their functions – manufacture – pigments, varnishes, lacquers.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this 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. GopalaRao M. and Marshall Sittig, ― Dryden‘s Outlines of Chemical Technology‖, 3rd Edition, East-West Press, New Delhi, 2008.

REFERENCES

1. SrikumarKoyikkal,"Chemical Process Technology and Simulation",PHILearning Ltd (2013).
2. W.V. Mark & S.C. Bhatia, "Chemical process Industries Volume I" CBS Publishers & Distributors limited.
3. W Smith, R Chapman, "Chemical Process Industries : Inorganic Chemicals and Allied Industries Volume 1", CBS Publishers & Distributors limited.

WEB LINKS

1. https://www.youtube.com/watch?v=npJ1N-1K84E
2. http://nptel.ac.in/courses/103103029/

CM15603 **MASS TRANSFER II** **3 2 0 4**

COURSE OBJECTIVES

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

UNIT I 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 II DISTILLATION **15**

Vapour-liquid equilibria, Raoult's law. Methods of distillation: simple distillation - calculations using Rayleigh equation, Flash vaporization, 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 EXTRACTION **15**

Equilibrium in ternary systems; 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 IV LEACHING **15**

Solid-liquid equilibria; calculations in single stage, multi stage cross flow and counter current leaching, Leaching Equipment - batch and continuous - Bollman, Rotocel 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

At the end of this 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. N. Anantharaman, K.M. MeeraSheriffaBaegum, " Mass Transfer Theory and practice" Printice Hall of India.
2. Treybal Robert E., ―Mass Transfer Operations‖, 3rd Edition, McGraw-Hill Book Company Ltd., 1980.

REFERENCES

1. K.A. Gavhane, "Mass Transfer II" NiraliPrakashan Publication, (2016).
2. Geankopolis C.J., ―Transport Processes and Separation Process Principles‖, 4th Edition, Prentice Hall of India, 2004.
3. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 7thEdn., McGraw-Hill, 2005.

WEB LINKS

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

CM15604 PROCESS ECONOMICS AND MANAGEMENT 3 0 0 3

COURSE OBJECTIVES

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

UNIT I PRINCIPLES OF MANAGEMENT AND ORGANISATION 9

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

UNIT II INVESTMENT COSTS AND COST ESTIMATION 9

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

UNIT III PROFITABILITY, INVESTMENT ALTERNATIVE ANDREPLACEMENT 9

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

UNIT IV ANNUAL REPORTS AND ANALYSIS OF PERFORMANCE 9

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

UNIT V ECONOMIC BALANCE 9

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

TOTAL PERIODS 45

COURSE OUTCOMES

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

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

TEXT BOOKS

1. Peters, M. S. and Timmerhaus, C. D. RE West , “Plant Design andEconomics for Chemical Engineers”, III Edn, McGraw Hill, 2003.
2. Holand, F.A., Watson, F.A. and Wilkinson, J.K., "Introduction to ProcessEconomics", 2nd Edn, John Wiley, (1983)

REFERENCES

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

WEB LINKS

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

CM15605 CHEMICAL PROCESS PLANT SAFETY AND HAZARD ANALYSIS 3 0 0 3

COURSE OBJECTIVES

- To have the awareness of safety codes and safety programmes.
- To identify and prevent the hazards and safe handling of materials.
- To design a plant with necessary safety measures.
- To maintain the chemical process without complete breakdown of plant and loss of life.
- To 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, Fault tree, 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 equipments;

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 free 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

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

- use Personal Protective Equipment’s for a particular hazardous environment.
- identify and protect the effect of occupational health hazards .
- commission of the plant and to ensure the safety procedures.
- 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,NiraliPrakashan 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).

WEB LINKS

1. http:// www.nptel.ac.in
2. http://www.msubbu.in/sp/mo/
3. https://www.slideshare.net/AnitaSharma7/industrial-safety-15679444

CM15606 CHEMICAL REACTION ENGINEERING LABORATORY 0 0 4 2

COURSE OBJECTIVES

- To impart knowledge on design of reactors.

LIST OF EXPERIMENTS

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

TOTAL PERIODS 60

COURSE OUTCOMES

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

- calculate overall efficiency and conversion rate in different types reactors.

CM15607 CHEMICAL PROCESS EQUIPMENT DESIGN I 0 0 4 2

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

COURSE OBJECTIVES

- To develop skill to design and install process equipments used widely in thechemical industry.

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 Thickner
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

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

- have skill to design and installprocess equipments used widely in a chemical industry.

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 IndiaLtd.
3. S.D.Dawande, "Process Design of Equipments", Central Techno Publications, Nagpur, 2000.
4. R.H. Perry, "Chemical Engineers' Handbook", McGraw-Hill.
5. W.L.McCabe, J.C.Smith and Harriet, "Unit Operation of Chemical Engineering", McGraw-Hill.
6. Robert Treybal, "Mass Transfer Operations", McGraw-Hill.
7. J.M. Coulson and J.Richardson, "Chemical Engineering", vol. 6, Asian Books Printers Ltd.

EN15601 CAREER DEVELOPMENT LABORATORY II 0 0 2 1

COURSE OBJECTIVES

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

UNIT I CORPORATE READINESS 6

Business Communication – Inter and Intra Personal 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.

REFERENCES

1. Agarwal, r.s.” a modern approach to verbal & non verbal reasoning”, , S.Chand & co ltd, New Delhi.
2. Abhijit guha, “quantitative aptitude for competitive examinations “, Tata Mcgraw hill
3. Word power made easy by norman lewis ,wr.goyal publications.
4. Johnson, d.w. (1997). Reaching out – interpersonal effectiveness and self Actualization -- Boston: Allyn and bacon.
5. Infosys Campus Connect Program – students’ guide for soft skills.
6. Mitra ,barun.k, “ Personalaity Development & Softskills “ , Oxford University.

ELECTIVE I

CM15151 FOOD TECHNOLOGY 3 0 0 3

COURSE OBJECTIVES

- To acquire knowledge on general aspects on food industry and their needs.
- To categories the quality and nutritive aspects of food.
- To point out the processing methods and their preservation.
- To familiarize the food preservation methods.
- To 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 their Control.

UNIT III GENERAL ENGINEERING ASPECTS AND PROCESSING METHODS 9

Preliminary processing methods; conversion and preservation operations.

UNIT IV FOOD PRESERVATION METHODS 9

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

UNIT V PRODUCTION AND UTILISATION OF FOOD PRODUCTS 9

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

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this 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, Applied Scientific Publishers, London, 1990.

2. Ronald H. Schmidt and Gary E. Rodrick, ―Food Safety Handbook‖, John Wiley and Sons, New Jersey, 2005.
3. Charm S.E., The Fundamentals of Foods Engineering, The AVI Publishing Co., Westport,1963

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

CM15152 BIOCHEMICAL ENGINEERING 3 0 0 3

COURSE OBJECTIVES

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

At the end of this 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 2nded,1986, McGraw Hill.
2. Michael L. Shuler and FikretKargi, 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

CM15153 DRUGS AND PHARMACEUTICAL TECHNOLOGY 3 0 0 3

COURSE OBJECTIVES

- To understand the legal requirements of product development and manufacturing.
- To understand the ethical responsibility involved in industrialization of pharmaceutical products.
- To understand the chemical and biochemical process.
- To design of tablets and formulations for coating pills and capsules in various drying process.
- To 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; 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, pHmetry.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this 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. 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, BailliereTindall, 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

CM15154 FUNDAMENTALS OF NANOSCIENCE 3 0 0 3

COURSE OBJECTIVES

- To familiar with the history associated with the development of the field of nanoscience,
- To familiar with the key technological advances which facilitated the advancement of the field.
- To understand the underlying reasons for the unique properties associated with nanomaterial.
- To familiar with the instrumentation and technologies currently utilized to manipulate and fabricate a variety of nanomaterials currently in use or under investigation.
- To 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, Nanoclaysfunctionalization 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, solar cell, battery.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this 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 andPhiladelphia, 1996.
2. N John Dinardo, "Nanoscalecharecterisation of surfaces & Interfaces", 2nd edition, Weinheim Cambridge, Wiley-VCH, 2000.

REFERENCES

1. G Timp (Editor), "Nanotechnology", AIP press/Springer, 1999.
2. AkhleshLakhtakia (Editor),"The Hand Book of NanoTechnology,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

ELECTIVE II

CM15251 INDUSTRIAL WASTE WATER TREATMENT 3 0 0 3

COURSE OBJECTIVES

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

UNIT I WASTE WATER TREATMENT AN OVERVIEW 9

Terminology – Regulatios – Health and Environment Concerns in wastewater management– Constituents in waste water inorganic– Organic andmetallic constituents.

UNIT II PROCESS ANALYSIS AND SELECTION 9

Components of waste water flows – Analysis of Data – Reactors used in wastewater treatment– Mass Balance Analysis – Modeling of ideal and non ideal flowin 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 andenergatus – Aerobic biological oxidation – Anaerobic fermentation and oxidation– Trickling filters – Rotating biological contractors – Combined aerobicprocesses – Activated sludge film packing.

UNIT V ADVANCED WASTE WATER TREATMENT 9

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

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this 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: McGraw Hill, G.Tchobanoglous, FI Biston, 2002.
2. Industrial Waste Water Management Treatment and Disposal by WasteWater McGraw Hill III Edition 2008.

REFERENCES

1. Eckenfelder, W. W, Jr. "Industrial Water Pollution Control" McGraw-Hill: NewYork, 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

CM15252 INDUSTRIAL INSTRUMENTATION 3 0 0 3

COURSE OBJECTIVES

- To understand the purpose of instrumentation in Industrial processes.
- To learn the working of different types of temperature measuring instruments like RTD, Thermistor, and thermocouple.
- To have a sound knowledge about analytical instrument and chromatography.
- To have an idea about the fundamental of process control and programmable controllers.
- To 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, Measurementterms – 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 forprocess 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-Automaticcontrollers – Electronic controllers - Electric controllers (Traditional) – Hydraulic controllers – Fluidics - Programmable controllers.

UNIT V FLOW CONTROL 9

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

TOTAL PERIODS 45

COURSE OUTCOMES

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

- explain the purpose of instrumentation in industrial processes
- know the working of different types of temperature measuring instruments like RTD, Thermistor, and
- thermocouple.
- apply the knowledge on chromatography techniques.
- explain the types and fundamentals of controllers.

- know the various flow and level measurement devices used for industrial purposes.

TEXT BOOKS

1. Fribance, “Industrial Instrumentation Fundamentals” ,McGraw Hill Co. Inc.New York 1985
2. 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 AutomaticProcess Control”, 2nd Edn., JohnWiley, New York, 1997
3. Jason L. Speyer,WalterH.Chung,”StochasticProcesses,Estimation, andControl”,PHI Ltd (2013).

WEB LINKS

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

CM15253 **FERMENTATION ENGINEERING** **3 0 0 3**

COURSE OBJECTIVES

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

UNIT I INTRODUCTION TO FERMENTATION PROCESSES 9

Microbial biomass – Microbial Enzymes – Microbial metabolites – Recombinantproducts – 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 – Flowmeasurement 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 FERMENTATIONPRODUCTS 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 – TreatmentProcesses – Physical, chemical and biological – Aerobic process – Anareobic treatment.

UNIT V FERMENTATION ECONOMICS 9

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

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this 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 microbes
- know different treatment techniques in effluents using microorganisms
- inculcate on the economic balances with cost optimization and sterlization

TEXT BOOKS

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

REFERENCES

1. Bioprocess Engineering Hydersen B.K Nancy A.delaK.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/

CM15254 GREEN CHEMISTRY AND ENGINEERING 3 0 0 3

COURSE OBJECTIVES

- To identify the grand challenges of green chemistry and consider what it will take to resolve them.
- To explain the meaning and importance of low dose adverse chemical effects and endocrine disruptors, which present major environmental and health threats.
- To 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. EnvironmentalPersistence. 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.-PollutionPrevention in Storage Tanks.

UNIT IV PROCESS AND ESTIMATION INTEGRATION 9

Process Energy Integration. Process Mass Integration. Case Study of aProcess Flow sheet- Estimation of Environmental Fates of Emissions andWastes.

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-CycleAssessments.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this 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 ConsciousDesign 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?.