

PAAVAI ENGINEERING COLLEGE, NAMAKKAL – 637 018

(AUTONOMOUS)

B.E. CHEMICAL ENGINEERING

REGULATION 2016

(CHOICE BASED CREDIT SYSTEM)

CURRICULUM

SEMESTER III

S.No	Category	Course Code	Course Title	L	T	P	C
Theory							
1	BS	MA16301	Transforms and Boundary Value Problems	3	2	0	4
2	PC	CM16301	Materials Technology	3	0	0	3
3	PC	CM16302	Chemical Process Calculations	3	2	0	4
4	PC	CM16303	Mechanical Operations	3	0	0	3
5	BS	CH16301	Environmental Science and Engineering	3	0	0	3
6	PC	CH16302	Physical Chemistry	3	0	0	3
Practical							
7	PC	CH16303	Physical Chemistry Laboratory	0	0	4	2
8	PC	CM16304	Mechanical Operations Laboratory	0	0	4	2
9	HS	EN16301	Business English Course Laboratory	0	0	2	1
TOTAL				18	4	10	25

SEMESTER IV

S.No	Category	Course Code	Course Title	L	T	P	C
Theory							
1	BS	MA16403	Probability and Statistics	3	2	0	4
2	PC	CM16401	Instrumental Method of Analysis	3	0	0	3
3	PC	CM16402	Process Heat Transfer	3	0	0	3
4	PC	CM16403	Fluid Flow Operations	3	0	0	3
5	PC	CH16401	Organic Chemistry	3	0	0	3
6	ES	EE16408	Electrical Machines Drives and Sensors	3	0	0	3
Practical							
7	PC	CH16402	Organic Chemistry Laboratory	0	0	4	2
8	PC	CM16404	Fluid Mechanics Laboratory	0	0	4	2
9	ES	EE16409	Electrical Engineering Laboratory	0	0	4	2
TOTAL				18	2	12	25

TEXT BOOKS

1. Veerarajan T., “Transforms and Partial Differential Equations”, Tata McGraw Hill Education Pvt. Ltd., New Delhi, Second reprint, 2012.
2. Narayanan S., Manickavasagam Pillai.T.K and Ramanaiah.G “Advanced Mathematics for Engineering Students” ,Vol. II & III, S.Viswanathan Publishers Pvt Ltd. 1998

REFERENCES

1. Larry C. Andrews, Bhimsen K. Shivamoggi, “Integral Transforms for Engineers”, SPIE Optical Engineering press, Washington USA (1999).
2. Ramana.B.V., “Higher Engineering Mathematics”, Tata Mc-GrawHill Publishing Company limited, New Delhi (2010).
3. Glyn James, “Advanced Modern Engineering Mathematics”, 3rd Edition, Pearson Education (2007).
4. Erwin Kreyszig., “Advanced Engineering Mathematics” 10th Edition,Wiley Publications
5. Ray Wylie C and Barrett.L.C, “Advanced Engineering Mathematics”, Tata McGraw Hill Education Pvt Ltd, Sixth Edition, New Delhi, 2012.

WEB LINKS

1. <https://www.youtube.com/watch?v=coe-UA5ONI0>
2. <https://www.youtube.com/watch?v=gZNm7L96pfY>
3. <http://172.16.100.200/NPTEL/displayweb.html?type1=111103021%2F35.pdf>
4. <https://www.youtube.com/watch?v=4GHY8sRKPu>
5. <http://172.16.100.200/NPTEL/displayweb.html?type1=111104031%2Flectures.pdf%23page%3D101>.

COURSE OBJECTIVES

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

UNIT I INTRODUCTION 9

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

UNIT II FERROUS AND NON-FERROUS METALS 9

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

UNIT III POLYMERS, CERAMICS, GLASSES 9

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

UNIT IV INORGANIC MATERIALS 9

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

UNIT V CORROSION AND PREVENTION 9

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

TOTAL PERIODS 45**COURSE OUTCOMES**

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

- choose appropriate material for process equipment with advanced properties and its processing method depending on type of application.
- gain knowledge on different types of materials, properties and applications in process industries
- acquire the knowledge about industrial polymerization methods, glass processing and properties of ceramics.
- understand and build reinforced structures by knowing the special properties of cement.
- gain knowledge about different types of corrossions and suggest preventive methods.

TEXT BOOKS

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

REFERENCES

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

WEB LINKS

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

COURSE OBJECTIVES

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

UNIT I BASIC CHEMICAL CALCULATIONS 15

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

UNIT II MATERIAL BALANCE (Without chemical reaction) 15

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

UNIT III MATERIAL BALANCE (With chemical reaction) 15

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

UNIT IV ENERGY BALANCE 15**Thermo Physics**

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

Thermo Chemistry

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

UNIT V FUELS AND COMBUSTION 15

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

TOTAL PERIODS 75

COURSE OUTCOMES

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

- understand various types of units and dimensions, basic laws about behavior of fluids and solid.
- formulate material and energy balances with or without chemical reactions and apply them for a given process.
- experiment and solve material balance problems involving chemical reactions.
- learn what energy balances are, and how to apply them and finally, to learn how to deal with the complexity of larger problems.
- calculate flue gas composition from fuel composition and vice versa.

TEXT BOOKS

1. K.A. Gavhane, ‘Stoichiometry’ NiraliPrakashanPublications, (2015).
2. Bhatt, B.I. and Vora, S. M., “Stoichiometry”, 4th Edition, Tata McGraw Hill Publishers Ltd., (2005).

REFERENCES

1. Venkataramani, V. and Anantharaman, N., “Process calculations”, Prentice Hall of India (P) Ltd., 2003.
2. K.V.Narayanan, B.Lakshmiathy, ”Stoichiometry and Process Calculation”, PHI Learning Ltd.(2013).
3. Himmelblau, D., “Basic Principles and Calculations in Chemical Engineering”, 6th Edition, Prentice Hall of India (P) Ltd., (2000).

WEB LINKS

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

TEXT BOOKS

1. Kiran D Patil, "Mechanical Operations" 3rd Edition, Nirali Publication. (2016).
2. Foust, A. S., Wenzel, L.A., Clump, C.W., Naus, L., and Anderson, L.B., "Principles of Unit Operations", 2nd Edn., John Wiley & Sons, (1994).

REFERENCES

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

WEB LINKS

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

COURSE OBJECTIVES

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

UNIT I INTRODUCTION TO ENVIRONMENTAL STUDIES AND NATURAL RESOURCES 9

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

UNIT II ECOSYSTEMS AND BIODIVERSITY 9

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

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

Conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.

UNIT III POLLUTION 9

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

UNIT IV SOCIAL ISSUES AND ENVIRONMENT

9

Sustainable development : Unsustainable to sustainable development – urban problems related to energy. Water conservation - rain water harvesting - watershed management. Resettlement and rehabilitation of people.

Environmental ethics: Issues - possible solutions – climate change - global warming and its effects on flora and fauna - acid rain - ozone layer depletion - nuclear accidents - nuclear holocaust. Environment protection act: Air (Prevention and Control of Pollution) act– water (Prevention and control of Pollution) act – wildlife protection act – forest conservation act – issues involved in enforcement of environmental legislation.

UNIT V HUMAN POPULATION AND ENVIRONMENT

9

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

TOTAL PERIODS 45

COURSE OUTCOMES

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

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

TEXT BOOKS

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

REFERENCES

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

COURSE OBJECTIVES

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

UNIT I CHEMICAL KINETICS 9

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

UNIT II CATALYSIS AND SURFACE CHEMISTRY 9

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

UNIT III PHOTOCHEMISTRY 9

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

UNIT IV COLLOIDS 9

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

UNIT V THE DISTRIBUTION LAW 9

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

TOTAL PERIODS 45**COURSE OUTCOMES**

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

- explain the chemical kinetics, electrochemical equilibria in different applications.
- demonstrate the catalysis and bio-catalysis reaction
- list the biochemical reactions equilibria towards different applications.
- comprehend the knowledge about industrial chemical reactions such as production of soaps, colloids.

- develop the basic concepts of chemical reaction and mechanism in large scale production
- apply the distribution law to separate the desired synthesized compounds using suitable immiscible solvents

TEXT BOOKS

1. KundandJain,PhysicalChemistry,S.ChandandCompany,NewDelhi(2011).
2. Puri B.H. Sharma L.R. and M.S.Prathama, “Principles of Physical Chemisry”, S.Chand and Company, New Delhi(2012).
3. B.S.Bahl, ArunBahl and G.D.Tuli, “Essentials of Physical Chemistry”, S.Chand and Company, New Delhi(2015).

REFERENCES

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

WEB LINKS

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

COURSE OBJECTIVES

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

LIST OF EXPERIMENTS

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

TOTAL PERIODS 60**COURSE OUTCOMES**

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

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

REFERENCES

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

COURSE OBJECTIVES

- To acquire a sound working knowledge on different types of crushing equipments and separation characteristics of different mechanical operation separators.

LIST OF EXPERIMENTS

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

TOTAL PERIODS 60**COURSE OUTCOMES**

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

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

REFERENCES

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

COURSE OBJECTIVES

- To develop the reading skills of the students and to familiarize them in skimming and scanning.
- To install the communication concepts and enhance the students' conversational skills through various practice sessions.
- To familiarize them with a variety of business correspondence.
- To develop the receptive skills such as listening and reading and to make the students well versed in the productive skills (writing & speaking).
- To assist them in improving their vocabulary and comprehension of grammar.

UNIT I READING AND VOCABULARY 8

Understanding short, notices, messages - detailed comprehension of factual material - skimming & scanning skills - interpreting visual information - reading for gist and specific information - reading for grammatical accuracy and understanding of text structure - reading and information transfer.

UNIT II WRITING 7

Fixing appointments - asking for permission - giving instructions - apologizing and offering compensation - making or altering reservations - dealing with requests - giving information about a product.

UNIT III LISTENING 8

Listening to short telephonic conversation - Listening to short conversation or monologue - Listening to specific information - Listening to recorded interview, discussion.

UNIT IV SPEAKING 7

Conversation between the interlocutor and the candidate - general interaction and social language - A mini presentation by each candidate on a business theme - organising a larger unit of discourse - giving information and expressing opinions - to way conversation between candidates followed by further prompting from the interlocutor- Expressing opinions - agreeing and disagreeing.

TOTAL PERIODS 30**LIST OF EXPERIMENTS**

1. Reading
2. Writing
3. Listening
4. Speaking

COURSE OUTCOMES

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

- enrich the business vocabulary through reading.
- develop their pronunciation skills.
- speak effectively in English in various occasions.
- prepare flawless reports and proposals.
- understand and communicate as a professional.

TEXT BOOKS

1. Cambridge BEC Preliminary, Self Study Edition, Cambridge University Press, New York, 2012.
2. Whitby, Norman. Business Benchmark, Pre-intermediate to intermediate, Business Preliminary, Shree Maitrey Printech Pvt. Ltd., Noida, 2014.

REFERENCES

1. Raman, Meenakshi & Sangeetha Sharma. Technical Communication: Principles and Practice Oxford University Press, New Delhi. 2011.
2. Rizvi, Ashraf. M. Effective Technical Communication. Tata McGraw-Hill, New Delhi.2005.
3. Rutherford, Andrea. J Basic Communication Skills for Technology. Pearson, New Delhi.

WEB SOURCE

1. <http://www.cambridge.org/us/cambridgeenglish/catalog/cambridge-english-exams-ielts/business-benchmark>

SEMESTER IV

MA16403

PROBABILITY AND STATISTICS (COMMON TO CHEMICAL TO AGRI.)

3 2 0 4

COURSE OBJECTIVES

- To acquire knowledge of the random variable and manipulate.
- To analyse the relationship between the two random variables.
- To determine the concepts of hypotheses testing, its need and applications.
- To equip with statistical techniques for designing experiments, analyzing, interpreting and presenting research data.
- To apply the statistical tools in engineering problems..

UNIT I RANDOM VARIABLES 15

Discrete and continuous random variables - Moments - Moment generating functions - Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions.

UNIT II TWO - DIMENSIONAL RANDOM VARIABLES 15

Joint distributions - Marginal and conditional distributions - Covariance - Correlation and Linear regression - Transformation of random variables - Central limit theorem (for independent and identically distributed random variables).

UNIT III TESTING OF HYPOTHESIS 15

Sampling distributions - Estimation of parameters - Statistical hypothesis - Large sample test based on Normal distribution for single mean and difference of means - Tests based on t, Chi-square and F distributions for mean, variance and proportion - Contingency table (test for independent) - Goodness of fit.

UNIT IV DESIGN OF EXPERIMENTS 15

One way and Two way classifications - Completely randomized design - Randomized block design - Latin square design - 2^2 factorial design.

UNIT V STATISTICAL QUALITY CONTROL 15

Control charts for measurements (X and R charts) - Control charts for attributes (p, c and np charts) - Tolerance limits - Acceptance sampling.

TOTAL PERIODS 75

COURSE OUTCOMES

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

- understand the fundamental concepts of probability.
- acquire the knowledge on standard distributions for real life phenomenon.
- learn the sampling distributions and statistical techniques for engineering and management problems.
- realize the principles to be adopted for designing the experiments.
- gain knowledge on the quality control charts and sampling.

TEXTBOOKS

1. Milton. J. S. and Arnold. J.C., "Introduction to Probability and Statistics", Tata McGraw Hill, 4th Edition, 2007.
2. Johnson. R.A. and Gupta. C.B., Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 7th Edition, 2007.

3. Papoulis. A and Unnikrishnapillai. S., "Probability, Random Variables and Stochastic Processes" McGraw Hill Education India , 4th Edition, New Delhi , 2010.

REFERENCES

1. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2012.
2. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia , 8th Edition, 2007.
3. Ross, S.M., "Introduction to Probability and Statistics for Engineers and Scientists", 3rd Edition, Elsevier, 2004.
4. Spiegel. M.R., Schiller. J. and Srinivasan. R.A., "Schaum"s Outline of Theory and Problems of Probability and Statistics", Tata McGraw Hill Edition, 2004.

WEB LINKS

1. <https://www.youtube.com/watch?v=IYdiKeQ9xEI>
2. https://www.youtube.com/watch?v=J70dP_AECzQ
3. <https://www.youtube.com/watch?v=pvvoK4rlzqQ>
4. <https://www.youtube.com/watch?v=IEP3swFeauE>
5. <https://www.youtube.com/watch?v=SAfS56Ez0QY>

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 MASSSPECTROMETRY 9

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

UNIT IV SEPARATION METHODS 9

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

UNIT V ELECTRO ANALYSIS AND SURFACE MICROSCOPY 9

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

TOTAL PERIODS 45**COURSE OUTCOMES**

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.
- interpretate electromagnetic radiation absorbed, scattered, or emitted by atoms.
- identify unknown or confirming the presence of suspected compounds in materials.
- operate and analyze the samples using chromatographic and HPLC techniques.
- improve the selectivity and sensitivity of the sample and its detection.

TEXT BOOKS

1. H.Kumar, "Instrumental Methods of Chemical Analysis"PragatiPrakashan; Latest Edition edition (2016).
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. Gurdeep R Chatwal Sham K Anand, "Instrumental Methods Of Chemical Analysis", 1 st edition, Himalaya publishing house (2015).

WEB LINKS

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

COURSE OBJECTIVES

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

UNIT I CONDUCTION 9

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

UNIT II CONVECTION 9

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

UNIT III RADIATION 9

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

UNIT V HEAT EXCHANGERS 9

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

UNIT IV EVAPORATORS 9

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

TOTAL PERIODS 45**COURSE OUTCOMES**

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

- derive equations for the calculation of heat flux and estimation of intermediate temperatures in multilayer systems.
- application for various correlations of convective heat transfer to different problems.
- explain radiation in different type of solids and estimate emissivity.
- students gain knowledge in various heat transfer methodology in process engineering and to design heat transfer equipments heat exchangers and evaporation
- design of single and multiple effect evaporators and can calculate the economy and capacity of evaporators.

TEXT BOOKS

1. K.A. Gavhane, "Heat Transfer", Eighteenth Edition, Niralai Publication (2016).
2. Rajput "Process Heat Transfer ", McGraw-Hill, (1999).

REFERENCES

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

WEB LINKS

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

COURSE OBJECTIVES

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

UNIT I FLUID PROPERTIES AND STATICS 15

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

UNIT II FLOW OF COMPRESSIBLE AND INCOMPRESSIBLE FLUIDS 15

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

UNIT III FLOW OF FLUIDS THROUGH SOLIDS 15

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

UNIT IV TRANSPORTATION 15

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

UNIT V METERING 15

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

TOTAL PERIODS 75**COURSE OUTCOMES**

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

- understand the fundamental concepts of physical properties of fluids and its importance in fluid flow operations.
- treat problems in the movement of fluids through all kinds of process equipment and use dimensional analysis for scaling experimental results
- understand the fluid flow through packed and fluidized beds

- deal with the important engineering tasks of moving fluid through process equipment and of measuring and controlling fluids in flow.
- analyse pipe flows as well as fluid machineries used to transport the fluid and their performance

TEXT BOOKS

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

REFERENCES

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

WEB LINKS

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

COURSE OBJECTIVES

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

UNIT I CARBOHYDRATES 9

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

UNIT II HETEROCYCLIC COMPOUNDS 9

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

UNIT III DYES 9

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

UNIT IV AMINOACIDS AND PROTEINS 9

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

UNIT V PHARMACEUTICAL CHEMISTRY 9

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

TOTAL PERIODS 45**COURSE OUTCOMES**

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

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

TEXT BOOKS

1. R.T. Morrison and R.N. Boyd "Organic Chemistry" VI Edition Prentice Hall Inc (1996)USA.
2. K.S. Tiwari, N.K. Vishnoi and S.N. Malhotra "A text book of Organic 35 Chemistry" Second Edition, Vikas Publishing House Pvt. Ltd. (1998), NewDelhi.
3. P.L.Soni, A text book of Organic Chemistry, S Chand Publishers, (2001), New Delhi.

REFERENCES

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

COURSE OBJECTIVES

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

UNIT I DC MACHINES 9

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

UNIT II AC MOTOR 9

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

UNIT III FUNDAMENTALS OF ELECTRIC DRIVES 9

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

UNIT IV TRANSDUCERS AND SENSORS 9

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

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

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

TOTAL PERIODS 45**COURSE OUTCOMES**

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

- select and utilize various of dc machines.
- employ effective control techniques to electrical motors.
- understand concept applied in electric drives.
- select appropriate Sensors for engineering applications.
- apply solid state speed control of DC. and AC. drives.

TEXT BOOKS

1. Nagrath .I.J. & Kothari .D.P, “Electrical Machines”, Tata McGraw-Hill,2004.
2. VedamSubrahmaniam, “Electric Drives (concepts and applications)”, Tata McGraw- Hill, 2001.
3. D. Patranabi, “Sensors and Transducers”, PHI Learning Pvt. Ltd.,200

REFERENCES

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

WEBLINKS

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

COURSE OBJECTIVES

- To learn basic principles involved in analysis and synthesis of different organic derivatives.

LIST OF EXPERIMENTS

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

TOTAL PERIODS 60**COURSE OUTCOMES**

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

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

REFERENCES

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

COURSE OBJECTIVES

- To calibrate flow meters, find pressure loss for fluid flows and determine pump characteristics.

LIST OF EXPERIMENTS

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

TOTAL PERIODS 60**COURSE OUTCOMES**

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

- understand the fundamental fluid flow properties and its measurements.

REFERENCES

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

COURSE OBJECTIVES

- To make the students conduct various experiments on electrical machines analyze their performance.
- To conduct the relevant experiments for determining the performance characteristics of transducers.

LIST OF EXPERIMENTS

1. Load test on DC shunt motor and DC Seriesmotor.
2. Open circuit characteristics and load characteristics of DCshunt
3. Speed Control of DC Shunt Motor (Armature and Fieldcontrol)
4. Swinburne's test.
5. Load test on three phase squirrel cage inductionmotor
6. Speed control of three phase squirrel cage inductionmotor.
7. Load test on single phase inductionmotor.
8. Study of DC & ACStarters.
9. Study of displacement transducer –LVDT
10. Study of pressuretransducer

TOTAL PERIODS 60**COURSE OUTCOMES**

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

- summarize the characteristics and speed control of electrical machines
- predict the performance characteristics of transducers