Faculty of Engineering

Syllabus
SE (Chemical Engineering) 2015 course
(With effect from Academic Year 2016 - 17)

Savitribai Phule Pune University
Structure for SE (Chemical Engineering)-2015 Course

Subject Code	Subject	Teaching scheme			Examination Heads					Total Marks	Credits Th+PR
		Lect.	Practical	Tut. / Draw.	Online	Theory End Sem.	TW	PR	OR		
Term-I											
207004	Engineering Mathematics-III	4	-	1 Tut.	50	50	25	-	-	125	5
209341	Chemistry-I	4	2	-	50	50	-	50	-	150	4+1
209342	Fluid Mechanics	4	2	-	50	50	25	-	50	175	4+1
209343	Engineering Materials	3	2	-	50	50	-	-	50	150	3+1
209344	Process Calculations	3	-	-	50	50	-	-	-	100	3
209345	Introduction to Chemical Engineering	1	-	2 Drg.	-	-	25	-	-	25	2
209346	Soft Skills		2				25			25	1
	Audit Course-1	-	-	-	-	-	-	-	-	**Grade :PP/NP**	
	Total	**19**	**08**	**03**	**250**	**250**	**100**	**50**	**100**	**750**	**25**
Term-II											
209347	Chemistry - II	4	2	-	50	50	-	50	-	150	4+1
209348	Heat Transfer	4	2	-	50	50	-	-	50	150	4+1
209349	Principles of Design	4	-	2 Drg.	50	50	50	-	-	150	4+1
209350	Chemical Engineering Thermodynamics-I	4	-	-	50	50	-	-	-	100	4
209351	Mechanical Operations	4	2	-	50	50	-	-	50	150	4+1
209352	Workshop Practices	-	2	-	-	-	50	-	-	50	1
	Industrial Training	To be evaluated in the Fifth Semester									
	Audit Course-2	-	-	-	-	-	-	-	-	**Grade :PP/NP**	
	Total	**20**	**08**	**02**	**250**	**250**	**100**	**50**	**100**	**750**	**25**

Note: For non -audit courses, students are given certificates based on the assignments submitted by them.

Abbreviations: TW: Term Work, OR: Oral, PR: Practical, PP: Passed (Only for non-credit courses), NP: Not Passed (Only for non-credit courses)

Savitribai Phule Pune University, Pune
Second Year of Chemical /Bio Technology/Printing Engineering
Semester I (2015 Course)
207004: Engineering Mathematics III

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Lectures: 4 Hrs./Week	Theory: 4	Ins-Sem: 50 Marks
Tutorials: 1 Hr./Week	Tutorial: 1	End-Sem: 50 Marks
		Term work: 25 Marks

Prerequisites: - Differential and Integral Calculus, Taylor series and Infinite series, Linear Differential equations of first order and first degree, Fourier series, Vector algebra.

Course Objectives:

After Completion of the course, student will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. Ordinary and partial differential equations applied to Chemical engineering problems, heat and mass transfer.
2. Integral Transforms such as Laplace transform, Fourier transform and applications to ordinary and partial differential equations arising in Vibration theory, Fluid Mechanics, Heat and Mass Transfer and Thermodynamics.
3. Vector differentiation and integration applied to problems in Fluid Mechanics.

Course Outcomes:

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

1) Solve higher order linear differential equations and apply to modeling and analyzing chemical transformation and heat and mass transfer systems.
2) Apply Laplace Transform and Fourier Transform techniques to solve differential equations involved in vibration theory, Liquid level systems and related chemical engineering applications.
3) Perform vector differentiation and integration, analyze the vector fields and apply to fluid mechanics problems.
4) Solve various partial differential equations such as wave equation, one and two dimensional heat flow equations.

Unit I: Linear Differential Equations (LDE) and Applications (09 Hours)

LDE of n^{th} order with constant coefficients, Method of variation of parameters, Cauchy's & Legendre's DE, Simultaneous & Symmetric simultaneous DE. Applications of LDE to chemical engineering problems and mass spring system.

Unit II: Fourier Transform (FT) (09 Hours)

Fourier integral theorem. Fourier Sine & Cosine integrals. Fourier Transform, Fourier Cosine Transform, Fourier Sine Transforms and their inverses. Finite FT, Application of FT to problems on one and two dimensional heat flow problems.

Unit III: Laplace Transform (LT) and Applications (09 Hours)

Definition of LT, Inverse LT, Properties & theorems, LT of standard functions, LT of some special functions viz. error, First order Bessel's, Periodic, Unit Step, Unit Impulse, ramp, jump, parabolic, Si(t) and Ei(t).

Applications of LT for solving ordinary differential equations, liquid level systems, consisting of single tank and two tanks in series (interacting and non-interacting systems), second order systems (damped vibrator).

Unit IV: Vector Differential Calculus (09 Hours)

Physical interpretation of Vector differentiation. Radial, Transverse, Tangential & Normal components of velocity and acceleration. Vector differential operator, Gradient, Divergence & Curl, Directional derivative, Solenoidal, Irrotational and Conservative fields, Scalar potential, Vector identities.

Unit V: Vector Integral Calculus and Applications (09 Hours)

Line, Surface and Volume integrals, Work-done, Green's Lemma, Gauss's Divergence theorem, Stoke's theorem.

Applications of vectors to problems in Fluid Mechanics, Continuity equations, Stream lines, Equations of motion, Bernoulli's equations.

Unit VI: Applications of Partial Differential Equations (PDE) (09 Hours)

Basic concepts, modeling of Vibrating string, Wave equation, one and two dimensional Heat flow equations, method of separation of variables, use of Fourier series. Applications of PDE to problems of Chemical and allied engineering.

Text Books:

1. Advanced Engineering Mathematics, 9e, by Erwin Kreyszig (Wiley India).
2. Advanced Engineering Mathematics, 7e, by Peter V. O'Neil (Cengage Learning).

Reference Books:

1. Advanced Engineering Mathematics, 2e, by M. D. Greenberg (Pearson Education).
2. Advanced Engineering Mathematics, Wylie C.R. & Barrett L.C. (McGraw-Hill, Inc.)
3. Higher Engineering Mathematics by B. S. Grewal (Khanna Publication, Delhi).
4. Applied Mathematics (Volumes I and II) by P. N. Wartika & J. N. Wartikar (Pune Vidyarthi Griha Prakashan, Pune).
5. Higher Engineering Mathematics by B.V. Ramana (Tata McGraw-Hill).
6. Advanced Engineering Mathematics with MATLAB, 2e, by Thomas L. Harman, James Dabney and Norman Richert (Brooks/Cole, Thomson Learning).

Guidelines for Tutorial and Term Work:

i) Tutorial shall be engaged in four batches (batch size of 20 students maximum) per division.
ii) Term work shall be based on continuous assessment of six assignments (one per each unit) and performance in internal tests.

Savitribai Phule Pune University
SE (Chemical Engineering)-2015 Course
209341: Chemistry-I
Credits: 4+1

Teaching Scheme
Theory: 4 hrs. /Week
Practical: 2 Hrs./Week

Examination Scheme
Online: 50 marks
End Semester: 50 marks
Practical Exam: 50 marks

Prerequisites: Knowledge of fundamental Chemistry up to XII standard and first year Engineering Chemistry.

Course Objectives

1. To impart the basic concepts of organic chemistry
2. To develop understanding about concepts of organic reactions for analysis of unit Processes
3. To study the different analytical instrumentation techniques

Course Outcomes

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

COURSE CONTENTS

Unit I: Bonding and Reactivity (L08)

Covalent Bonding- Introduction to VBT (revision). Molecular orbital theory, MO structures of s-s, s-p , p-p overlaps , molecular orbital structure of butadiene, benzene, MO energy diagrams for diatomic molecules H2 , O2 , CO. Aromaticity-conditions necessary for delocalization of electrons, resonance structures stability rules, resonance in phenol, aniline, ,benzaldehyde ,nitrobenzene molecules, Inductive effect and Resonance effect on pKa and pKb values of acids and bases. Reaction intermediates -carbonations, carbon ions, free radicals and their stability. Types of reagents, types of reactions.

Unit II: Kinetics and Photochemistry (L08)

Kinetics: Rate of reaction, rate constant, order of reaction, kinetics of first and second order reactions, numerical on above, Activated complex theory of reaction rates kinetics of complex reactions. Photochemistry: Introduction and importance, Stark-Einstein law, photochemical rate law, examples of photochemical reactions kinetics of i) H_2, Cl_2 reaction ii) dimerisation of anthracene.

Unit III: Instrumental methods of Analysis (L08)

Chromatography: Adsorption and partition principles, Study of TLC, column, HPLC, Gas Chromatography and their applications. b) Optical methods: UV, Lambert-Beer law, λ_{max}, calculation of λ_{max} for olefinic and cyclic structures using Woodward Feiser rules, instrumentation IR spectroscopy-introduction, instrumentation and Interpretation of spectra, applications., Flame photometry- principle, instrumentation and applications.

Unit IV: Solutions (L08)

Solution :-definition, why substances dissolve, temperature and solubility, solution of gas in gas, gases in liquid, Henry's law, the ideal solution, Raoult'1s law of ideal solution, solutions of liquids in liquids, theory of dilute solution. Colligative properties, osmosis, osmotic pressure, Colligative properties of dilute solution- lowering of vapor pressure, elevation of boiling point and thermodynamic derivation, depression in freezing point and thermodynamic derivation. Abnormal behavior of solutions of electrolytes, Van't Hoff factor. Numerical on all above.

Unit V: Reaction Mechanisms (L08)

Substitution at saturated carbon (SN^1,SN^2) - mechanism, kinetics, stereochemistry, factors favoring it. Electrophonic aromatic substitution in benzene and mono substituted benzenes, activating and deactivating groups, nitration, Friedel-Craft reactions, sulphonation, and diazotization. Nucleophilic substitution on carbonyl carbon. Addition of HX on C=C, 1, 2-Eliminations- E_1 mechanism, E_2, (Saytzeff, Hoffman products), factors favoring it. Rearrangements- Beckmann, Claisen, Favorskii.

Unit VI: Heterocyclic compounds and Dyes (L08)

Aromaticity, preparation, reactions of pyrrole, furan, pyridine, and quinoline.
Dyes- Nomenclature, methods of application, color and chemical constitution (chromophore-auxochrome theory), classification of dyes on the basis of chemical structure, diazotization and coupling for azo dyes ,synthesis of crystal violet, alizarin, methyl orange, phenolphthalein.

Books:

1 Inorganic chemistry - J.D. Lee
2 Physical chemistry -P L Soni
3 Physical Chemistry- Atkins
4 Instrumental methods of chemical analysis ----Chatwal -Anand
5 Analytical chemistry- Skooge and West
6 Reaction mechanism - Jerry March
7 Instrumental Methods of Analysis, H.H.Willard, L.L. Merritt and J.A. Dean & F.A Settle, CBS Publishers, 7th Edition, 1988

Guidelines for Instructor's Manual

The Instructor's manual should include Aim, theory, procedure, fig, observations, calculations and results for every experiment.

Guidelines for Student's Lab Journal

Laboratory journal should be completed on regular basis. Index, illustrations should be properly written. Assignments given over and above the practical topics should also be attached in the journal.

Presentation in the journal should be neat.

Guidelines for Lab /TW Assessment

Assignment or practical work write-up should be submitted in the next laboratory session. Assessment should be carried out with grades.

Guidelines for Conduct of Laboratory Course

- Arrangements for the practical should be done prior General laboratory safety instructions should be told to the students.
- Specific chemicals, machinery, hardware handling instructions should be given in the instructions
- Aim and objectives of the practical should be explained.
- After completion of experiment, review the attainment of aim and objectives of the experiment.

Suggested List of Laboratory Assignments

1 Diameter of solute molecule by viscosity measurements.
2 2. To determine rate constant of first order reaction of acid catalyzed hydrolysis of ester.
3 Preparation of benzoic acid from benzamide, crystallization and purity checking by TLC.
4 To determine molecular weight of solid by Elevation in B.P
5 Analysis of sample on HPLC/FTIR/GC
6 To find molecular wt. of solute by depression in freezing point of solvent
7 To determine Partition coefficient of iodine between water and CCl4 and hence to
8 determine the molecular condition of iodine
9 To estimate sodium ion concentration in solution by flame photometer
10 Colorimetric estimation of cobalt/ nickel ion in solution
11 Preparation of aspirin from salicylic acid.
12 Estimation of Cu++ ions by spectrophotometer (Any six experiments from the above)
13 Identification of given organic compound (with maximum one functional group) by
14 systematic analysis (Minimum 4 compounds)
15 Determination of percentage composition of binary mixture using Ostwald’s viscometer

Note: Practical examination will be for three hours and students will perform TWO experiments (one organic analysis and one from remaining)

Savitribai Phule Pune University
SE (Chemical Engineering)-2015 Course
209342: Fluid Mechanics
Credits: 4+1

Teaching Scheme
Theory: 4 hrs. /Week
Practical: 2 Hrs. /Week

Examination Scheme
Online: 50 marks
End Semester: 50 marks
Oral: 50 marks

Prerequisites:

Courses in Engineering Mathematics, Engineering Mechanics, Physics

Course Objective

1 To introduce basic concepts of fluid mechanics and their applications in Chemical Engineering.
2 To study basic equations of fluid flow and applications to determine losses occurring through pipelines.
3 To develop relationships among process or system variables using dimensional analysis.

Course Outcomes:

On completion of the course, learner will be able to–

1 Understand basic concepts of fluid mechanics and their applications in Chemical Engineering.
2 Understand fluid statics and its applications related to pressure measuring devices in chemical industry.
3 Analyze basic equations of fluid flow and their applications to determine fluid flow rate by different devices.
4 Formulate mathematical equations for flow of fluid through different systems and determine different losses occurring in pipelines.
5 Develop relationships among process or system variables using dimensional analysis.
6 Understand applications of different valves and pumps for transportation of fluid through pipelines.

COURSE CONTENTS

Unit I Introduction (L08)

Fluid, Properties of fluid, classification of fluids, Newton's law of viscosity and numerical, rheological classification of fluids, types of flow, lines to describe the flow, application of fluid flow in Chemical Engineering.

Unit II Fluid Pressure and Measurement (L08)

Pascal's law, Hydrostatic law, concept of atmospheric, gauge, vacuum and absolute pressure, manometers, and pressure measurement by simple and differential manometer, Numerical based on above.

Unit III Basic Equations of Fluid Flow and Flow Measuring Devices (L08)

Basic equations of fluid flow: continuity equation, equation of motion, flow measurement using venturimeter, orifice meter, rotameter, pitot tube, Numerical based on above.

Unit IV:Flow of Incompressible Fluids in Conduits (L08)

Laminar flow through circular pipe: Hagen Poiseuille equation, relation between average and maximum velocity, friction factor chart, Darcy Weisbach equation, major and minor losses, Numerical based on above.

Unit V : Dimensional Analysis (L08)

Fundamental dimensions of quantities, dimensional homogeneity, types of similarities dimensional analysis by Rayleigh's method and Buckingham's method, dimensionless numbers.

Unit VI:Boundary Layer and Transportation of Fluids (L08)

Concept of hydrodynamic boundary layer, growth over a flat plate, different thickness of boundary layer, types of fluidization, different types of valves and pumps, centrifugal pump working and characteristics.

Textbooks:

1. McCabe,W. L, J. Smith, and P. Harriot, Unit Operations of Chemical Engineering, McGraw-Hill International Edition, Seventh edition,(2004).
2. Modi, L.P., Seth, S.M., "Hydraulics and Fluid Mechanics", Standard Book House,New Delhi,2002
3. Noel de Nevers; Fluid Mechanics for Chemical Engineers, Third Edition; McGraw Hill, (2005).
4. M. Coulson, J.F. Richardson, with J.R. Backhurst and J.H. Harker, Coulson, Richardson Chemical Engineering, Volume-1", 6th ed., Butterworth-Heinemann,1999

Guidelines for Instructor's Manual

The Instructor's manual should include Aim, theory, procedure, fig, observations, calculations and results for every experiment.

Guidelines for Student's Lab Journal

Laboratory journal should be completed on regular basis. Index, illustrations should be properly written. Assignments given over and above the practical topics should also be attached in the journal.

Presentation in the journal should be neat.

Guidelines for Lab /TW Assessment

Assignment or practical work write-up should be submitted in the next laboratory session. Assessment should be carried out with grades.

Guidelines for Conduct of Laboratory Course

- Arrangements for the practical should be done prior General laboratory safety instructions should be told to the students.
- Specific chemicals, machinery, hardware handling instructions should be given in the instructions
- Aim and objectives of the practical should be explained.
- After completion of experiment, review the attainment of aim and objectives of the experiment.

Suggested List of Laboratory Assignments

1. Determination of viscosity.
2. Reynolds experiment to determine laminar and turbulent flow.
3. Bernoulli's theorem
4. Flow through venturimeter
5. Flow through orifice meter
6. Flow through rotameter
7. Major losses
8. Minor losses
9. Characteristics of centrifugal pump
10. Verification of stokes law
11. Flow through packed bed
12. Flow through coil

Savitribai Phule Pune University
SE (Chemical Engineering)-2015 Course
209343: Engineering Materials
Credits: 3+1

Teaching Scheme
Theory: 3 hrs. /Week
Practical: 2 Hrs. /Week

Examination Scheme
Online: 50 marks
End Semester: 50 marks
Oral Exam: 50 marks

Prerequisites:

Course Objectives:

1. To impart the basic concepts of material science
2. To develop understanding about selection based on properties for various applications
3. To study the different methods for testing of materials
4. The applications of advance materials like nanomaterials

Course Outcomes:

On completion of the course, learner will be able to–

COURSE CONTENTS

Unit I : Introduction (L06)

Introduction to materials and their principle properties, Structure property relationships in materials. Introduction to determination of mechanical properties of materials ASTM methods.

Unit II: Basic Principles in Selection of Materials for Fabrication and Erection of Chemical Plant (L06)

Testing of materials, destructive and nondestructive tests, structure of atom and chemical bonds, crystal structures and their influence on material properties, Deformation and slip processes.

Unit III: Metals and their Alloys: (L06)

Iron – Carbon diagram, Ferrous and nonferrous alloys, mild steel, special steels, stainless steels, brasses, aluminum alloys and titanium alloys, high and low temperature material, insulation, refractories.

Heat Treatments: Methods for fabrication, rolling, bending, central punching, riveting, and welding.

Unit IV: Nanomaterials (L06)

Classification, synthesis, characterization and application of Nanomaterials – Fullerenes, Bucky balls, carbon nano tubes, fullerites. Nano particles – silver nano-particles. Applications of Nano materials in Chemical Industry

Unit V : Experimental Techniques: (L06)

Electron Microscopes; scanning electron microscopy (Basics, Principal Elements, working), transmission electron microscopy (Basics, Principal Elements, working). Scanning probe microscopes; scanning tunneling microscopy, atomic force microscopy, other kinds of microscopes; X-ray diffraction.

Unit VI: Typical Engineering Materials: **(L06)**

Definition of ceramics and glasses; interaction between structure, processing, and Mechanical, electrical and thermal properties of ceramic phase; Applications of ceramic and glass materials; Crystalline and noncrystalline ceramics, refractories, clays, cements**.** Organic protective coatings.

Textbooks:

1 James F. Shacketford, introduction to material science, McMillan publishing company, New York ISBN 1990.
2 D.Z. Jestrazebaski, properties of Engg. Materials, 3rd Ed. Toppers. Co. Ltd.
3 J.L. Lee and Evans, Selecting Engineering materials for chemical and process plants, Business Works 1978.
4 A text book of machine design, Khurmi R.S. and Gupta J.K.
5 Introduction to Nano Technology, John Wiley & Sons by Charles P Poole, Frank J Owens.
6 Nano materials, synthesis, properties and applications, Institute of physics publishing, Bristol and Philadelphia, by A.S. Edelstein and R.C. Kamarhati

Guidelines for Student's Lab Journal

Laboratory journal should be completed on regular basis. Index, illustrations should be properly written. Assignments given over and above the practical topics should also be attached in the journal.

Presentation in the journal should be neat.

Guidelines for Lab /TW Assessment

Assignment or practical work write-up should be submitted in the next laboratory session. Assessment should be carried out with grades.

Guidelines for Conduct of Laboratory Course

- Arrangements for the practical should be done prior General laboratory safety instructions should be told to the students.
- Specific chemicals, machinery, hardware handling instructions should be given in the instructions
- Aim and objectives of the practical should be explained.
- After completion of experiment, review the attainment of aim and objectives of the experiment.

Suggested List of Laboratory Assignments

1. Microstructure observation and study of metals and alloys. (Minimum five) low Carbon steel, medium carbon steel, high carbon Steel, tin, bronze, brass, phosphor Bronze.
2. Study of properties of polymeric materials; impact test and polymeric Tests. Synthesis of Polymers like nylon, PVC, PTFE etc
3. Different types of hardness test on metals. i.e. Rockwell hardness test, Brinell hardness test, Shore Scleroscope tests.
4. Izod and Charpy impact test on mild steel, copper, brass and aluminum.
5. Chemical analysis of metals and alloys (Any one element to be analyzed e.g. Molybdenum from stainless steel, carbon from steel, copper from brass etc.
6. Macrostructure observation: (flow lines observation in forging by macro etching Sulphur printing of steel.)
7. Study experiments based in, i) Dye penetration ii) Rubber lining, iii) Ultrasonic test, iv) Heat treatments.
8. Study of Nanomaterials, Synthesis of Nanomaterials.
9. Study of Moisture Adsorption by Nanomaterials.
10. Study of Temperature V/S Relative Humidity for Nanomaterials.
11. To synthesize gold/silver (Au/Ag) Nanoparticles and record the optical absorption spectra using simple absorption spectrometer.
12. To synthesize zinc oxide (ZnO) Nanoparticles using a chemical route and calculate the size using UV-Vis absorption spectrum.
13. To synthesize titanium Nanoparticles (TiO2) using a chemical route and determine the phase and size using X-ray diffraction. (Using Scherrer formula).
14. To synthesize the Fe2O3 Nanoparticles of different shapes and calculate the average size using scanning electron microscope (SEM) or transmission emission microscope (TEM).

Note: Minimum 8 experiments to be performed from the above suggested experiments.

Savitribai Phule Pune University
SE (Chemical Engineering)-2015 Course
209344: Process Calculations
Credits: 3

Teaching Scheme
Theory: 3 hrs. /Week

Examination Scheme
Online: 50 marks
End Semester: 50 marks

Prerequisites

Basics Mathematics, Applied Sciences, Momentum Transfer

Course Objective

1 Develop ideas in dimensional analysis and to be familiar with different unit systems and conversion from one set of system to another.
2 Understand the various unit operations and unit processes performed in a chemical industry.
3 Learn fundamentals of stoichiometry and apply the material balance concept and precisely calculate the amount of materials required to carry out the suitable unit operation or process.
4 Learn the application of the general energy balance equation and precisely calculate the energy requirements of the unit operation or process involved.

Course Outcomes

On completion of the course, learner will be able to

1. Calculate the composition of the materials.
2. Apply the various laws governing solid, liquid and gas phases.
3. Perform material balance for various unit operations or processes in Chemical Engineering.
4. Calculate the energy requirement for various unit operations or processes in Chemical Engineering

COURSE CONTENTS

Unit I : Mathematical Principles (L08)

Introduction to unit processes and operations and their symbols, process flow sheet, Concept of steady and unsteady state operations, Units and dimensions: basic and derived units, different ways of expressing units and quantities, conversion of units, properties of pure substances, PVT behavior, ideal and real gas laws. Mole fractions and partial pressures, application of Dalton's, Amagat's, Henry's laws, concept of vapor pressure, Raoult's law and its applications, vapor pressure plots and effect of temperature on vapor pressure.

Unit II: Material Balance for Physical Systems (L08)

Concept, material balance calculations, recycling and bypassing operations, introduction to unsteady state processes with examples like batch reactor, accumulation of inert components, etc.

Unit III: Material Balance for Reacting Systems (L08)

Concept, material balance calculations, electrochemical reactions, recycling and By-passing Operations.

Unit IV: Energy Balance (L10)

Concept, energy and Thermo chemistry, energy balances, heat capacity of pure substances and mixtures, latent heats, enthalpy of pure substances and mixtures, absolute enthalpy, heat of reaction, adiabatic reactions, thermo chemistry of mixing processes, dissolution, liquid-liquid mixtures, gas-liquid systems.

Unit V : Stoichiometry and Unit Operations (L08)

Distillation, humidification, absorption and stripping, extraction and leaching, crystallization, Psychrometry, drying, evaporation, introduction to stoichiometry and industrial problems

Unit VI: Fuels and Combustion (L08)

Calorific values, coal, liquid fuels, gaseous fuels, air requirement and flue gases, combustion calculations.

Textbooks:

1. Bhatt B.I. and Vora S.M., “Stoichiometry”, 2nd Edition, Tata McGraw Hill, New Delhi, 2004.
2. Hougen O.A., Watson R.M. and Ragatz R.A., “Chemical Process Principles Part I”, 2nd Edition, CBS Publications, 1976. (ISBN : 9798123909539)
3. David M. Himmelblau, “Basic Principles and Calculations in Chemical Engineering”, 8th Edition, Prentice Hall of India, New Delhi, 2012. (ISBN : 0132346605)
4. Narayanan. K.V. and Lakshmikutty.B, “Stoichiometry and Process Calculations”, 2nd
    a. Edition, Prentice Hall of India, New Delhi, 2009. (ISBN : 8120329929)
5. Venkatramani V, Ananatharaman N, Sheriffa Begum, “Process Calculations”, 2nd Edition,Prentice Hall of India, 2011.
6. Richard M. Felder, Ronald W. Rousseau, “Elementary Principles of Chemical Processes”,3rd Edition, John Wiley and Sons, 2005.

Savitribai Phule Pune University
SE (Chemical Engineering)-2015 Course
209345: Introduction to Chemical Engineering
Credits: 2

Teaching Scheme
Theory: 1 hr. /Week
Drawing: 2 hrs/ Week

Examination Scheme
TW: 25 Marks

Prerequisites:

Course Objectives:

1. To study the basic unit operations and unit processes in Chemical industry.
2. To study the basic concepts of chemical processes.
3. To study process instrumentation and safety.

Course Outcomes:

On completion of the course, learner will be able to–

1 Understand scope of Chemical engineering.
2 Understand unit operations in Chemical industry.
3 Understand unit processes in Chemical industry.
4 Understand basic chemical calculations.
5 Understand basic concept of chemical processes.
6 Understand process instrumentation and safety.

COURSE CONTENTS

Unit I : Introduction (L02)

Introduction to Chemical engineering; history of Chemical engineering and chemical technology; scope of Chemical Engineering, nature of Industries.

Unit II: Basic Chemical Calculations: (L02)

Basic Concepts: concept of mole, weight percent, mole percent, normality, molarity, molality, vapor pressure, partial pressure.

Unit III: Unit Operations (L02)

Introduction, Definition, examples like size reduction, sedimentation, filtration, distillation, evaporation, absorption, extraction, fluid handling, fluid-solid contacting, fluid-solid separation, fluid storage, mixing, solid handling, crystallization, drying, leaching, size separation.

Unit IV: Unit Processes (L02)

Introduction to unit processes with simple examples like sulphonation, polymerization, oxidation, hydrogenation, saponification, etherification, nitration, chlorination.

Unit V : Basic Concepts of Chemical Processes (L02)

Conversion, yield, efficiency, flow diagram, flow sheets, & block diagram, with examples.

Unit VI: Process Instrumentation and Safety (L02)

Temperature scale, measurement of temperature using bimetallic thermometer, mercury expansion thermometer, gas filled thermometer, pressure scales & units, measurement of pressure, level measurement, flow measurement, measurement, personal protection devices

Textbooks:

1 Unit operations in chemical engineering by W.L. McCabe and J.C. Smith and Peter Harriott, McGraw Hill 5th ed. 1993.
2 Himmelblau, D.H, Basic Principles and Calculations in Chemical Engineering, 5th Edn. Prentice Hall, New York, 1990.
3 Coulson J M and Richardson J F, Chemical Engineering, Vol. I and II, Pergamon Press, NY, 1990.
4 Badger and Banchero, Introduction to Chemical Engineering, 1st Edn. McGraw Hill, NewYork, 1954.

Guidelines for Student's Lab Journal

Laboratory journal should be completed on regular basis. Index, illustrations should be properly written. Assignments given over and above the practical topics should also be attached in the journal.

Presentation in the journal should be neat.

Guidelines for Lab /TW Assessment

Assignment or practical work write-up should be submitted in the next laboratory session. Assessment should be carried out with grades.

Guidelines for Conduct of Laboratory Course

- Arrangements for the practical should be done prior General laboratory safety instructions should be told to the students.
- Specific chemicals, machinery, hardware handling instructions should be given in the instructions
- Aim and objectives of the practical should be explained.
- After completion of experiment, review the attainment of aim and objectives of the experiment.

TW: Based on the study of the Laboratory equipment. Minimum 8 should be completed from the following lists.

1. Study of history of chemical engineering and chemical technology
2. Study of Basic Chemical Calculations
3. Study of Size reduction
4. Study of Sedimentation
5. Study of Distillation
6. Study of Evaporation
7. Study of Absorption
8. Study of Extraction
9. Study of Crystallization
10. Study of Sulphonation
11. Study of Nitration,
12. Study of Oxidation
13. Study of Etherification
14. Study of flow diagram, flow sheets, & block diagram, with examples
15. Study of Temperature measuring instruments
16. Study of Pressure measuring instruments
17. Study of Level measuring instruments
18. Study of Flow measuring instruments
19. Study of Viscosity measuring instruments
20. Study of Personal protection devices in Chemical Industry

Savitribai Phule Pune University
SE (Chemical Engineering)-2015 Course
209346: Soft Skills
Credits: 1

Teaching Scheme
Practical: 2 hr. /Week

Examination Scheme
TW: 25 Marks

Course Objectives:

1. Focus on over all personality development of the student and to improve his technical writing and documentation.
2. To understand the purpose and process of communication
3. To produce documents reflecting different types of communication such as technical descriptions, proposals, and reports
4. To develop a positive attitude and self-confidence in the workplace
5. To develop appropriate social and business ethics.

Course Outcomes:

On completion of the course, learner will be able to

1. Communicate, interact and present his ideas to the other professionals
2. Understand and aware of importance, role and contents of soft skills through instructions, knowledge acquisition, demonstration and practice.
3. Developing self-motivation, raised aspirations and belief in one's own abilities, defining and committing to achieving one's goals
4. Assessing the requirements of a task, identifying the strengths within the team, utilizing the diverse skills of the group to achieve the set objective

COURSE CONTENTS

Unit I : Self –awareness and Self Development

a) Self-Assessment, Self-Awareness, Perceptions and Attitudes, Positive Attitude, Values and Belief Systems, Self-Esteem, Self-appraisal, Personal Goal setting
b) Career Planning, Personal success factors, Handling failure, Depression and Habit, relating SWOT analysis & goal setting, prioritization

Unit II: Communication Skill

a) Speaking skills: Importance of speaking effectively, speech process, message, audience, speech style, feedback, conversation and oral skills, fluency and self-expression, body language phonetics and spoken English, speaking techniques, word stress, correct stress patterns, voice quality, correct tone, types of tones, positive image projection techniques.

b) Presentation skills: Nature and importance of oral presentation, planning the presentation, preparing the presentation, organizing your presentation, rehearsing and presentation. Improving delivery, checklist for making presentation.
c) Professional writing: Formal and Informal letter writing, Report writing, Resume writing- Sentence structure, sentence coherence, emphasis. Letter writing skills - form and structure, style and tone. Inquiry letters, Instruction letters, complaint letters, Routine business letters, Sales Letters etc.

Unit III: Corporate/Business Etiquettes

Corporate grooming and dressing, Email and telephone etiquettes, etiquettes in social & office setting: Understand the importance of professional behavior at the work place, Understand and Implement etiquettes in workplace, presenting oneself with finesse and making others comfortable in a business setting. Importance of first impression, Grooming, Wardrobe, Body language, Meeting etiquettes (targeted at young professionals who are just entering business environment) , Introduction to Ethics in engineering and ethical reasoning, rights and responsibilities

Unit IV: Interpersonal Relationship

a) Team work, Team effectiveness, Group discussion, Decision making: Team Communication. Team, Conflict Resolution, Team Goal Setting, Team Motivation Understanding Team Development, Team Problem Solving, Building the team dynamics. Multicultural team activity
b) Group Discussion: Preparation for a GD, Introduction and definitions of a GD, Purpose of a GD, Types of GD, Strategies in a GD , Conflict management, Do's and Don'ts in GD

Unit V : Leadership Skills

Leaders' role, Responsibilities and skill required: Understanding good Leadership behaviors, Learning the difference between Leadership and Management, Gaining insight into your Patterns, Beliefs and Rules, Defining Qualities and Strengths of leadership, Determining how well you perceive what's going on around you, interpersonal Skills and Communication Skills, Learning about Commitment.

Unit VI: Other Skills

a) Time management- The Time management matrix, apply the Pareto Principle (80/20 Rule) to time management issues, to prioritize using decision matrices, to beat the most common time wasters, how to plan ahead, how to handle interruptions , to maximize your personal effectiveness, how to say "no" to time wasters, develop your own individualized plan of action
b) Stress management- understanding the stress & its impact, techniques of handling stress Problem solving skill, Confidence building

Textbooks:

1 Krishna Mohan & Meera Banerji, Developing Communication Skills, Macmillan India Ltd, 2009.
2 Simon Sweeney, English for Business Communication, Cambridge University Press, 2012.

3 Sanjay Kumar & Pushp Lata, Communication Skills, Oxford University Press, 2011.
4 Priyadarshi Patnaik, Group Discussion and Interview Skills, Cambridge University Press/Foundation Books, 2011
5 Gopalaswamy Ramesh &Mahadevan Ramesh, The Ace of Soft Skills: Attitude, Communication and Etiquette for Success, Pearson, 2010.

Guidelines for Student's Lab Journal

Laboratory journal should be completed on regular basis. Index, illustrations should be properly written. Assignments given over and above the practical topics should also be attached in the journal.

Presentation in the journal should be neat.

Guidelines for Lab /TW Assessment

Assignment or practical work write-up should be submitted in the next laboratory session. Assessment should be carried out with grades.

Guidelines for Conduct of Laboratory Course

- Arrangements for the practical should be done prior General laboratory safety instructions should be told to the students.
- Specific chemicals, machinery, hardware handling instructions should be given in the instructions
- Aim and objectives of the practical should be explained.
- After completion of experiment, review the attainment of aim and objectives of the experiment.

Suggested List of Laboratory Assignments

Term Work/Assignments
1. SWOT analysis
2. Personal & Career Goal setting – Short term & Long term
3 Presentation Skill
4. Letter/Application/Notice/Agenda/Minutes writing
5. Report writing
6. Listening skills using Language laboratory
7. Group discussion
8. Resume writing
9. Team Activity
10. Public Speaking

Note: Perform any 8 exercises out of above 10 with exercise No. 6 as compulsory.

Savitribai Phule Pune University
SE (Chemical Engineering) 2015 Course
209347: Chemistry-II
Credits: 4+1

Teaching Scheme
Theory: 4 Hrs /Week
Practical: 2 Hrs./Week

Examination Scheme
Online: 50 marks
End Semester: 50 marks
Practical: 50 marks

Prerequisites: Knowledge of fundamental Chemistry up to XII standard and first year Engineering Chemistry.

Course Objectives

1. To impart the basic concepts of organic chemistry
2. To develop understanding about concepts of organic reactions for analysis of unit Processes
3. To study the different analytical instrumentation techniques

Course Outcomes

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

- Demonstrate knowledge of biomolecules and their structures
- Demonstrate understanding of transition metals and coordination chemistry
- Demonstrate knowledge of adsorption and catalysis
- Demonstrate knowledge of industrial chemistry

COURSE CONTENTS

Unit I : Biomolecules (L08)

Carbohydrate: Cyclic structure of glucose, cellulose, starches. Starch based products, Cellulose acetate, nitrate, ether. Proteins-formation of peptide linkage, features of peptide linkage, alpha-helical configuration, beta-pleated structure, primary, secondary, tertiary, quaternary structures of proteins. Amino acids-alpha- amino acids, classification, properties and reactions. General introduction of cofactors and coenzymes, catalytic site of enzyme, factors affecting enzyme activity, classification of enzymes. Vitamins and hormones.

Unit II: Transition metals and Co-ordination chemistry (L08)

Electronic configuration of first series transition metals, shapes of d- orbital characteristics (variable oxidation states, magnetic property, color of transition metal compounds). Ligands, C.N. and geometry, nomenclature of complexes, chelates . Theories of co-ordination- i) Werner ii) EAN iii) VBT for tetrahedral and octahedral complexes iv) CFT (including crystal field splitting in octahedral field and tetrahedral field, CFSE for octahedral complexes , applications of CFT)

Unit III: Volumetric Analysis (L08)

Standard solutions and their preparations, Concentration terms, calculation of equivalent weight in different reactions, types of titrations-neutralization (with titration curves)., complexometric, redox and precipitation with examples. Theory of indicators in above titrations.Numericals on all above

Unit IV: Adsorption and Catalysis (L08)

(a) Adsorption: Introduction to Freundlich and Langmuir theories of adsorption, adsorption from solution, B.E.T. Theory of adsorption of gases, activation energy, numerical on above.

(b) Catalysis - characteristics, types, adsorption theory of catalysis, promoters, poisons, enzyme catalysis, industrial applications of catalysts; Zeolites- structure, properties (adsorption, catalysis), applications as catalyst for reactions(amination of alcohol. NO_X pollution control, alkylation ,cracking conversion of methanol),

i) Co-ordination catalysts- In Wacker process, carbonylation, photolysis of water
ii) Oxide catalysts- oxide surface structure, application of V_2O_5, $Fe_2(MoO_4)$ for oxidation.

Unit V : Stereochemistry (L08)

Basic concepts, conformation isomerism of ethane, propane, butane, cyclohexane, monosubstituted cyclohexane, optical isomerism with 1 and 2 chiral centres, AA, AB type, erythro, threo, mesodiastereomerism, geometrical isomerism (compounds with one double bond)

Unit-VI Industrial Chemistry (L08)

a) Pharmaceuticals and drugs-broad classification on the basis of their mode of action, different drug formulations, synthesis and uses of as aspirin, paracetamol and pencillin G.
b) Pesticides- broad classification based on target species, chemical nature and on site of action with examples and uses. Types of pesticide formulations, pesticide toxicity. Synthesis of B.H.C, parathion and carbaryl.
c) Fertilizers-applications of nitrogen, phosphorous and potassium fertilizers, plant hormones, synthesis of urea, normal superphosphate, potassium nitrate and indole-3-acetic acid.

Textbooks:

1 Organic Chemistry- Finarvol 1 and 2
2 Organic Chemistry- Bahl and Bahl
3 Inorganic chemistry---J D Lee (ELBS)
4 Inorganic chemistry ----Cotton, Wilkinson
5 Instrumental methods of chemical analysis ----Chatwal –Anand
6 Analytical chemistry- Skooge and West
7 Analytical chemistry- Christian
8 Physical Chemistry- Anand Negi
9 Physical Chemistry- Atkins
10 Stereochemistry – Elliel
11 Environmental chemistry- S.S. Dara
12 Environmental Chemistry-Samir K Banerji

Guidelines for Student's Lab Journal

Laboratory journal should be completed on regular basis. Index, illustrations should be properly written. Assignments given over and above the practical topics should also be attached in the journal.

Presentation in the journal should be neat.

Guidelines for Lab /TW Assessment

Assignment or practical work write-up should be submitted in the next laboratory session. Assessment should be carried out with grades.

Guidelines for Conduct of Laboratory Course

- Arrangements for the practical should be done prior General laboratory safety instructions should be told to the students.
- Specific chemicals, machinery, hardware handling instructions should be given in the instructions
- Aim and objectives of the practical should be explained.
- After completion of experiment, review the attainment of aim and objectives of the experiment.

Suggested List of Laboratory Assignments

1. Adsorption of acetic acid on charcoal to verify Freundlich isotherm
2. Determination of purity of sod. Carbonate by titration method
3. Preparation of tris ethylene diammine nickel (II) thiosulphate
4. Preparation of tetramine copper (II) sulphate, pot. trioxalato aluminate
5. Preparation of osazone derivative of glucose
6. Estimation of glucose/acetone in solution
7. Oxidation of toluene to benzoic acid by oxidation with KMnO4
8. Conversion of benzoic acid into its anilide derivative and its crystallization
9. Purification of organic compounds by crystalisation and sublimation (one each)
10. Determination of chloride content by Mohrs method
11. Preparation of nitrobenzene
12. Sulphonation of benzene/toluene

(Any 10 experiments of the above)
Note - practical examination will be for three hours and students will perform TWO experiments

Savitribai Phule Pune University
SE (Chemical Engineering) 2015 Course
209348: Heat Transfer
Credits: 4+1

Teaching Scheme
Theory: 4 Hrs /Week
Practical: 2 Hrs./Week

Examination Scheme
Online: 50 marks
End Semester: 50 marks
Oral: 50 marks

Prerequisites:

Physics, Engineering Mathematics-I and II, Fluid Mechanics

Course Objectives:

1 To use heat transfer principles to understand the behavior of thermal systems.
2 To recognize the various modes of heat transfer i.e. conduction, convection and radiation.
3 To provide the basic tools those are used in thermal system design and to expose students to heat transfer applications in industry

Course Outcomes:

On completion of the course, learner will be able to

1 Students have an ability to demonstrate an understanding of the basic concepts of conduction, radiation, and convection heat transfer
2 Students will be having an ability to conduct experiments as well as to analyze and interpret data.
3 Students have an ability to demonstrate an understanding of the concept of conservation of energy and its application to problems involving conduction, radiation, and/or convection heat transfer.
4 Students also have an ability to identify, formulate and solve engineering problems

COURSE CONTENTS

Unit I : Basics concepts of Heat Transfer and Heat conduction (L08)

The relation of heat transfer with thermodynamics, Modes of heat transfer, Thermal conductivity, thermal insulation, units and dimensions. General differential equation of conduction, Steady state heat conduction through a plane slab, composite slab, hollow cylinder, composite cylinder and hollow sphere. Contact resistance, heat transfer between surfaces and surrounding, critical thickness of insulation. Heat transfer through extended surfaces of uniform cross section. Introduction to transient/unsteady state heat conduction.

Unit II: Convection without Phase Change: (L08)

Natural and forced convection, principal heat balance equation in laminar flow Empirical equations for convection heat transfer in turbulent flow through tubes, through annulus and over a flat plate. Dimensional analysis, dimensional groups used in heat transfer

Unit III: Convection with Phase Change: (L08)

Condensation: Modes and features, Nusselt's equation, condensation on vertical and horizontal plate Boiling: Pool boiling of saturated liquid, types of boiling, concept of critical heat flux.

Unit IV: Radiation (L08)

Thermal radiation, black body radiation, properties of radiation, laws of radiation. The radiation shape factor, various cases of radiation between two surfaces, radiation shields

Unit V : Heat Exchangers (L08)

Basic types of heat exchangers, overall heat transfer coefficient, fouling factor. Double pipe heat exchanger design by LMTD and effectiveness-NTU methods calculations of overall heat transfer coefficient and area), Shell and tube heat exchangers

Unit VI: Evaporation (L08)

Introduction, types of evaporators, material and energy balance, boiling point elevation, capacity and economy, multiple effect evaporators

Textbooks:

1. J P Holman, "Heat Transfer" 9th edition, Tata McGraw Hill Publications, New Delhi (2004)
2. S. P. Sukhatme, "A Textbook on Heat Transfer", 4thed, Universities Press (India), 2005
3. D. Q. Kern, "Process Heat Transfer", 11th ed., Tata McGraw Hill Publication, New Delhi
4. Bird R.B., Stewart W.E., Lightfoot E.N. "Transport phenomena" 2ed., Wiley Publications,2002
5. Yunus A. Cengel "Heat and Mass Transfer" 3rd ed., Tata McGraw Hill Publications, New Delhi (2007)

Guidelines for Student's Lab Journal

Laboratory journal should be completed on regular basis. Index, illustrations should be properly written. Assignments given over and above the practical topics should also be attached in the journal.

Presentation in the journal should be neat.

Guidelines for Lab /TW Assessment

Assignment or practical work write-up should be submitted in the next laboratory session. Assessment should be carried out with grades.

Guidelines for Conduct of Laboratory Course

- Arrangements for the practical should be done prior General laboratory safety instructions should be told to the students.
- Specific chemicals, machinery, hardware handling instructions should be given in the instructions
- Aim and objectives of the practical should be explained.
- After completion of experiment, review the attainment of aim and objectives of the experiment.

Suggested List of Laboratory Assignments

1 Heat conduction
2 2. Natural convection
3 Thermal radiation-determination of emissivity
4 Thermal radiation-Stefan-Boltzmann Constant.
5 Double pipe heat exchanger
6 Shell and tube heat exchanger
7 Plate Heat exchanger
8 Heat transfer in agitated vessels
9 Double effect evaporator
10 Open pan evaporator
11 Heat pipe demonstrator
12 Fluidized bed heat transfer

Students will perform any eight experiments and submit the journal.

Savitribai Phule Pune University
SE (Chemical Engineering) 2015 Course
209349: Principles of Design
Credits: 4+1

Teaching Scheme
Theory: 4 Hrs /Week
Drawing: 2 hrs./ Week

Examination Scheme
Online: 50 marks
End Semester: 50 marks
Term work: 50 marks

Prerequisites: -

Course Objectives:

1 To impart the basic concepts of chemical engineering drawing and mechanical design.
2 Knowledge of basics of process equipment design and important parameters of equipment design
3 To acquire basic understanding of design parameters, complete knowledge of design procedures for commonly used machine components
4 To develop understanding about drawing of shafts, coupling, bearings, keys belts etc.

Course Outcomes:

On completion of the course, learner will be able to–

1 Formulate and analyze stresses and strains in machine elements and structures subjected to various loads.
2 Apply multidimensional static failure criteria in the analysis and design of mechanical components.
3 Analyze and design power transmission shafts carrying various elements with geometrical features.
4 Analyze and design structural joints like riveted and welded joints.
5 Design internal pressure vessels and external pressure vessels.

COURSE CONTENTS

Unit I : Basic Considerations in Design (L08)

Distinction between process design and process equipment design (mechanical design), Design Codes, Design working pressure and temperature, Design Loads, Concept of Stress, strain and modulus of elasticity, Factor of Safety, Young's Modulus, Stress Concentration, Fatigue, Creep, Endurance Limit, Lateral strain and Poisson's Ratio, Stresses due to static and dynamic loads. Thermal stresses, Impact stresses, corrosion allowance, weld joint efficiency factor.

Unit II: Design Preliminaries (L08)

Shear force and bending moment, SFD and BMD for point load and uniformly distributed load, deflection in beams, bending stress, torsional shear stress, Principal stresses and principal planes, application of principal stresses in designing machine members, theories of failure.

Unit III: Design of Shafts, Keys and Couplings (L08)

Shafts: Types of shafts, Design of shafts under steady load, suddenly applied load and fluctuating loads, shafts subjected to combined loads, equivalent bending and twisting moments.
Keys: Types of keys, stresses developed in flat keys, shear and crushing design procedure.
Couplings: Types of couplings, Design of sleeve, split muff and flange coupling

Unit IV: Riveted and Welded joints, Belt drives and Bearings (L08)

Joints: Design of riveted and welded joints
Drives: Types of belts and belt drives, ratio of driving tension, condition for transmission of maximum power.
Bearings: Sliding contact bearings, Types of Sliding contact bearings, life of a bearing, Rolling contact bearings, advantages and disadvantages of rolling contact bearings over sliding contact bearings, types of rolling contact bearings.

Unit V : Design of Thin Walled Pressure Vessels (L08)

Introduction to pressure vessels, types of pressure vessels, proportioning of pressure vessels, selection of L/D ratio, optimum proportions, codes and standards for pressure vessels (IS: 2825; 1969), design stress, design criteria, design of shell (spherical and cylindrical), design of different types of heads and closures, design of flanges and nozzles, compensation for openings and branches. Design of pressure vessels subjected to external pressure.

Unit VI: Design of High Pressure Vessel (L07)

Materials of construction, stresses in thick cylinder, pre stressing of thick walled vessels, monoblock, multilayer, autofrettage, shrink fitted shell, ribbon and wire wound vessel, analysis and design of high pressure vessels including shell and head along with the stress distribution.

Textbooks:

1 L.E. Brownell, E. Young, 1963, Process equipment design, John Wiley, New York.
2 B.C. Bhattacharya, 2015, Introduction to Chemical Equipment Design, C.B.S. Publishers.
3 V. V. Mahajani, S. B. Umarji, 2014, Joshi's Process Equipment Design, Trinity Presss.
4 J.M. Coulson, J.F. Richardson, R.K. Sinott, 2005, Chemical Engineering Design Vol. 6, Pergamon Press.
5 R. S. Khurmi, J. K. Gupta, 2005, A Textbook of Machine Design, Eurasia Publishing House.

Guidelines for Student's Lab Journal

Laboratory journal should be completed on regular basis. Index, illustrations should be properly written. Assignments given over and above the practical topics should also be attached in the journal.

Presentation in the journal should be neat.

Guidelines for Lab /TW Assessment

Assignment or practical work write-up should be submitted in the next laboratory session. Assessment should be carried out with grades.

Guidelines for Conduct of Laboratory Course

- Arrangements for the practical should be done prior General laboratory safety instructions should be told to the students.
- Specific chemicals, machinery, hardware handling instructions should be given in the instructions
- Aim and objectives of the practical should be explained.
- After completion of experiment, review the attainment of aim and objectives of the experiment.

Suggested List of Laboratory Assignments

Term-work shall consist of drawing of minimum 06 Sheets based on the above syllabus out of which 02 Sheets should be performed (drawn) using AUTOCAD/Autodesk or design software. Every student should submit the sheets and journal which will form the term work.

Savitribai Phule Pune University
SE (Chemical Engineering) 2015 Course
209350: Chemical Engineering Thermodynamics-I
Credits: 4

Teaching Scheme
Theory: 4 Hrs /Week

Examination Scheme
Online: 50 marks
End Semester: 50 marks

Prerequisites: -

Course Objectives:

1 Be able to understand the basic thermodynamic terminology and scope, Thermodynamic laws and their applicability and limitations.
2 Select an appropriate equation of state for representing the P-V-T behavior of gases and/or liquids.
3 Calculate changes in U, H, S and G for ideal gases and also for non-ideal gases.
4 Understand the working principle and performance of refrigerators and heat pumps

Course Outcomes:

On completion of the course, learner will be able to

1 Reiterate the first and second laws of thermodynamics, and understand the practical implications of these laws in engineering design.
2 Use problem solving skills developed during the course to solve problems related to processes involving thermal changes.
3 Understand the concepts of heat, work and energy conversion, and can calculate heat and work quantities for industrial processes.
4 An ability to evaluate entropy changes in a wide range of processes and determine the reversibility or irreversibility of a process from such calculations.
5 Understand processes involving power production, refrigeration, and liquefaction, and be able to calculate relevant system efficiencies for these processes.

COURSE CONTENTS

Unit I : Introduction to Chemical Engineering Thermodynamics (L08)

The scope of thermodynamics, fundamental and derived quantities, first law of thermodynamics: Formation of 1st law of thermodynamics, state and path functions, thermodynamic systems, steady state flow system, phase rule, reversible process heat capacity,

Unit II: Volumetric Properties of Pure Fluids (L08)

The P.V.T. behavior of pure substance, the viral equation, the ideal gas, the constant volume, constant pressure, adiabatic, polytrophic processes, real gas, applications of Viral equation, critical properties, Vander Wall equation, Benedict- Webb – Rubin equation, Redlich –Kwong equation.

Unit III: Heat Effects (L06)

Sensible heat effects, temperature dependence of heat capacity, standard heat of reaction, standard heat of formation, standard heat of combustion, temperature dependence of ΔH^0, heat effects of industrial reactions.

Unit IV: Second Law of Thermodynamics (L08)

Limitations of First Law, Statements of second law, analysis of Carnot cycle, ideal and actual engine efficiencies, various thermodynamic cycles, power cycles with external combustion or heat pump cycles, power cycles with internal combustion**,** Concept of entropy and derivation from second law, mathematical statement of 2nd law, statement of 3rd law.

Unit V : Thermodynamic Properties of Fluids (L08)

Fundamental property relations for closed systems, Maxwell relationships, residual properties, residual properties by equations of state, two-phase systems, Clausius- Clapeyron equation, type of thermodynamic diagram, availability.

Unit VI: Refrigeration (L08)

Refrigeration cycle (p-v, t-s, h-s, and h-x diagrams) for vapor compression and Adsorption refrigeration systems, Evaluation of COP, duty and load of such cycles, heat pumps, liquefaction.

Textbooks:

1 J. M. Smith, H. C. Vanness, M. M. Abott, 2005, Introduction to Chemical Engineering Thermodynamics, McGraw Hill, 7th edition
2 T. E. Daubert, 1986, Chemical Engineering Thermodynamics, McGraw Hill
3 H. C. Weber, H. P. Meissner, 1957, Thermodynamics for Chemical Engineers, John Wiley and Sons, 2nd Edition
4 K. V. Narayanan, 2011, Chemical Engineering Thermodynamics, Prentice Hall Of India, New Delhi
5 Y.V.C. Rao, 1997, Chemical Engineering Thermodynamics, Universities Press

Savitribai Phule Pune University
SE (Chemical Engineering) 2015 Course
209351: Mechanical Operations
Credits: 4+1

Teaching Scheme
Theory: 4 Hrs /Week
Practical: 2 Hrs./Week

Examination Scheme
Online: 50 marks
End Semester: 50 marks
Oral: 50 marks
TW: 25 marks

Prerequisites: First year courses in engineering.

Course Objectives:

1 To study properties of solids, separation and size reduction of solids.
2 To understand fluid solid separation using sedimentation, fluidization and beneficiation methods.
3 To study mixing and agitation, filtration, handling and conveying of solids.

Course Outcomes:

On completion of the course, learner will be able to

1 To select suitable type of screening and size reduction equipment for different particle sizes.
2 To select suitable type of thickeners and clarifiers for separation of suspended solid particles from liquid for example applications in Wastewater treatment plants.
3 To apply fluidization and beneficiation techniques in Chemical Industries.
4 To select a suitable type of agitator for mixing and agitation and to estimate power consumption in mixing and agitation.
5 To select a suitable type of filter for filtration of a slurry or a suspension.
6 To select a suitable type of conveyor for transportation of different types of solids.

COURSE CONTENTS

Unit I : Screening and Size Reduction of Solids (L08)

Properties of solids, Performance of screening equipment / testing sieves, U.S.sieve series, Tyler standard sieve series, sieve shaker, types of screen analysis.

Necessity of size reduction, Crushing efficiency, energy requirement calculations by using crushing laws. Classification of size reduction equipment: Crushers, Grinders, Ultrafine grinders, Cutters. Dry versus wet grinding. Open and closed circuit grinding

Unit II: Settling and Sedimentation (L08)

Motion of particle in fluid, drag force, drag coefficient. Gravity settling methods, Terminal falling velocity, Stoke's law and Newton's law of settling.

Gravity sedimentation operations, Sedimentation test, Kynch theory, Determination of thickener area and depth of thickener. Thickeners, Clarifiers, Sedimentation centrifuges.

Unit III: Fluidization and Beneficiation Equipment (L08)

Types of fluidization, fluidized bed systems, determination of minimum fluidization velocity, flow through packed bed, applications of fluidized bed.

Flotation cell, magnetic separator, cyclone separator, liquid cyclone, electrostatic separator, precipitator, scrubbers, fabric filter, mineral jig.

Unit IV: Mixing and Agitation (L08)

Types of Impellers, flow patterns in un-baffled and baffled tanks, Draft tube, mechanically agitated vessel, power requirement in mixing, performance of mixers, Paste and viscous material mixing, solid-solid mixing, Batch and continuous mixers. Agitator selection.

Unit V : Filtration (L08)

Classification of filtration and filters. Theory of filtration-equations. Filter media and filter aids. Batch and continuous filters. Plate and frame filter press, filling and washing in a filter press, horizontal pressure leaf filters. Rotary drum vacuum filters. Centrifugal filters-basket type.

Unit VI: Handling and Conveying of Solids (L08)

Storage of solids, characteristics of bulk solids, Conveyors: Principle, Construction and Working. Advantages, Disadvantages and design calculations of Belt Conveyors, Screw conveyors, Chain & Flight conveyors, Bucket elevators and Pneumatic conveyors.

Textbooks:

1 McCabe W. L. &Smith J.C. "Unit Operations in Chemical Engineering". McGraw Hill Publications.
2 Coulson J. M. and Richardson J.F. "Chemical Engineering Vol. 2", Pergamon Press.
3 Badger W. L and Banchero J.T. "Introduction to Chemical Engineering", McGraw Hill Publications.
4 Foust A. S "Principles of Unit Operation".
5 George G. Brown, "Unit operations", CBS publishers and distributors.

Guidelines for Student's Lab Journal

Laboratory journal should be completed on regular basis. Index, illustrations should be properly written. Assignments given over and above the practical topics should also be attached in the journal.

Presentation in the journal should be neat.

Guidelines for Lab /TW Assessment

Assignment or practical work write-up should be submitted in the next laboratory session. Assessment should be carried out with grades.

Guidelines for Conduct of Laboratory Course

- Arrangements for the practical should be done prior General laboratory safety instructions should be told to the students.
- Specific chemicals, machinery, hardware handling instructions should be given in the instructions
- Aim and objectives of the practical should be explained.
- After completion of experiment, review the attainment of aim and objectives of the experiment.

Suggested List of Laboratory Assignments

1 To determine effectiveness of given set of standard screen.
2 To determine energy consumption and crushing law constants for jaw crusher.
3 To determine Critical speed of Ball mill & Average particle size of the product obtained in ball mill OR Average particle size of product obtained in Buhrstone mill.
4 To determine mixing Index of a mixture in Ribbon Blender. OR To determine mixing Index of mix in Sigma Mixer.
5 To determine filter medium resistance and specific cake resistance by using Rotary Drum Vacuum filter.
6 To determine filter medium resistance and specific cake resistance by using Plate & frame filter Press OR by using centrifugal filter.
7 To determine area of batch thickener by conducting batch sedimentation test.
8 To determine minimum fluidization Velocity & to verify Ergun's Equation.
9 To determine collection efficiency of Cyclone separator for various particle sizes and pressure drops.
10 To determine separation efficiency by using magnetic separator.
11 To determine separation efficiency by using froth flotation cell.
12 To study conveying of solids by using *working models* of Belt conveyor, Chain conveyor, Screw conveyor, Bucket conveyor or elevator and pneumatic conveyor.

Savitribai Phule Pune University
SE (Chemical Engineering)-2015 Course
Course Code: 209352
Course Name: Workshop Practices
Credits: 1

Teaching Scheme
Practical: 2 Hrs./Week

Examination Scheme
Teamwork: 25 marks

Prerequisites

Engineering Graphics I and II, Manufacturing Practices.

Course Objectives

To introduce the students basic concepts in engineering drawing and hands on during workshop practices

COURSE CONTENTS

After completion of this course the students should be able to demonstrate

Course Contents

List of practicals:

1. One job on lathe with taper turning thread cutting, drilling.
2. One job on lathe + milling machine – keyway cutting, gear cutting etc.
3. One job of welding.
4. One job of pattern making and foundry – one simple job of non- ferrous material.

A record of the work performed should be presented in the form of a journal based on topics under (A) and the jobs completed under practicals (B).

Books:

1. S. K. HajraChoudhary, A. K. HajraChoudhary; Elements of Workshop Technology; Vol. I: Manufacturing Processes, Vol. II: Machine Tools; Media Promoters and Publisheres Pvt. Ltd.(2004)
2. N. D. Bhatt, V. M. Panchal; Machine Drawing; Charotor Publishing House, Anand, India.(2002)
3. NarayanaK. L, P. Kannaiah, K. andVenkata Reddy; Machine Drawing; New Age International Limited.(2008)
4. GoutamPohit, and GoutamGhosh; Machine Drawing with AutoCAD, PEARSON Education.(2006)

Guidelines for Instructor's Manual

The Instructor's manual should include Aim, theory, procedure, figure, observations, calculations and results for every experiment.

Guidelines for Student's Lab Journal

The students should drawing during practical in the drawing hall and complete the same during same practical and obtain the sign of the faculty. Neatness in drawing should be maintained.

The students should prepare the job on their own during workshop practices.

Guidelines for Lab Assessment

Term work should be based on continuous monitoring of students during sessions.

Savitribai Phule Pune University
SE (Chemical Engineering)-2015 Course
Audit Course-1

Teaching Scheme
Assignments

Examination Scheme
Certification

The course will be conducted by the institute to develop skills in the engineering students. They should announce the course prior to beginning of the term.

COURSE CONTENTS

The students as a part of this audit course will submit six assignments based on above work. Successful completion of assignments will allow students to earn basic certification.

Savitribai Phule Pune University
SE (Chemical Engineering)-2015 Course
Audit Course-2

Teaching Scheme
Assignments

Examination Scheme
Certification

The course will be conducted by the institute to develop skills in the engineering students. They should announce the course prior to beginning of the term

COURSE CONTENTS

The students as a part of this audit course will submit six assignments based on above work. Successful completion of assignments will allow students to earn basic certification.