

**PAAVAI ENGINEERING COLLEGE, NAMAKKAL – 637 018**

**(AUTONOMOUS)**

**B.TECH. CHEMICAL ENGINEERING**

**CURRICULUM**

**REGULATIONS 2015**

**SEMESTER III**

<b>COURSE CODE</b>	<b>COURSE TITLE</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
MA15301	Transforms and Boundary value problems	3	2	0	4
CH15302	Physical Chemistry	3	0	0	3
CM15301	Fluid Mechanics	3	2	0	4
CM15302	Chemical Process Calculations	3	2	0	4
CM15303	Materials Technology	3	0	0	3
CH15301	Environmental Science and Engineering	3	0	0	3
CH15303	Physical Chemistry Laboratory	0	0	4	2
CM15304	Fluid Mechanics Laboratory	0	0	4	2
EN15301	Business English Course Laboratory	0	0	2	1

**SEMESTER IV**

<b>COURSE CODE</b>	<b>COURSE TITLE</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
MA15403	Probability and Statistics	3	2	0	4
CH15401	Organic Chemistry	3	0	0	3
EE15410	Electrical Machine Drives and Sensors	3	0	0	3
CM15401	Mechanical Operations	3	0	0	3
CM15402	Process Heat Transfer	3	0	0	3
CM15403	Chemical Engineering Thermodynamics I	3	0	0	3
CH15402	Organic Chemistry Laboratory	0	0	4	2
CM15411	Mechanical Operations Laboratory	0	0	4	2
EE15411	Electrical Engineering Laboratory	0	0	4	2



- have grasped the concept of expression of a function, under certain conditions, as a double integral leading to identification of transform pair and specialization on fourier transform pair, their properties.
- have obtained capacity to formulate and identify certain boundary value problems encountered in engineering practices, decide on applicability of the fourier series method of solution, solve them and interpret the results.
- be capable of mathematically formulating certain practical problems in terms of partial differential equations, solve them and physically interpret the results.
- have learnt the basics of z – transform in its applicability to discretely varying functions, gained the skill to formulate certain problems in terms of difference equations and solve them using the z – transform technique bringing out the elegance of the procedure involved.

### **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-Graw Hill Publishing Company limited, New Delhi (2010).
3. Glyn James, “Advanced Modern Engineering Mathematics”, 3<sup>rd</sup> Edition, Pearson Education (2007).
4. Erwin Kreyszig, “Advanced Engineering Mathematics” 10<sup>th</sup> 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.
6. Datta K.B., “Mathematical Methods of Science and Engineering”, Cengage Learning India Pvt Ltd, Delhi, 2013.

### **WEB LINKS**

1. <https://www.youtube.com/watch?v=coe-UA5ONI0>
2. <https://www.youtube.com/watch?v=gZNm7L96pfY>
3. <https://www.youtube.com/watch?v=4GHY8sRKPuU>
4. <http://172.16.100.200/NPTEL/displayweb.html?type1=111103021%2F35.pdf>
5. <http://172.16.100.200/NPTEL/displayweb.html?type1=111104031%2Flectures.pdf%23page%3D101>

**COURSE OBJECTIVES**

- To define the different basic terms related to the field of chemical reaction kinetics.
- To understand the importance of catalysis and surface chemistry.
- To create awareness of the significance of photochemistry towards different industry applications.
- To gain the knowledge in Colloids and its synthesis and characterization.
- To impart knowledge on distribution laws of solvents.

**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 – Michalis Menton 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 particles – 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 – I<sub>2</sub>–CCl<sub>4</sub>–H<sub>2</sub>O System – Nature of interaction–of the solute with one of the solvents – Dissociation- Association – Applications of Distribution law – Process of Extraction.

**TOTAL: 45 PERIODS**

## **COURSE OUTCOMES**

At the end of the course the student will be able to

1. translate the basic concepts of chemical reaction and mechanism in large scale production.
2. impart the knowledge about catalytic activity used in heterogeneous and homogeneous catalysis in industries.
3. Apply the photochemistry laws for the determination of yield of reaction.
4. implement basic principle of colloids and its application in preparation of drugs.
5. find and report the distribution coefficient of different solvents in extraction process.

## **TEXT BOOKS**

1. Kund and Jain, Physical Chemistry, S.Chand and Company, New Delhi (2011).
2. Puri B.H. Sharma L.R. and M.S.Prathama, "Principles of Physical Chemistry", S.Chand and Company, New Delhi (2012).
3. B.S.Bahl, Arun Bahl and G.D.Tuli, "Essentials of Physical Chemistry", S.Chand and Company, New Delhi (2015).

## **REFERENCES**

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

## **WEB LINKS**

1. [www.cheresources.com](http://www.cheresources.com)
2. [www.library.njit.edu/research\\_helpdesk/subject\\_guides/chemistry.php](http://www.library.njit.edu/research_helpdesk/subject_guides/chemistry.php)

**COURSE OBJECTIVES**

- To understand the fundamental concepts, fluid properties, fluid statics and to develop mathematical relations using Dimensional analysis.
- To have clear concepts on fluid properties characteristics while static, during flow through ducts, pipes and other channels.
- To impart knowledge on dynamic characteristics for through packed and porous medium.
- To study the principles and working of various types of pumps used to transport the fluid and their performance.
- To identify and classify the metering devices for fluid handling.

**UNIT I FLUID PROPERTIES AND STATICS 15**

Physical properties of fluids – Classification of fluids – Rheology – Manometry – Pressure measurement – variation of pressure with height – hydrostatic equilibrium – Concept of buoyancy – Fluid statics and its applications. Dimensional homogeneity, Rayleigh and Buckingham- $\pi$  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 for motion – Correction for fluid friction – Correction for pump work. 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 – Motion under gravitational and centrifugal fields – Terminal settling velocity – Fluidization – Mechanism – Types – General properties – Applications.

**UNIT IV METERING 15**

Measurement of fluid flow – variable head and variable area meters: Orifice meter – Venturimeter – Pitot tube – Rotameter – determination of discharge and discharge coefficient – Weirs and notches – Hot wire anemometers

**UNIT V TRANSPORTATION 15**

Transportation of fluids – Performance curves and characteristics – classification of affinity laws Centrifugal, Positive displacement, Rotary and Reciprocating pumps – Fans, blowers and compressors. Introduction to valves and pipe fittings.

**TOTAL: 75 PERIODS**

## **COURSE OUTCOMES**

At the end of course, students will be able to

1. differentiate the types of fluids and able to measure pressure difference of flowing fluids and to use dimensional analysis for scaling experimental results
2. analyze and calculate friction factor for different types of flow in various types of constructions.
3. minimize the pressure drop of fluid while flow through packed and fluidized beds
4. test the characteristics of pumps and its characteristic curves.
5. find the discharge coefficient and measure the flow rate of fluids.

## **TEXT BOOKS**

1. Noel de Nevers, "Fluid Mechanics for Chemical Engineers", Second Edition, McGraw-Hill, (1991).
2. Munson, B. R., Young, D.F., Okiishi, T.H. "Fundamentals of Fluid Mechanics", 5th Edition, John Wiley, 2006.
3. R.K. Bansal, "Fluid Mechanics and Hydraulic Machines", Revised Ninth Edition, Laxmi Publications (p) limited, 2014.

## **REFERENCES**

1. White, F.M., "Fluid Mechanics", IV Edition, McGraw-Hill Inc., 1999.
2. James O Wilkes and Stacy G Bike, "Fluid Mechanics for Chemical Engineers' Prentice Hall PTR (International series in Chemical Engineering) (1999)
3. McCabe W.L, Smith, J C and Harriot. P "Unit operations in Chemical Engineering", McGraw Hill, VII Edition, 2005.
4. K.A. Gavhane, " Unit Operations I", Nirali Prakashan, 2010

## **WEBLINKS**

1. [www.nptel.ac.in](http://www.nptel.ac.in)
2. [www.msubbu.in](http://www.msubbu.in)
3. [www.unitoperation.com](http://www.unitoperation.com)
4. <http://www.learncheme.com/screencasts/fluid-mechanics>
5. [http://checalc.com/fluid\\_flow.html](http://checalc.com/fluid_flow.html)

**COURSE OBJECTIVES**

- To know about the different system of units and its dimensions and Learn laws related to the behavior of gases, liquids and solids; Representation of vapour-gas mixtures
- To formulate, apply and how to solve the material balance problems and to determine the humidity by the use of psychrometric chart.
- To do the calculations and operations needed for the desired conversion of reactants.
- To relate the air requirement for combustion calculations of fuels.
- To recognise the basics of thermo chemistry and thermo physics calculations.

**UNIT I BASIC CHEMICAL CALCULATIONS 15**

Units and Dimensions – Fundamental and derived units – conversions – Basis of calculations – Methods of 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 gas 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 FUELS AND COMBUSTION 15**

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

**UNIT V 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.

**TOTAL: 75 PERIODS**



## **COURSE OUTCOMES**

At the end of course, students will be able to

1. convert one system of unit to another system and apply the basic laws about behaviour of fluids and solids in process calculations.
2. formulate material balance without chemical reactions and apply them for solving problems involving different unit operations and to find the humidity of the air.
3. experiment and solve material balance problems involving chemical reactions.
4. calculate the burning of solid, liquid and gaseous fuels
5. perform energy balances, and how to apply them and finally, how to deal with the complexity of larger problems.

## **TEXT BOOKS**

1. Bhatt, B.I. and Vora, S. M., "Stoichiometry", 4th Edition, Tata McGraw Hill Publishers Ltd., 2005.
2. Hougen, O.A., Watson, K.M. and Ragatz, R.A., "Chemical Process Principles", Vol. I, CBS Publishers and Distributors, 1995.

## **REFERENCES**

1. Venkataramani, V. and Anantharaman, N., "Process calculations", Prentice Hall of India (P) Ltd., 2003.
2. Himmelblau, D., "Basic Principles and Calculations in Chemical Engineering", 6<sup>th</sup> Edition, Prentice Hall of India (P) Ltd., 2000.
3. Chohey, N.P. and Hicks, T.G., "Handbook of Chemical Engineering Calculations", 2<sup>nd</sup> Edition, McGraw Hill Inc., 1984.
4. K.V.Narayanan, B.Lakshmi pathy, "Stoichiometry and Process Calculation", PHI Learning Ltd.(2013).
5. K. A. Gavhane, "Introduction to Chemical Process Calculations", Niralai Prakashan.

## **WEB LINKS**

1. <http://www.msubbu.in/sp/pc/>
2. [www.nptel.ac.in](http://www.nptel.ac.in)
3. [www.unitoperation.com](http://www.unitoperation.com)
4. <https://www.youtube.com/watch?v=BaEHVpKc-1Q>
5. <https://www.youtube.com/watch?v=oUd4WxjoHKY>

**COURSE OBJECTIVES**

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

**UNIT I INTRODUCTION 10**

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 10**

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, COMPOSITES, CERAMICS 10**

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

**UNIT IV INORGANIC MATERIALS 7**

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 8**

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: 45 PERIODS**

## **COURSE OUTCOMES**

At the end of course, students will be able to

- choose appropriate material for process equipment with advanced properties and its processing method depending on type of application.
- suggest different type of heat treatment techniques and can control the processing methods to produce a material with desired properties.
- acquire the information about industrial polymerization methods, glass processing and properties of ceramics.
- select and build reinforced structures by manufacturing special property cements.
- defend different types of corrosions and suggest preventive methods.

## **TEXT BOOKS**

1. Budinsky K G and Budinsky K M “Engineering materials- Properties and Selection” Prentice Hall of India (2002).
2. Khanna O P, “Material Science and metallurgy” Dhnapat Rai Publications (1995).
3. Er.R.K. Rajput “Engineering Materials” S.Chand Publications, 2014.

## **REFERENCE**

1. Henry R Clauser, “Industrial and Engineering materials” McGraw Hill Book Co. (1975).
2. Agrawal B.K., —Introduction to Engineering Materials, Tata McGraw Hill, 1988.
3. Donald Askeland and Wendelin Wright., —Essentials of Materials Science and Engineering, SI Edition, 3rd Edition, Cengage Learning, 2013.
4. James A. Lee, Materials of Construction for Chemical Process Industries, Mc Graw Hill, 1950.
5. Frank Rumford, Chemical Engineering Materials, Nabu Press, 2013.

## **WEBLINKS**

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-OP4ElhGWI>
4. <http://nptel.ac.in/courses/113105028/>

**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 maintain the ecological balance and preserve bio-diversity.
- To get familiar with the roles and responsibilities 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. Land resources: Land as resource - land degradation - soil erosion. 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 (ponds, streams, 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 - field study.

**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 - pollution case studies. Disaster management: Floods – earthquake - cyclone - landslides. Electronic wastes.

#### **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 - wasteland reclamation - consumerism and waste products. 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: 45 PERIODS**

#### **COURSE OUTCOMES**

At the end of the course the student will be able to

- develop the relationship between the human population and environment.
- analysis the basic concepts of environment studies and natural resources.
- Gain the knowledge about ecosystem and biodiversity.
- discuss about causes, effects and control measures of various types of pollution.
- recall of information on the social issues and various environmental acts.

#### **TEXT BOOKS**

1. T.G.Jr. Miller, Environmental Science, 10<sup>th</sup>Edn, Wadsworth Publishing Co., (2004).
2. Raman Sivakumar, Introduction to Environmental Science and Engineering, 2<sup>nd</sup>Edn, Tata McGraw Hill Education Private Limited, New Delhi,(2010).
3. Benny Joseph, “Environmental Science and Engineering”, Tata McGraw Hill, (2010).

#### **REFERENCES**

1. BharuchaErach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., 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, JaicoPublising House, Mumbai, 2004.
5. Clair Nathan Sawyer, Perry L. McCarty, Gene F. Parkin, “Chemistry for Environmental Engineering and Science”, McGraw Hill Science, 2010.

#### **WEB LINKS**

1. [www.chegg.com](http://www.chegg.com)
2. [www.vidhyarathiplus.com](http://www.vidhyarathiplus.com)

**COURSE OBJECTIVE**

- 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  $K_a$  of the weak acid
5. Conductometric experiments- Verification of Oswald'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 ( $\Delta E$ )
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 pH.
15. Application of Phase Rule to Phenol-Water system

**TOTAL: 60 PERIODS****COURSE OUTCOMES**

At the end of the course the student will be able to

1. determine the properties and characteristics of solvents and mixtures.
2. analyse experimentally the various properties of acids & bases.
3. examine 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 OBJECTIVE**

- To learn experimentally 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: 60 PERIODS****COURSE OUTCOMES**

At the end of course, students will be able to

- perform the fluid flow rate measurements by knowing fundamental fluid flow properties.
- analyze and interpret the experimental data with theory to provide valid results.
- Practically understand the friction on fluid flow by the channels and their characteristics at different operating conditions.

**REFERENCES**

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

**WEBLINKS**

1. [www.nptel.ac.in](http://www.nptel.ac.in)
2. <http://vlab.amrita.edu>
3. <http://iitg.vlab.co.in/>

**COURSE OBJECTIVES**

- To develop the reading skills of the students and make them familiarized in skimming and scanning.
- To instill the communication concepts to enhance the students' conversational skills through various practice sessions and to familiarize them with a variety of business correspondence.
- To inculcate the receptive skills i.e. Listening and Reading and to make the students well versed in the Productive skills and to assist them in improving their vocabulary and comprehension of grammar.

**UNIT I READING & VOCABULARY**

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

**UNIT II WRITING**

Re-arranging 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**

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

**UNIT IV SPEAKING**

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 - two way conversation between candidates followed by further prompting from the interlocutor- Expressing opinions- agreeing and disagreeing

**TOTAL: 30 PERIODS**

**COURSE OUTCOMES**

At the end of course, students will be able to

- to enrich the vocabulary through reading and to develop their pronunciation skills.
- speak effectively in English in all occasions.
- to prepare flawless reports and proposals.



### **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.

### **REFERENCE BOOKS**

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. 2001.

### **WEB LINKS**

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



## **TEXTBOOKS**

1. Milton. J. S. and Arnold. J.C., "Introduction to Probability and Statistics", Tata McGraw Hill, 4<sup>th</sup> Edition, 2007.
2. Johnson. R.A. and Gupta. C.B., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 7<sup>th</sup> Edition, 2007.
3. Papoulis. A and Unnikrishnapillai. S., "Probability, Random Variables and Stochastic Processes" McGraw Hill Education India, 4<sup>th</sup> Edition, New Delhi, 2010.

## **REFERENCES**

1. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8<sup>th</sup> 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, 8<sup>th</sup> Edition, 2007.
3. Ross, S.M., "Introduction to Probability and Statistics for Engineers and Scientists", 3<sup>rd</sup> 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](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 learn the classification, properties and preparation of carbohydrates.
- To acquire knowledge in the preparation of essential organic compounds.
- To get the information about synthesis of dyes.
- To study the reactions of amino acids and their groups.
- To know the production of various drugs in pharmaceutical industry.

**UNIT I CARBOHYDRATES 9**

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

**UNIT II HETEROCYCLIC COMPOUNDS 9**

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

**UNIT III DYE CHEMISTRY 9**

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

**UNIT IV AMNIO ACIDS AND PROTEINS 9**

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

**UNIT V PHARMACEUTICAL CHEMISTRY 9**

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

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

At the end of the course the student will be able to

- prepare carbohydrates by knowing various reaction mechanism and their properties.
- synthesis different type of heterocyclic organic compounds.
- have thorough knowledge on theory of colors and preparing dyes.
- classify and synthesis of amino acids and proteins.
- synthesis drugs and 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 Chemistry" Second Edition, Vikas Publishing House Pvt. Ltd. (1998) New Delhi.
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. Rajbir Singh, "Physical Organic Chemistry", Mittal Publications, 2012.
4. Felix A. Carroll, "Perspective on Structure and Mechanism in Organic Chemistry", John Wiley and Sons, 2012.
5. Eric V. Anslyn and Dennis A. Dougherty, "Modern Physical Organic Chemistry", 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 acquire knowledge on the operation of solid state speed control of D.C. and A.C. drives

To study the fundamentals of Sensors application.

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

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

**UNIT V 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.

**TOTAL: 45 PERIODS****COURSE OUTCOMES**

On Completion this course, the student will be able to

- select and utilize various of dc machines.
- employ effective control techniques to electrical motors.
- ability to understand concept applied in Electric drives.

- able to apply solid state speed control of D.C. and A.C. drives.
- select appropriate Sensors for engineering applications.

### **TEXT BOOKS**

1. Nagrath .I.J. & Kothari .D.P, “Electrical Machines”, Tata McGraw-Hill, 2004.
2. VedamSubrahmaniam, “Electric Drives (concepts and applications)”, Tata McGraw- Hill, 2001.
3. D. Patranabi, “Sensors and Transducers”, PHI Learning Pvt. Ltd., 2003.

### **REFERENCES**

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

### **WEBLINKS**

1. [https://en.wikipedia.org/wiki/DC\\_motor](https://en.wikipedia.org/wiki/DC_motor)
2. [https://en.wikipedia.org/wiki/AC\\_motor](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](http://www.kbelectronics.com/Variable_Speed_DC_Drives.html)

**COURSE OBJECTIVES**

- To study the characteristics of particulate solids and its storage techniques.
- To know the principles of size reduction and the equipment need for crushing and grinding.
- To impart knowledge in separating solids from solids, solids from liquids.
- To understand theory and mechanism of filtration techniques.
- To attain knowledge on Mixing of solid-solid, liquid-liquid components.

**UNIT I PROPERTIES AND STORAGE OF SOLIDS 9**

General characteristics of solids – Properties of masses of particles – their behaviour under different external forces – agglomeration. Different methods for storage of solids – Conveyors, Elevators – Pneumatic conveying.

**UNIT II SIZE REDUCTION 9**

Principle and Objectives – Laws of size reduction – Size reduction methods – classification of equipment – disintegration – preparation of colloids – techniques for size analysis.

**UNIT III MECHANICAL SEPARATIONS 9**

Screening and Screening equipment – material balance over the screen – screen capacity – effectiveness of screens – gravity settling – sedimentation – thickening – centrifugal separation – impingement methods – industrial dust removing equipment with special reference to electrostatic and magnetic separators – floatation – Cyclones.

**UNIT IV FILTRATION 9**

Theory and mechanism of filtration- principles – pressure drop – constant pressure and rate filtration – Batch and continuous filters – centrifuges – membrane filters.

**UNIT V MIXING AND AGITATION 9**

Equipment for blending and kneading – dispersion operations – agitated vessels – flow patterns – power for agitation – correlations.

**TOTAL: 45 PERIODS**

**COURSE OUTCOME**

At the end of course, students will be able to

- identify storage and conveying methods of solids which is the integral part of the process industries.
- decide the best suitable size reduction equipment needed for a specific process industry by analysing, interpreting and evaluating data.
- perform the various types of mechanical operations and know its importance in industries.



- select and design various types of fluid-solid separation equipment based on the behaviour and properties of materials used in industries
- find the power requirement for effective agitation and mixing of fluids.

### **TEXT BOOKS**

1. McCabe, W.L, Smith J.C and Harriot, P., “Unit Operations in Chemical Engineering”, McGraw-Hill, Fourth Edition, 1984.
2. Badger W.L. and Banchero J.T., “Introduction to Chemical Engineering”, Tata McGraw Hill, 1997.
3. 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. K.A. Gavhane, “ Unit Operations I”, Nirali Prakashan, 2010.
3. Anup K Swain, Hemlata Patra, G K Roy, “Mechanical Operations”, Tata McGraw Hill Education Private Limited, 2011.
4. Kiran D Patil, “Mechanical Operations Fundamental principles and applications” Revised second Edition, Nirali Publication, 2010.
5. Bhattacharaya., “Mechanical Operations”, Khanna Publishers, 2001.

### **WEB LINKS**

1. [www.nptel.ac.in](http://www.nptel.ac.in)
2. <http://checalc.com/solved/agitator.html>
3. <http://www.msubbu.in/sp/mo/>
4. <https://www.youtube.com/watch?v=T-IDyR2cWHQ>
5. <https://www.youtube.com/watch?v=rwiXby6j3Io&list=PL99W7Jjt6ODg0J2rpRf9R-WBqlcerhXt5>

**COURSE OBJECTIVES**

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

**UNIT I BASIC CONCEPTS AND FIRST LAW 9**

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

**UNIT II SECOND LAW OF THERMODYNAMICS 9**

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

**UNIT III THERMODYNAMIC PROPERTIES OF REAL GASES 9**

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

**UNIT IV THERMODYNAMIC FORMULATIONS 9**

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

**UNIT V COMPRESSION OF FLUIDS 9**

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

**TOTAL: 45 PERIODS**

## **COURSE OUTCOMES**

At the end of course, students will be able to

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

## **TEXT BOOKS**

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

## **REFERENCES**

1. Kyle, B.G., “Chemical and Process Thermodynamics III Edition”, Prentice Hall of India Pvt. Ltd., 1999.
2. Elliott J.R., Lira, C.T., “Introductory chemical engineering thermodynamics”, Prentice Hall, 1998
3. Rao, Y.V.C., “Chemical Engineering Thermodynamics” Universities Press, 2005
4. Pradeep ahuja,” Chemical Engineering Thermodynamics”, PHI Learning Ltd (2009).
5. Gopinath Halder,” Introduction to Chemical Engineering Thermodynamics”, PHI Learning Ltd (2009).
6. K.A. Gavhane, “Chemical Engineering Thermodynamics I”, Nirali Prakashan, 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>
4. <http://www.msubbu.in/ln/td/>



## **COURSE OUTCOMES**

At the end of course, students will be able to

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

## **TEXT BOOKS**

1. Kumar, D.S., "Heat and Mass Transfer", 5th Edition, S.K. Kataria and Sons, 2000.
2. McCabe, W.L. and Smith, J.C., "Unit Operations in Chemical Engineering", 5<sup>th</sup> Edition. McGraw Hill Publishing Co., 2001.

## **REFERENCES**

1. Kern, D.Q., "Process Heat Transfer", Tata McGraw Hill Publishing Co., 1990.
2. Hollman, "Heat Transfer", 8th Edition, McGraw Hill, 1997.
3. Kreith, F., "Principles of Heat Transfer", 4th Edition, Harper and Row, 1976.

## **WEB LINKS**

1. <http://nptel.ac.in/courses/103103032/1>
2. <https://www.youtube.com/watch?v=qa-PQOjS3zA>
3. [https://www.youtube.com/watch?v=Atnjo7dD\\_bA](https://www.youtube.com/watch?v=Atnjo7dD_bA)
4. <https://www.youtube.com/watch?v=LDF6gFK17Gc>
5. <https://www.youtube.com/watch?v=VBaz3NIIJ9o>

**COURSE OBJECTIVE**

- 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:
  - a) Acetylation – Preparation of acetanilide from aniline.
  - b) Hydrolysis – Preparation of salicylic acid from methyl salicylate. iii. Substitution – Conversion of acetone to iodoform.
  - c) Nitration – Preparation of m-dinitrobenzene from nitrobenzene.
  - d) Oxidation – Preparation of benzoic acid from benzaldehyde/ benzyl alcohol

**TOTAL: 60 PERIODS****COURSE OUTCOMES**

The student is able to

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

**REFERENCES**

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

**COURSE OBJECTIVE**

- To enable the students to develop 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

**COURSE OUTCOME**

Students would gain the practical knowledge on

- Various separation techniques like filtration, sedimentation, screening, elutriation, crushing and centrifugation.
- performance of various size reduction equipment by carrying out experiments.
- Selection of suitable equipment needed for a specific mechanical operation.

**TOTAL: 60 PERIODS**

**WEB LINKS**

1. [www.unitoperation.com](http://www.unitoperation.com)
2. [www.nptel.ac.in](http://www.nptel.ac.in)

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

**TOTAL: 60 PERIODS****COURSE OUTCOMES**

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

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