Savitribai Phule Pune University

UG CHOICE BASED CREDIT SYSTEM

SYLLABUS

FOR

UNDER GRADUATE ROGRAMME IN SECOND YEAR CHEMICAL ENGINEERING

(2019 Course)

UNDER

FACULTY OF SCIENCE AND TECHNOLOGY

WITH EFFECTIVE FROM A.Y. 2020-21

Savitribai Phule Pune University, Pune

SE(Chemical) 2019 Course (With effect from Academic Year 2020-21) for Semester-III

Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks						Credits			
		Theory	Practical	Tutorial	ISE	ESE	TW	PR	OR	Total	TH	PR	TUT	Total
207004	Engineering Mathematics-III	03	--	01	30	70	25	--	--	125	03	--	01	04
209341	Industrial Chemistry I	03	04	--	30	70	--	50	--	150	03	02	--	05
209342	Fluid Mechanics	03	02	--	30	70	25	--	25	150	03	01	--	04
209343	Engineering Materials	03	02	--	30	70	--	--	25	125	03	01	--	04
209344	Process Calculations	03	--	01	30	70	25	--	--	125	03	--	01	04
209345	Soft Skills	--	02	--	--	--	25	--	--	25	--	01	--	01
	Total	**15**	**10**	**02**	**150**	**350**	**100**	**50**	**50**	**700**	**15**	**05**	**02**	**22**
209346	Audit Course 3	--	MOOC Certificate Course in Chemical &Allied Engineering											

Savitribai Phule Pune University, Pune

SE(Chemical) 2019 Course (With effect from Academic Year 2020-21) for Semester-IV

Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks						Credits			
		Theory	Practical	Tutorial	ISE	ESE	TW	PR	OR	Total	TH	PR	TUT	Total
209347	Industrial Chemistry II	03	04	--	30	70	--	50	--	150	03	02	--	05
209348	Heat Transfer	03	02	--	30	70	--	--	25	125	03	01	--	04
209349	Principles of Design	03	02	--	30	70	25		--	125	03	01	--	04
209350	Chemical Technology I	03	--	--	30	70	--	--	--	100	03	--	--	03
209351	Mechanical Operations	03	02	--	30	70	25	--	25	150	03	01	--	04
209352	Project Based Learning	--	04	--	--	--	50	--	--	50	--	02	--	02
	Total	**15**	**14**	**--**	**150**	**350**	**100**	**50**	**50**	**700**	**15**	**07**	**--**	**22**
209353	**Audit Course 4**	--	Online Course/Spoken Tutorial/NPTEL Certificate Course in Chemical & Allied Engineering											

Savitribai Phule Pune University, Pune
Second Year of Chemical /Bio Technology/Printing Engineering – Sem I (2019 Course)
Course Code: 207004, Course Name: Engineering Mathematics III

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Lectures: 3 Hrs./Week	Theory: 3	In-Sem Exam: 30 Marks
Tutorials: 1 Hr./Week	Tutorial: 1	End-Sem Exam: 70 Marks
		Term work: 25 Marks

Prerequisites: - Differential & Integral calculus, Linear Differential equations of first order and first degree, Collection, classification & representation of data, Permutations & combinations Fourier series and Vector algebra.

Course Objectives:
To make the students familiarize with concepts and techniques in Ordinary and Partial differential equations, Fourier transform, Laplace transform and Vector calculus. The aim is to equip them with the techniques to understand advanced level mathematics and its applications that would enhance analytical thinking power, useful in their disciplines.

Course Outcomes (CO's): At the end of this course, students will be able to
1) Solve higher order linear differential equations and its applications to engineering problems in their disciplines.
2) Apply Integral transform techniques such as Fourier transform & Laplace transform to solve differential equations involved in Vibration theory, Heat transfer, Liquid level systems and related engineering applications.
3) Apply Statistical methods like correlation & regression and probability theory as applicable to analyzing and interpreting experimental data in testing and quality control.
4) Perform vector differentiation & integration, analyze the vector fields and apply to fluid flow problems.
5) Solve Partial differential equations such as wave equation, one and two dimensional heat flow equations.

Unit I: Linear Differential Equations (**LDE**) and Applications (08 Hours)
LDE of n^{th} order with constant coefficients, Complementary Function, Particular Integral, Method of Variation of parameters, Cauchy's and Legendre's DE, Simultaneous and Symmetric simultaneous DE. Applications of LDE to engineering problems and Mass spring system.

Unit II: Laplace Transform **(LT)** and Applications (08 Hours)
Definition of LT, Inverse LT, Properties & theorems, LT of standard functions, LT of some special functions viz. Periodic, Unit Step, Unit Impulse, Error, Si(t) and Ei(t), first order Bessel's.
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 III: Fourier Transform (**FT**) (07 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 IV: Statistics and Probability (07 Hours)

Measures of central tendency, Measures of dispersion, Coefficient of variation, Moments, Skewness and Kurtosis, Correlation and Regression, Reliability of Regression estimates.
Probability, Probability density function, Probability distributions: Binomial, Poisson, Normal, Test of hypothesis: Chi-square test.

Unit V: Vector Calculus (08 Hours)

Vector differentiation, Gradient, Divergence and Curl, Directional derivative, Solenoidal and Irrotational fields, Vector identities. Line, Surface and Volume integrals, Green's Lemma, Gauss's Divergence theorem and Stoke's theorem.

Unit VI: Applications of Partial Differential Equations (PDE) (08 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. Higher Engineering Mathematics by B.V. Ramana (Tata McGraw-Hill).
2. Higher Engineering Mathematics by B. S. Grewal (Khanna Publication, Delhi).

Reference Books:

1. Advanced Engineering Mathematics, 10e, by Erwin Kreyszig (Wiley India).
2. Advanced Engineering Mathematics, 2e, by M. D. Greenberg (Pearson Education).
3. Advanced Engineering Mathematics, 7e, by Peter V. O'Neil (Cengage Learning).
4. Differential Equations, 3e by S. L. Ross (Wiley India).
5. Introduction to Probability and Statistics for Engineers and Scientists, 5e, by Sheldon M. Ross (Elsevier Academic Press)
6. Partial Differential Equations for Scientists and Engineers by S. J. Farlow (Dover Publications, 1993)

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) 2020 Course
209341: Industrial Chemistry-I
Credits: 3+2

Teaching Scheme	**Examination Scheme**
Theory: 3 hrs. /Week	Insem : 30 marks
Practical:4Hrs./Week	End Semester: 70 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

- Analyze the type of forces and synthesize the materials based on their properties
- Estimate the kinetics of reaction and analyze the factors controlling the rate of reactions.
- Analyze the given chemical substance by different Instrumentation techniques
- Estimate the quantity of solute and synthesize the solution based on the properties.
- Evaluate the mechanism of reactions and apply proper factor for increasing the yield of the desired product.
- Apply the basic concepts of dyes and synthesize industrially important dyes.

Unit I: Bonding and Reactivity (L07)

Covalent Bonding- Introduction to VBT, 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 N2, 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.

Unit: II **Reaction Dynamics & Photochemistry** (L07)

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 using steady state approximation. Photochemistry: Introduction, Grotthus –Draper law, Stark-Einstein law, quantum yield, examples of photochemical reactions kinetics of i) H_2, Cl_2 reaction ii) dimerisation of anthracene.

Unit: III Instrumental methods of Analysis (L07)

Chromatography: Adsorption and partition principles, Study of TLC, column, HPLC, Gas Chromatography and their applications. b) Optical methods: UV, Lambert-Beer law, application of UV visible, IR spectroscopy-introduction, instrumentation, applications, identification of functional groups, cis and trans isomers, H-bonding (inter or intramolecular), strength of bond. Flame photometry- principle, instrumentation and applications.

Unit: IV Solution (L07)

Solution:-definition, 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 (L07)

Substitution at saturated carbon (SN1,SN2) - 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, 2Eliminations- E1 mechanism, E2, (Saytzeff, Hoffman products), factors favoring it. Rearrangements- Beckmann, Claisen, Favorskii.

Unit VI: Heterocyclic compounds and Dyes (L07)

Aromaticity, preparation, reactions of pyrrole, furan, pyridine, and quinoline. Dyes-Nomenclature, methods of application, color and chemical constitution (chromophoreauxochrome 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

Suggested List of Practical's (Any 8)

1 Diameter of solute molecule by viscosity measurements.
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)
14 Systematic analysis (Minimum 4 compounds)
15 Determination of percentage composition of binary mixture using Ostwald's viscometer

Savitribai Phule Pune University
SE (Chemical Engineering)-2020 Course
209342: Fluid Mechanics
Credits: 3+1

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

Examination Scheme
In Sem : 30 marks
End Semester: 70 marks
TW: 25 marks, Oral: 25

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 Determine fluid properties and rheological behaviour of fluids
2 Apply the equation of fluid statics and select manometers for the pressure measurement
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 correlations amongst the system variables using dimensional analysis and to study concept of boundary layer theory.
6 Select valves and pumps for transportation of fluid through pipelines and concept of fluidization.

Unit I Introduction (L07)
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 (L07)
Pascal's law, Hydrostatic law, concept of atmospheric, gauge, vacuum and absolute pressure, manometers, and pressure measurement by simple and differential manometer.

Unit III Basic Equations of Fluid Flow and Flow Measuring Devices (L07)
Basic equations of fluid flow: continuity equation, equation of motion, flow measurement using venturimeter, orifice meter, rotameter, pitot tube.

Unit IV: Flow of Incompressible Fluids in Conduits (L07)
Laminar flow through circular pipe: Hagen Poiseuille equation, relation between average and maximum velocity, friction factor chart, Darcy Weisbach equation, major and minor losses.

Unit V: Dimensional Analysis and Boundary Layer Theory (L07)
Fundamental dimensions of quantities, dimensional homogeneity, types of similarities dimensional analysis by Rayleigh's method and Buckingham's method, dimensionless numbers; Concept of hydrodynamic boundary layer, growth over a flat plate, different thickness of

boundary layer, drag on a flat plate, drag coefficient.

Unit VI: Fluidization and Transportation of Fluids (L07)

Fluidization, types of Fluidization, minimum Fluidization velocity, entrainment in Fluidization, Operating characteristics of gas-solid, liquid –solid and liquid – gas, fluidized beds; different types of valves and pumps, blowers and compressors cavitations.

Text Books:

1. McCabe,W. L, J. Smith, and P. Harriot, Unit Operations of Chemical Engineering, McGraw-HillInternational 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, figures, observations, calculations and results for each experiment.

Guidelines for Student's Lab Journal

Laboratory journal should be completed by the students in his/her own hand writing.

Guidelines for Lab:

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

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 Helical coil
13. Flow through Spiral coil

Note: Minimum any eight experiments to be performed from above list of experiments.

Savitribai Phule Pune University
SE (Chemical Engineering) 2020 Course

209343: Engineering Materials

Credits: 3+1

Teaching Scheme	**Examination Scheme**
Theory: 3 Hrs /Week	In-Sem: 30 marks
Practical: 2Hrs/Week	End Semester: 70 marks
	Oral: 25marks

Prerequisites: First year courses in engineering.

- **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, learners will be able to

1. Describe scope of Engineering materials, properties of materials and Selection of materials
2. Test different materials and describe organic materials.
3. Define corrosion, describe it's types, Control and prevent corrosion.
4. Describe polymers Compare types of polymerization and classify plastics, rubbers.
5. Describe Nanomaterials and its synthesis.
6. Test internal properties of engineering materials.

Unit I: Introduction: (L07)
Scope of engineering materials, Definition and explanation of- Melting point, Boiling point, Specific heat, Thermal, conductivity, Thermal expansion, Thermal insulation, Stresses, Strain, Yield stress, Fatigue, Creep.

Unit II: Testing of Engineering Materials: (L07)
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 Organic Materials: (L07)
Iron – Carbon diagram high and low temperature material, insulation, refractories.
Definition and importance of Polymer Addition and condensation Polymerization Plastics: definition, classification, general properties and uses Rubbers : definition, classification, general properties and uses Compare natural and synthetic rubber Vulcanizing of rubber

Unit IV: Corrosion and Its Prevention: (L07)
Definition of corrosion, Types of corrosion: Direct corrosion, Electro-chemical corrosion, Galvanic corrosion, High temperature corrosion , Factors affecting corrosion rate Methods for control and prevention of corrosion.

Unit V: Nanomaterials: (L07)

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

Unit VI: Experimental Techniques: (L07)

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.

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
7. R. A. L Jones, Soft Condensed Matter, Oxford University Press, 2002.
8. William D. Callister, David G. Rethwisch Materials Science and Engineering: An Introduction, Wiley Publisher.
9. B. S. Mitchell An Introduction to Materials Engineering and Science for Chemical and Materials Engineers, John Wiley & Sons, 2004.

Guidelines for Student's Lab Journal:

Laboratory journal should be completed by the students in his/her own hand writing.

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. Study of properties of polymeric materials; impact test and polymeric Tests. Synthesis of Polymers like nylon, PVC, PTFE etc
2. Different types of hardness test on metals. i.e. Rockwell hardness test, Brinell hardness test, Shore Scleroscope tests.
3. Izod and Charpy impact test on mild steel, copper, brass and aluminum.
4. 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.
5. Study experiments based in, i) Dye penetration ii) Rubber lining, iii) Ultrasonic test, iv) Heat treatments.
6. Study of Nanomaterials, Synthesis of Nanomaterials.
7. Study of Moisture Adsorption by Nanomaterials.
8. Study of Temperature V/S Relative Humidity for Nanomaterials.
9. To synthesize gold/silver (Au/Ag) Nanoparticles and record the optical absorption spectra using simple absorption spectrometer.
10. To synthesize zinc oxide (ZnO) Nanoparticles using a chemical route and calculate the size using UV-Vis absorption spectrum.
11. To synthesize titanium Nanoparticles (TiO2) using a chemical route and determine the phase and size using X-ray diffraction. (Using Scherrer formula).
12. To synthesize the Fe2O3 Nanoparticles of different shapes and calculate the average
13. 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)-2020 Course
209344: Process Calculations

Credits: 3+1

Teaching Scheme	**Examination Scheme**
Theory: 3 Hrs. /Week	In sem : 30 marks
Tutorial:1 Hr/Week	End Semester: 70 marks
	TW; 25 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 materials.
2. Apply the various laws governing solid, liquid and gas phases.
3. Perform material balance with and without chemical reaction.
4. Perform material balance for various unit operations or processes in Chemical Engineering.
5. Calculate the energy requirement for various unit operations or processes in Chemical Engineering.

Unit I: Mathematical Principles (L07)

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.

II: Material Balance for Physical Systems (L07)

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 (L07)

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

Unit IV: Energy Balance **(L07)**

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 **(L07)**

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

Unit VI: Fuels and Combustion **(L07)**

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.

Tutorial

To apply the knowledge of the software like ChemCad/ASPEN/DWSIM to solve at least five industry problems of chemical engineering unit operations or processes based on material balance with and without chemical reactions and energy balance.

Savitribai Phule Pune University
SE Chemical Engineering - 2020 Course
209345: Soft Skills
Credits: 1

Teaching Scheme	**Examination Scheme:**
Practical: 02 Hrs/Week	TW: 25 marks

With a view to meet the trained human resource requirements of the Chemical Process and allied industries, students of Chemical Engineering will go through soft skills. The training of students will be conducted in order to improve their personality. This course has an objective of helping them to find suitable jobs by inculcating soft skills components through appropriate training.

- Art of Communication, Importance of internal and external communication. General Communication process, verbal & Non-verbal Communication. Effective Listening skis.
- Interpersonal Skills, Effective presentation skills, Self-awareness. Dealing with emotions. Team work. Leadership qualities.
- Professional etiquettes, Importance of per-placement talks. How to prepare for a Campus interview. Asking right questions during and after pre-placement talks. Collecting relevant information about the visiting company.
- Preparation of resume Effective Interview and group discussion techniques. Effective body language. Undestanding psychology of interviewers. NLP (Neuro-linguistic programming) & NAC (NeuroAssociative conditioning) techniques. Mock interviews and Group Discussion.
- Effective goal setting. Developing a vision mission and purpose for successful professional life (Designing your career). Creative visualization. Power of positive thinking. Art of Living and leaving for professional success. Eustress & distress. Management of stress and strain through meditation & yoga.

Books Recommended:

1. Stephen R. Covey, The 7 habits of highly effective people, Free Press 1989.
2. Stephen R. Covey, The 8th habit, Free Press 1989.
3. Napoleon Hill, Think and grow rich, The Napoleon Hill Foundation, 2012.
4. Anthony Robins, Awaken the giant within, Free Press; New edition, 1992.
5. Nasha Fitter, You're hired, Penguin India, 2009.

Term Work: Term work and theory are considered to be integral part of the course. Term work shall consist of a journal consisting of regular assignments and presentations completed in the practical class and at home, the total number of assignments should 8, generally covering the topics mentioned above. For the purpose of assignments, extensive use of research papers published in technical journals and articles published in magazines and newspapers may be made available so that there is no repetition by the individuals. Oral presentations exercises and group discussions should be conducted batch wise so that there is a closer interaction. **Students should be sent to industrial visits for exposure to corporate environment.**

Savitribai Phule Pune University
SE (Chemical Engineering) 2020 Course

209347 : Industrial Chemistry-II
Credits: 3+2

Teaching Scheme	Examination Scheme
Theory: 3 hrs. /Week	Insem: 30 marks
Practical: 4Hrs./Week	End Semester: 70 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

- Apply the concept of naturally occurring polymer and synthesize the new polymers.
- Apply the theory of synthesis of complex and evaluate their properties
- Analyze the given chemical substance by different Instrumentation techniques.
- Understand catalyst and its mechanism and apply it in the synthesis of compounds
- Understand concept of isomerism and analyze different isomers and their properties
- Understand concept of thermodynamics and apply in chemical industries.

Unit I: Green Chemistry (L07)

Carbohydrate: Cyclic structure of glucose, cellulose, starches. Starch based products, Cellulose acetate, nitrate, ether. catalytic site of enzyme, factors affecting enzyme activity, definition, goals of green chemistry, efficiency parameters, need of green chemistry, Major applications, traditional and green path way of adipic acid, polycarbonate, indigo dye, ibuprofen, carbaryl

Unit II: Transition metals and Co-ordination chemistry (L07)

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 (L07)

Standard solutions and their preparations, Concentration terms, small scale units of concentration, 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: Surface Chemistry (L07)

(a) Adsorption: Introduction to Freundlich and Langmuir theories of adsorption, adsorption from

solution, B.E.T. Theory of adsorption of gases, Application of adsorption, numerical on above.
(b) Applications characteristics, types, adsorption theory of catalysis, promoters, poisons, industrial applications of catalysts; Zeolites- structure, properties , applications as catalyst for reactions (amination of alcohol. NOX pollution control, alkylation, cracking conversion of methanol), Hydroformylation using catalyst, coordination catalysts in Wackers process, carbonylation, photolysis of water.

Unit V: Stereochemistry (L07)

Introduction, classification interconversion of wedge formula, Fischer formula, Newman formula, conformation isomerism of ethane, propane, butane, cyclohexane, optical isomerism with 1 and 2 chiral centres, enantiomers, diastereomers and meso compounds, geometrical isomerism and E – Z nomenclature (compounds with one double bond)

Unit VI: Thermodynamics (L07)

Thermodynamics tems, First law of thermodynamics and its equation in adiabatic, isothermal, isochoric, isobaric process, Enthalpy and Enthalpy change in reaction, Hess's law, Cp, Cv Relation between them, Kirchhoff's law, its equation and application, Bond energies, Statement of second law of thermodynamic, concept of entropy and entropy change, free energy, Gibbs-**Helmholtz equation, criteria of spontaneity.**

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 Stereochemistry By - Ernest Eliel
7. Unit Process in organic synthesis By P. H. Groggins
8 Instrumental Methods of Analysis, H.H.Willard, L.L. Merritt and J.A. Dean & F.A Settle, CBS Publishers, 7th Edition, 1988

Suggested List of Practicals : (Any 8)

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 Sulphonation of benzene/toluene
12. To determine heat of crystallization of CuSO4.5H2O
13. To determine integral and differential heat of solution of a salt
14. To determine thermometric titration curve in the neutralization of strong acid and weak acids against strong base.

Savitribai Phule Pune University
SE Chemical Engineering - 2020 Course
209348: Heat Transfer
Credits: 3 +1

Teaching Scheme Online
Theory: 03 Hrs / Week
Practical: 02 Hrs/Week

Examination Scheme:
In-Semester Exam: 30 Marks
End Semester Exam: 70 marks
Oral Exam: 25 marks

Prerequisites: Fluid Mechanics and Engineering Mathematics-I and II

Course Objectives:

1. To use heat transfer principles to understand the heat transport by conduction, convection and radiation.
2. To design variety of heat exchange equipment and evaporators.
3. To provide the basic tools to expose students to heat transfer applications in industrial processes.

Unit I: Conduction (L07)

Introduction, Heat Transfer and Thermodynamics, Modes of heat transfer, Heat transfer fluxes and resistances, Thermal conductivity, Fourier's law of conduction; General equation for conduction. Conduction through plane, cylindrical and spherical and composite walls, Heat losses and insulation, Critical insulation thickness, introduction to heat transfer with heat sources.

Unit II: Convection (L07)

Introduction, thermal boundary layer, Natural and forced convections, film thickness, heat transfer coefficient, various resistances, Empirical equations for convection heat transfer in laminar and turbulent flow through tubes, through annulus and over a flat plate. Reynolds analogy, Chilton-Colburn analogy, Dimensional analysis, dimensional groups used in heat transfer.

Unit III: Radiation (L07)

Radiant energy-distribution, various laws of radiation and their derivations, Planck's law, Wien's law, The Stefan-Boltzmann law for blackbody, Kirchhoff's law, black body, gray body, emissive power; Exchange of energy between two surfaces; View factors, combined heat transfer by conduction, convection and radiation, Furnace calculations.

Unit IV: Boiling and Condensation (L07)

Introduction, importance of latent heat, Pool boiling and film boiling, concept of critical heat flux. Condensation: Modes and features, derivation of Nusselt equation on condensate film, condensation on vertical and horizontal plates, condensation on inside and outside pipes for horizontal and vertical flows.

Unit V: Heat Exchange Equipment (L07)

Types of heat exchangers; Co-current and counter-current flows, Fouling factors, choice of thermic fluids, Equivalent diameter; LMTD, correction factors, Temperature profiles in heat exchangers, pressure drop, Process design of heat exchangers including double pipe heat exchanger, Why multi-pass exchangers, shell and tube heat exchanger, effectiveness of co-current and counter-current heat exchangers, cross flow heat exchangers, Heat transfer equipment auxiliaries: Steam trap.

Unit VI: Evaporation **(L07)**

Introduction, solution properties, foaming, degradation due to high temperature, scaling, equipment material, types of evaporators, material and energy balance for single effect systems, boiling point elevation, capacity and economy, multiple effect evaporators. design of evaporators.

Books:

1. Holman J. P., "Heat Transfer", McGraw-Hill, Inc.
2. Kern D. Q., "Process Heat Transfer", McGraw-Hill, Inc.
3. Coulson, J. M., Richardson, J. E., "Chemical Engineering", Vol.- I, Pergamon Press.
4. Sinnott R. K., "Chemical Engineering", Vol.- VI, 4th Edition, Chemical Engineering Design, Elsvier.
5. Cengel Y. A., "Heat and Mass Transfer" 3rd ed., Tata McGraw Hill Publications, New Delhi (2007)

Guidelines for Student's Lab Journal

Laboratory journal should be completed by the students in his/her own hand writing.

Guidelines for Conduct of Laboratory Course

- General laboratory safety instructions should be told to the students before performance of the practicals.
- Specific chemicals, machinery, hardware handling instructions should be given in the SOPs and displayed in the laboratory.
- Aim and objectives of the laboratory experiment/assignment should be explained.
- Review the attainment of aim and objectives of the experiment after completion of experiment.

List of Practical (Minimum 8 practical to be performed)

1. Heat conduction – Determination of thermal conductivity
2. Convection (Natural/Forced)-Calculation of heat transfer coefficient
3. Thermal radiation-determination of emissivity
4. Construction of pool boiling curve
5. Determination of heat transfer coefficient of Double pipe heat exchanger
6. Determination of heat transfer coefficient of Shell and tube heat exchanger
7. Material balance and energy balance of Single effect evaporator
8. Design of shell and tube heat exchanger/ Calculations using HTRI software
9. Design of multiple effect evaporators using software (Excel, Chemcad, Python, UNISIM, ASPEN Etc.)
10. Study of Finned tube heat transport
11. Heat transfer analysis of Plate Heat exchanger
12. Heat transfer in agitated vessels

Students will perform eight experiments and submit the journal however Practical No. 8 & 9 is compulsory

Savitribai Phule Pune University
SE (Chemical Engineering) 2019 Course
209349 Principles of Design
Credits: 3+1

Teaching scheme:	**Examination scheme**
Lecture: 3 hr/week	In Semester: 30 Marks
Practical: 2 hr/week	End Semester: 70 Marks
	Term-work: 25 marks

Course Prerequisites: Basic knowledge about materials and properties, Knowledge about stress, strain and loads, Knowledge about basics of mechanical engineering

Course Objectives:

1. Apply basic knowledge of strength of materials for designing machine components.
2. Analyze stresses and strains in machine elements and structures subjected to various loads.
3. To develop understanding about drawing of shafts, keys, couplings etc.
4. To impart the basic concepts of chemical engineering drawing, mechanical design and process design for different process equipments
5. Define the approach and solve process design problems by employing knowledge of mathematics.
6. Critically review design alternatives and select and size appropriate process equipment.

Course Outcomes:

Students completing this course should 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 like keys and couplings with geometrical features.
4. Analyze and design structural joints like riveted and welded joints.
5. Select appropriate belt drive arrangement and bearings for required service.
6. Design pressure vessels for variety of unit operations (absorption/stripping, distillation, extraction, adsorption, crystallization, chemical conversions etc).

Unit 1. Basic considerations in design: (L07)

Concept of Stress, strain and modulus of elasticity, Factor of Safety, Stress Concentration, Lateral strain and Poisson's Ratio, Stresses due to static and dynamic loads. Thermal stresses, Impact stresses, Distinction between process design and process equipment design (mechanical design), Design Codes, Design working pressure and temperature, Design Loads, corrosion allowance, weld joint efficiency factor, proportioning of pressure vessels, selection of L/D ratio, optimum proportions

Unit 2: Design Preliminaries: (L07)

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 3: Design of shafts, keys, and couplings: (L07)

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 rigid flange coupling

Unit 4: **Design of joints and drives: (L07)**

Joints: Design of riveted joints, strength and efficiency of a riveted joint, Types of welded joints, Design of welded joints, strength of transverse fillet welded joints, strength of parallel fillet welded joints, strength of butt joints

Drives: Types of belts and belt drives, Velocity ratio, slip and creep of the belt, length of belt, ratio of driving tension, condition for transmission of maximum power

Unit 5: Design of thin-walled pressure vessels: (L07)

Introduction to pressure vessels, types of pressure vessels, 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: design of shell, heads, stiffening rings as per IS: 2825: 1969

Unit 6: Design of thick-walled pressure vessels (High pressure (L07)

Materials of construction, stresses in thick cylinder, prestressing 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

Reference Books:

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

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.

Suggested List of Laboratory Assignments

Term-work shall consist of drawing of minimum 07 Sheets based on the above syllabus out of which **03 Sheets/practical should be performed (drawn) using PV-LITE design software compulsorily**. Every student should submit the sheets and journal which will form the term work.

SavitribaiPhule Pune University
SE Chemical Engineering - 2020 Course
209350: Chemical Technology I
Credits: 3

Teaching Scheme Online
Theory: 03 Hrs / Week

Examination Scheme:
In-Semester Exam: 30 Marks
End Semester Exam: 70 marks

Course Outcomes: On completion of the course, learner will beable to

1. State basic principles of chemical process industry.
2. Describe various manufacturing processes used in chemical process industries.
3. Understand major engineering problems encountered in chemical process industries.
4. Determine process aspects like yield, byproducts formed,generation of waste.
5. Draw and explain process flow diagrams for a given process.
6. Understand use of various equipment/instruments used in process industry.

Unit I: Introduction: Chemical industries-facts and figures, Unit operation and unit process concepts, Chemical processing and role of chemical engineers. Chloro-Alkali Industries: Soda ash, Solvay process, dual process, Natural soda ash from deposits, Electrolytic process, Caustic soda.

Unit II: Phosphorus Industries: Phosphoric acid, Wet process, Electric furnace process, Calcium phosphate, Ammonium phosphates, Nitrophosphates, Sodium phosphate. Potassium Industries: Potassium recovery from sea water.

Unit III: Nitrogen Industries: Ammonia, Nitric acid, Urea from ammonium carbonate, Ammonium nitrate.

Unit IV: Soap and Detergents: Batch saponification production, Continuous hydrolysis and saponification process, Sulfated fatty alcohols, Alkyl-aryl sulfonates.

Unit V:Plastic Industries: Polymerization fundamentals, Polymer manufacturing processes, Ethenic polymer processes, Polycondensation processes, Polyurethanes.

Unit VI: Petroleum Processing: Production of crude petroleum, Petroleum refinery products, Types of refineries, Design of refinery, Choice of crude petroleum, Refinery processes, Pyrolysis and cracking, Reforming, Polymerization, Isomerization, Alkylation. Rubber: Elastomer polymerization processes, Rubber polymers, Butadiene-Styrene copolymer, Polymer oils and rubbers based on silicon.

Text / Reference:

1. Austin G.T., Shreve's Chemical Process Industries - International Student Edition, 5th Edition, McGraw Hill Inc., 1998.
2. Sittig M. and GopalaRao M., Dryden's Outlines of Chemical Technology for the 21st Century, 3rd Edition, WEP East West Press, 2010
3.Chemical Technology Vol. I, II, III, IV Chemical Engg. IIT Madras

Note: **Students should be sent to industrial visits for exposure to Chemical Industry.**

Savitribai Phule Pune University
SE (Chemical Engineering) 2020 Course
209351 : Mechanical Operations
Credits: 3+1

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

Examination Scheme
In-Sem: 30 marks
End Semester: 70 marks
TW: 25 marks, Oral: 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

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

Unit I : Screening and Size Reduction of Solids (L07)

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 (L07)

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 (L07)

Types of fluidization, fluidized bed systems, determination of minimum fluidization velocity, flow through packed bed, applications of fluidized bed. Ergun equation and its derivation,

Kozeny Carman equation, Darcy's law. Flotation cell, magnetic separator, cyclone separator, liquid cyclone, electrostatic separator, precipitator, scrubbers, fabric filter, mineral jig.

Unit IV: Mixing and Agitation (L07)

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.

Unit V: Filtration (L07)

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 (L07)

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 by the students in his/her own hand writing.

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.

List of Laboratory Experiments (Minimum 8 Experiments to be performed)

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.
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 separation efficiency by using magnetic separator.
9. To determine separation efficiency by using froth flotation cell.
10. To determine minimum fluidization Velocity & to verify Ergun's Equation.
11. To study Vacuum filter.
12. To determine collection efficiency of Cyclone separator for various particle sizes and pressure drops.
13. 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) 2019 Course
209352 Project-Based Learning
Credits: 02

Teaching Scheme:	**Examination Scheme:**
PR: 04 Hrs/Week	**TW: 50 Marks**

Course Objectives:

1. To improve the exposure, understanding and learning of the students.
2. To integrate knowledge and skills from various domains.
3. To help students gain confidence for meeting new challenges through lifelong learning.

Course Outcomes:

CO1: Student will be able to identify the problem and approach the solution comprehensively.
CO2: Students will comprehend the impact of engineering in a universal, economic, environmental, and societal context.
CO3: Students will be able to appreciate the need for, and develop a capability to employ life-long learning.

Group Structure:
Students can work individually or in a team of maximum 4.A faculty as a supervisor/mentor will be assigned to individual/groups.

Selection of Project/Problem:
The project will start by identifying latest problems related to various Chemical Engineering processes and will involve designing relevant solutions. The problems may be from environment or process industries or any other domain which can be studied and solved. The problem will give a foundation for the learning as it will be having a particular practical, scientific, social and/or technical sphere of influence. The problem should position as one precise case or demonstration of added general learning outcomes related to knowledge and/or modes of inquiry.
The learning from the problem will be based on the approach of solving the problem. Thus, the process of solving the problem will form the basis for Project-Based Learning (PBL). The solution of the problem can be elucidated from among three broad categories: Study-based, Laboratory-based and Computer-based. Under these broad categories, Project-Based Learning will lead to the learning of either or combination of understanding using literature survey, different computer programming tools, various lab opportunities for solving different problems, and understanding the preparation of report. This will lead to a well-rounded, lifelong learning for the students.

Assessment:
Progress of the PBL will be assessed on a weekly basis. The students and the mentor will be responsible for the weekly evaluation. The individual and the group performance must be monitored and will be continuously evaluated and be presented in the Continuous Assessment Sheet (CAS). An active participation from both the mentor and the students for the continuous assessment will enhance its efficiency and effectiveness.

The individuals or the groups should adhere to ethical standards, by maintaining a culture of authentic collaboration, self-motivation, peer-learning and personal responsibility. The mentors and the Department should support the students by providing proper guidance, explaining them the importance of the course and the various resources and services available for it.
The assessment will evaluate the various skills acquired during the learning through developing a model and/or report and/or presentation. The assessment will be considering:

- Individual assessment for each student (individual capacity, role and involvement in the project)
- Group assessment (defined roles, distribution of work, intra-team communication and teamwork)
- Documentation and presentation

Evaluation and Continuous Assessment:
It is recommended to have a continuous assessment of the course and therefore all the activities must be properly recorded on a regular basis. For the same, proper documentation in the form of Continuous Assessment Sheet (CAS), to be maintained by the mentor/Department and the students.

Recommended parameters for assessment, evaluation and weightage:

- Idea Inception **(5%)**
- Outcomes of PBL/ Problem Solving Skills/ Solution provided/ Final product **(50%)** (Individual assessment and team assessment)
- Documentation (Gathering requirements, design and modeling, implementation/execution, use of technology and final report, other documents) **(25%)**
- Demonstration (Presentation, User Interface, Usability etc) **(10%)**
- Contest Participation/publication **(5%)**
- Awareness/Consideration of Environment/Social ethics/Safety measures/Legal aspects **(5%)**