Syllabus

S.E. Chemical Engineering

(With effect from 2013-14)

Faculty of Engineering and Technology

North Maharashtra University, Jalgaon

NORTH MAHARASHTRA UNIVERSITY, JALGAON
STRUCTURE OF TEACHING & EVALUATION
S.E. (CHEMICAL ENGINEERING) W.E.F.2013-2014

SEMESTER III

COURSE CODE	NAME OF THE COURSE	GROUP	TEACHING SCHEME				EVALUATION SCHEME					CREDITS
							THEORY		PRACTICAL		TOTAL	
			THEORY HRS/week	TUTORIAL HRS/week	PRACTICAL HRS/week	TOTAL	ISE	ESE	ICA	ESE		
	Engineering Mathematics-III	A	3	1	--	4	20	80	--	--	100	4
CHL 301	Chemical Engineering Materials	B	3	--	--	3	20	80	--	--	100	3
CHL 302	Fluid Flow Operation	D	3	1	--	4	20	80	--	--	100	4
CHL 303	Applied Inorganic Chemistry	D	3	--	--	3	20	80	--	--	100	3
CHL 304	Applied Organic Chemistry	D	3	--	--	3	20	80	--	--	100	3
	Soft Skills-III	C	1	--	2	3	--	--	50	--	50	2
CHP 305	LAB Chemical Engineering Materials	B	--	--	2	2	--	--	50	--	50	1
CHP 306	LAB Fluid Flow Operation	D	--	--	2	2	--	--	25	25(OR)	50	1
CHP 307	LAB Applied Inorganic Chemistry	D	--	--	2	2	--	--	25	25	50	1
CHP 308	LAB Applied Organic Chemistry	D	--	--	2	2	--	--	25	25	50	1
	TOTAL		**16**	**2**	**10**	**28**	**100**	**400**	**175**	**75**	**750**	**23**

SEMESTER IV

COURSE CODE	NAME OF THE COURSE	GROUP	TEACHING SCHEME				EVALUATION SCHEME					CREDITS
							THEORY		PRACTICAL		TOTAL	
			THEORY HRS/week	TUTORIAL HRS/week	PRACTICAL HRS/week	TOTAL	ISE	ESE	ICA	ESE		
CHL 401	Chemical Engineering Processes-I	D	3	--	--	3	20	80	--	--	100	3
CHL 402	Process Calculations	D	3	1	--	4	20	80	--	--	100	4
CHL 403	Mechanical Operation	D	3	1	--	4	20	80	--	--	100	4
CHL 404	Applied Physical Chemistry	D	3	--	--	3	20	80	--	--	100	3
CHL 405	Chemical Engineering Processes-II	D	3	--	--	3	20	80	--	--	100	3
CHP 406	*LAB Computer Applications	B	1	--	2	3	--	--	50	--	50	2
CHP 407	#LAB Chemical Processes	D	--	--	2	2	--	--	50	25	75	1
CHP 408	LAB Mechanical Operation	D	--	--	4	4	--	--	50	25(OR)	75	2
CHP 409	LAB Applied Physical Chemistry	D	--	--	2	2	--	--	25	25	50	1
	TOTAL		**16**	**2**	**10**	**28**	**100**	**400**	**175**	**75**	**750**	**23**

NOTE: As Mechanical Operation practical requires 4 hrs workload for performance of practical hence two laboratory hours are merged to form a four hours slot.

*computer based Numerical Methods in Chemical Engineering.

should include practicals of Chemical Engineering Processes-I & Chemical Engineering Processes-II.

S.E. Chemical Engineering

Semester-III

Faculty of Engineering and Technology

North Maharashtra University, Jalgaon

Course Outline

Engineering Mathematics -III | **EM-III**

Course Title | Short Title | Course Code

Course Description:

This course is aimed at introducing the fundamentals of basic Mathematics to undergraduate students. The background expected includes a prior knowledge of Mathematics from first year engineering or diploma and familiarity with various laws, principles and theories. The goals of the course are to understand the basic principle of Mathematics and its application in different area.

	Hours per Week	No. of Weeks	Total Hours	Semester Credits
Lecture	**03**	**15**	**45**	**03**
Tutorial	**01**	**15**	**15**	**01**

Prerequisite Course(s): EM-I, EM-II/ Diploma Mathematics.

General Objective:

The basic necessity for the foundation of Engineering and Technology being Mathematics, the main aim is to teach mathematical methodologies and models, develop mathematical skill and enhance thinking and decision making power of student.

Learning Outcomes: After completion of this course learner will be able to:

1. Apply knowledge of mathematics in engineering and technology.

2. Identify, formulate and solve engineering problems.

3. Design Mathematical models for engineering problems and solve them.

SE Chemical Engineering **Semester – III**

Engineering Mathematics-III
(Course Content)

Teaching Scheme
Theory : 3 hours/ week
Tutorial : 1 hour/ week

Examination Scheme
End Semester Examination (ESE) : 80 Marks
Paper Duration (ESE) : 03 Hours
Internal Sessional Examination (ISE) : 20 Marks

UNIT-I: Linear Differential Equations: **(08 Hours, 16 marks)**

- Solution of LDE of order n with constant coefficients.
- Method of variation of parameters (Only second order).
- Cauchy's linear equation.
- Legendre's linear equation.

UNIT-II: Applications of Linear Differential Equations and Partial Differential equations

(08 Hours, 16 marks)

- Applications of linear differential equations to Chemical Engineering.
- Applications of Partial Differential equations to

  i) One dimensional heat flow equation $\frac{\partial u}{\partial t} = C^2 \frac{\partial^2 u}{\partial x^2}$

  ii) Two dimensional heat flow equation $\frac{\partial^2 z}{\partial x^2} + \frac{\partial^2 z}{\partial y^2} = 0$

UNIT-III: Laplace Transform **(08 Hours, 16 marks)**

- Definition and Existence of Laplace transforms.
- Laplace Transform of elementary/standard functions.
- Theorems & Properties of Laplace Transform (without proof).
- Inverse Laplace Transform.
- Laplace Transform of Unit step function.
- Solution of differential equations using LT.

UNIT-IV: Statistics and Probability distributions (08 Hours, 16 marks)

- Introduction to Mean, Mode, Median standard deviation, Variance, Coefficient of variation.
- Moments, Skewness and kurtosis.
- Correlation and Regression.
- Binominal Distribution.
- Poisson distribution.
- Normal distribution.

UNIT-V: Vector Calculus (08 Hours, 16 marks)

- Introduction to Gradient, Divergence, Curl, Solenoidal and Irrotational vector fields.
- Vector integration: Line Integral, Surface and Volume integrals.
- Gauss's, Stoke's and Green's Theorems (without proof).

REFERENCE BOOKS:

1. H.K. Dass - Advanced Engineering Mathematics (S. Chand Publication) New Delhi.
2. Erwin Kreyszig - Advanced Engineering Mathematics (Wiley Eastern Ltd.)
3. B.S. Grewal - Higher Engineering Mathematics, Khanna Publication, Delhi
4. Wylie C.R. & Barrett - Advanced Engineering Mathematics - Mc Graw Hill
5. B.V. Raman - Engineering Mathematics - Tata Mc- Graw – Hill.
6. A Text Book of Engineering Mathematics, By N. P. Bali, Laxmi Publication.

Course Outline

Chemical Engineering Materials **CEM** **CHL 301**
Course Title Short Title Course Code

Course Description: This course provides the knowledge of materials to undergraduate engineering students, and is designed to strengthen the fundamentals so that they can build their own interface of material selection in chemical industries with their industrial applications in the branch of chemical engineering.

	Hours per Week	No. of Weeks	Total Hours	Semester Credits
Lecture	03	15	40	03

Prerequisite Course(S): Engineering Chemistry-I&II

General Objectives:

1. To introduce the basics of material science and its significance in chemical process industry.
2. To study the metallurgical & mechanical properties of materials in chemical process industry.
3. To study industrially important materials.

Learning Outcomes:

Students completing this course will able to know the sources and importance of materials in context to chemical process industries. They will also study the technique of selection of linings to be used in chemical process industries. Students will be also in a position to identify industrially important materials on the basis of their mechanical, physical and chemical properties.

SE Chemical Engineering Semester – III

Chemical Engineering Materials

(Course Content)

Teaching Scheme

Theory : 3 hours/ week
Practical : 2 hour/ week

Examination Scheme

End Semester Examination (ESE) : 80 Marks
Paper Duration (ESE) : 03 Hours
Internal Sessional Examination (ISE) : 20 Marks
Internal Continuous Assessment (ICA) :50 Marks

UNIT-I **No. of Lect. – 08, Marks: 16**

Introduction to materials and their properties:

Simple stresses and strains, Concept of stress, strain, shear stress, shear strain, Hooks law, Elastic limit, stress-strain curve for mild steel and elastomeric materials, factor of safety, Poisson's ratio, Strain energy due to axial load and impact. Introduction to determination of mechanical properties of materials ASTM methods.

UNIT-II

No. of Lect. – 08, Marks: 16

Metallic Materials:

Cast iron, Wrought iron and steel, effect of addition of elements such as Si, C,P, Mn,N to Iron. Elastic and plastic deformation, heat treatments alloys such as stainless steel, brass, bronze, duralumin, alnico, Nichrome, solder material.

UNIT-III **No. of Lect. – 08, Marks: 16**

Selection of materials for fabrication and erection of chemical plant:

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-IV **No. of Lect. – 08, Marks: 16**

Electrical and Magnetic Materials

Factors affecting the resistivity of conductors, properties of materials such as Ag, Cu, Al, Nichrome and Ca as dielectric characteristics, insulating materials such as mineral oil, PVC, Mica fibers, glass and asbestos, Magnetisation, soft and hard magnetic materials such as a silicon iron, Alnico types alloys and ferrites.

UNIT-V **No. of Lect. – 08, Marks: 16**

Selection of materials and linings

1. Selection of Material of Construction
a) Selection materials of construction for sulfuric acid, Nitric acid, Phosphoric acid & phosphate fertilizers, Hydrogen & Ammonia plants.
b) Selection of materials for Urea synthesis reactors and CO_2 absorption systems.
2. Linings for process equipments
Metal lining, glass linings, ceramic linings & plastic linings.
Glassed steel for process equipment, Thermomechanical properties of glass lined equipments. Membrane linings for vessels holding corrosive liquids.

Textbooks:

1 R.B. Gupta, Material science, Satya Prakashan, 1981
2. V.K. Manchanda, A text book of material science.New India Publishing House
3. V. Raghavan, Material science and engineering, Prentice Hall of India
4. James F. Shacketford, Introduction to material science, McMillan publishing company, New York ISBN 1990.
5. D.Z. Jestrazebaski, Properties of Engg. Materials, 3rd Ed. Toppers.Co. Ltd.
6. J.L.Lee & Evans "Selecting Engineering materials for chemical & process plants" Business Works 1978.
7. Materials Engineering-II-Controlling corrosion in process equipments, Edited by Kenneth J. McNaughton and staff of Chemical Engineering, McGraw Hill Publication Co. ,New York,N.Y.

References:

Don W. Green, Perry's Chemical Engineers Handbook, 8th Edn., McGraw-Hill

Course Outline

Fluid Flow Operation | **FFO** | **CHL 302**
Course Title | Short Title | Course Code

Course Description:

This course provides the students basic understanding of fluids (liquids and gases) and the forces on them. Fluid mechanics can be divided into fluid statics, the study of fluids at rest; fluid kinematics, the study of fluids in motion; and fluid dynamics, the study of the effect of forces on fluid motion. It includes fluids transportation, filtration, and solids fluidization.

Lecture	Hours per Week	No. of Weeks	Total Hours	Semester Credits
	03	15	40	03
Tutorial	01	15	13	01

Prerequisite Course(S): - Engineering Mechanics, Mathematics

General Objectives:

1. To study fluid properties
2. To study velocity concept, the continuity equation, Eulers equation of motion a long streamline, Bernoullis equations for different conditions.
3. To study flow through pipeline system: Reynolds experiment, Laws of friction, Major and minor losses, friction factor chart, effect of heat transfer on friction factor, distribution of flowing fluids through branched pipes, hydraulic gradient line and total energy line.
4. To understand flow of compressible fluids, Continuity equation, total energy balance, mechanical energy balance, ideal gas equations, flow past immersed bodies , drag coefficient-friction in flow through bed of solids and Boundary layer theory:
5. To study flow and pressure measurement
6. To understand pumping of fluids

Learning Outcomes:

After completing the course the students will able to understand the role of mechanical and hydro dynamical unit operations in the field of chemical engineering. The students will also understand key concepts and fundamental principles, together with the assumptions made in their development, pertaining to fluid behavior, both in static and flowing conditions. The students will learn to deal effectively with practical engineering situations, including analysis and design of engineering systems and devices involving fluids and flow. Students will clearly understand the knowledge of piping & pumping system which is important in chemical industries.

SE Chemical Engineering **Semester – III**

Fluid Flow Operation
(Course Content)

Teaching Scheme

Theory : 3 hours/ week
Practical : 2 hour/ week
Tutorial : 1 hour/ week

Examination Scheme

End Semester Examination (ESE) : 80 Marks
Paper Duration (ESE) : 03 Hours
Internal Sessional Examination (ISE) : 20 Marks
Internal Continuous Assessment (ICA) : 25 Marks
End Semester Examination (ESE) (OR):25 Marks

UNIT-I **No. of Lect. – 08, Marks: 16**

Fundamental concepts of fluid flow, mechanism of compressible and non compressible fluid flow, equation of continuity, Reynolds number, significance, Bernoulli's theorem, distribution of velocities and fluid flow profiles, friction factor and friction losses in pipes, roughness factor and its significance, pipe fittings, equivalent length of fittings etc. Energy losses due to sudden contraction and expansion.

UNIT-II **No. of Lect. – 08, Marks: 16**

Boundary layer theory, Velocity profile and boundary layer growth along a flat plate, thickness of boundary layer (definition and formulae only), separation of boundary, boundary layer calculations for turbulent flows.
Dimensional analysis and model studies: Dimensional analysis, Buckingham's PI theorem, dimensionless numbers, application to fluid flow problem.

UNIT-III **No. of Lect. – 08, Marks: 16**

Flow measuring devices for incompressible and compressible fluids: orificemeter, venturimeter, pitot tube, rotameters, notches and weirs, gas flow meters, coefficient of discharge and calculations.

UNIT-IV **No. of Lect. – 08, Marks: 16**

Transportation of fluids, reciprocating and centrifugal pumps, pump characteristics, Diaphragm pumps, rotary pumps, screw pumps, gear pumps, pump power calculations, pump selection and trouble shooting of pumps, priming, cavitation , NPSH of pumps.

UNIT-V **No. of Lect. – 08, Marks: 16**

Fluidization, aggregate and particulate fluidization, minimum fluidization velocity, entrainment in fluidization. Packed Bed, pressure drop in packed beds, packing materials and their selection criteria, Loading and flooding in packed beds, Kazenger karma equation,- Industrial application.

Textbooks:

1) Dr.R.K. Bansal, Fluid Mechanics: Laxmi Publications, New Delhi.
2) Coulson J.M. and Richardson J.F.; Backhurst J.R. and Harker J.H.; Chemical Engineering, Vol. I , II & IV, Publishers: Butterworth - Heinmann, 2001-2002.
3) R.P.Vyas Fluid Mechanics, Denett Publication.
4) W.L. McCabe & J.C. Smith, Unit operations in chemical engineering: McGraw Hill/Kogakusha Ltd
5) I P. Chattopadhyay, Unit operations of chemical engineering-volume I: Khanna Publication New Delhi, 2nd edition 1996.

References:

Don W. Green, Perry's Chemical Engineers Handbook, 8th Edn., McGraw-Hill

Course Outline

Applied Inorganic Chemistry **AIOC** **CHL 303**
Course Title Short Title Course Code

Course Description:

This course provides the students basic understanding of theoretical inorganic chemistry and to apply this understanding in how solid-state inorganic materials are used in current and emerging applications.

	Hours per Week	No. of Weeks	Total Hours	Semester Credits
Lecture	**03**	**15**	**40**	**03**

Prerequisite Course(S): Engineering Chemistry-I & II

General Objectives:

1. To differentiate between the essential features and properties of covalent, ionic and metallic bonding & the concept of hybridization and its types.
2. To study the atomic orbital concept, molecular orbital theory, VSEPR theory of chemical bonding.
3. To recognize different types of transition metals and recall their industrially important compounds with basic properties.
4. To study basics of metallurgical operations for extracting metals from ores.
5. To know the Gibb's phase rule with basic terms involved in it and its importance.
6. To study the construction of phase diagrams for alloy systems.
7. To study the inorganic engineering materials & composites.

Learning Outcomes:

Students completing this course will able to differentiate between ionic and covalent interactions observed in molecules. They would also able to construct molecular orbital diagrams for simple molecules and will predict the shapes of small molecules based on VSEPR theory. They will also identify the engineering materials best suited for particular application in industry.

SE Chemical Engineering **Semester – III**

Applied Inorganic Chemistry
(Course Content)

Teaching Scheme
Theory : 3 hours/ week
Practical : 2 hour/ week

Examination Scheme
End Semester Examination (ESE) : 80 Marks
Paper Duration (ESE) : 03 Hours
Internal Sessional Examination (ISE) : 20 Marks
Internal Continuous Assessment (ICA) : 25 Marks
End Semester Examination (ESE) (PR):25 Marks

UNIT-I **No. of Lect. – 08, Marks: 16**

Chemical Bonding:
Ionic bond : The ionic model, Lattice energy, The Born- Haber cycle, Applications of lattice energy.
Metallic bond: Electron sea model , explanation of metallic properties on the basis of electron sea model.
Covalent bond: Polarity in covalent bonds, important characteristics of covalent bond : Bond length, bond angle, bond strength, Atomic orbital overlap concept, Valence bond & Molecular Orbital treatment of covalent bond, VSEPR theory.
Hybridisation , Wander Wall's forces.
Hydrogen bond: Intramolecular & intermolecular hydrogen bonding.

UNIT-II **No. of Lect. – 08, Marks: 16**

Principal & processes of metallurgy
Occurrence of metals, Mineral wealth of India, Ore dressing, Roasting, Calcination, Smelting, Fluxes, Slag, Types of Furnaces , Refining of metals.
Metallurgical Industries:
Iron & Steel Industries: Production of Pig Iron.
Production of Steel, Heat treatment of steel by annealing, Hardening, Tempering & by normalising
Aluminium Industries: Purification of alumina from bauxite by Bayer process, Production of Aluminium by electrolytic reduction of alumina.

UNIT-III **No. of Lect. – 08, Marks: 16**

Transition metal Chemistry:
Introduction: General characteristics of d block elements.
Titanium: Occurrence, Extraction, Properties and Uses
Preparation of TiO_2,$TiCl_4$, Ziegler Natta catalyst.
Vanadium: Occurrence, Extraction, Properties and Uses.
Preparation of vanadium metal, V_2O_5 , Ferro vanadium alloy.
Chromium: Occurrence, Extraction, Properties, Industrial applications.
Preparation of CrO_3 , $K_2Cr_2O_7$

Nickel : Occurrence, Extraction, Preparation by Mond process, Electrolytic process, Uses
Silver : Occurrence, Extraction, Properties, Uses, Silver Plating.
Platinum: Occurrence, Extraction, Properties, Uses.

UNIT-IV **No. of Lect. – 08, Marks: 16**

Inorganic Engineering Materials & Composites:
Abrasives: Introduction, Natural abrasives & synthetic abrasives
Glasses: Introduction, Manufacture of glass, Types of glasses & their applications
Composite Materials:
Introduction, constituents of composites, Types of composites, Processing of fiber-reinforced composites.

UNIT-V: **No. of Lect. – 08, Marks: 16**

Phase rule: Definition of phase rule, definitions of terms used in phase rule, Derivation of phase rule, one component water system, two component systems.
Phase diagrams: Definition, Usefulness of phase diagrams, Classification of phase diagram, Construction of phase diagrams., Phase diagram of Steel, Phase diagram of brass, Cu-Ni.

Textbook:

1) B. R. Puri & L. R. Sharma ,Principles of Inorganic Chemistry, S.Chand & Co.Delhi.
2) P.C.Jain & Monika Jain, Engineering Chemistry (15th Edn.) , Dhanpat Rai & Sons, New Delhi.

References:

1) J. D. Lee ,Concise Inorganic Chemistry , D.Van Nostrand Co.
2) P.L.Soni ,Textbook of Inorganic Chemistry, S.Chand & Sons ,New Delhi.
3) Dryden's .Outlines of Chemical Technology, Editors Gopal Rao& Marshall Sitting,East West Press, New Delhi.
4) M.M.Uppal , Engineering Chemistry ,Khanna Publications, New Delhi.
5) Raghupati Mukhopadhyay, R.K.Das's Industrial Chemistry: Metallurgy, Kalyani Publishers, New Delhi

Course Outline

Applied Organic Chemistry **AOC** **CHL 304**
Course Title Short Title Course Code

Course Description: This course provides the knowledge of organic concept to undergraduate engineering students, and is designed to strengthen the fundamentals so that they can build their own interface of applied organic chemistry concept with their industrial applications in the branch of chemical engineering.

	Hours per Week	No. of Weeks	Total Hours	Semester Credits
Lecture	**03**	**15**	**40**	**03**

Prerequisite Course(S): Engineering Chemistry-I & II

General Objectives:

1. To introduce the basics of organic chemistry and its significance in chemical process industry.
2. To recognize the factors affecting electron availability in organic reactions and thereby study the characteristics of electrophilic and nucleophilic reagents.
3. To study the name reactions with their mechanisms.
4. To study stereoisomerism in organic compound & influence of it on molecular properties.
5. To study the basic mechanism of electrophilic substitution reactions and its significance in industrially important products preparations.
6. To familiar the students with typical industrial manufacturing processes through flow diagram and procedures.
7. To recognize structure, preparation and applications of heterocyclic compounds.
8. To study industrially important polymers.

Learning Outcomes:

Students completing this course will able to know the sources and importance of organic compounds in context to chemical process industries. They would also study the technique of drawing the three dimensional molecule on two dimensional paper. They will also recognize the influence of spatial arrangement of atoms or groups on the chemical & physical properties of molecules. After finishing the course they will be able to identify industrially important polymers on the basis of their mechanical, physical and chemical properties.

SE Chemical Engineering **Semester – III**

Applied Organic Chemistry
(Course Content)

Teaching Scheme
Theory : 3 hours/ week
Practical : 2 hour/ week

Examination Scheme
End Semester Examination (ESE) : 80 Marks
Paper Duration (ESE) : 03 Hours
Internal Sessional Examination (ISE) : 20 Marks
Internal Continuous Assessment (ICA) :25 Marks
End Semester Examination (ESE) (PR) :25 Marks

UNIT-I **No. of Lect. – 08, Marks: 16**

Types of Intermediate & Reaction Mechanism:

Concept of organic chemistry. Importance of organic chemistry. Sources of Organic Compounds.
Covalent bonds, , Bond fission. Structure & formation of Carbonium ion & Carbanion , Free radicals & their stability. Factors affecting electron availability: Inductive, Resonance, Hyperconjugation & Steric effects., Electrophiles & Nucleophiles,
Study of reactions with reference to the mechanism involved.
Aldol condensation, Cannizzaro & cross Cannizzaro reactions, Claisen ester condensation, Reimer Tiemann reaction, .,Grignard reactions. , SN^1 & SN^2 reactions. Fridel Crafts alkylation& acylations.

UNIT-II **No. of Lect. – 08, Marks: 16**

Stereochemistry:

Basic concept of stereochemistry , Structural Isomerism, Different methods of representation of three dimensional molecule on paper , Conformational isomerism: Conformations of Ethane & n-Butane & their relative stability. Conformations of Cyclohexanes Geometrical isomerism: Cis-Trans isomerism shown by alkenes.
Optical isomerism: Measurement of Optical activity by Polarimeter , Specific rotation, Enantiomerism, Necessary conditions of optical activity, Optical isomerism of Lactic acid & Tartaric acid., Distereoisomerism , Baeyer's angle strain concept.

UNIT-III **No. of Lect. – 08, Marks: 16**

Chemistry of heterocyclic compounds:

Classification of heterocyclic compouds.
Furan: Structure , Preparation, Properties, Reactions & Uses.
Pyrrole: Preparation, Properties, Reactions & Uses.
Thiophene: Preparation, Properties, Reactions & Uses.
Pyridine: Structure, Preparation, Properties, Reactions & Uses.
Quinoline : Skraup synthesis, Properties, Reactions & Uses

Petroleum:

Origin and composition , Petroleum mining, refining, compositions and uses of main petroleum fractions., Cracking & its importance in chemical industries, Octane number , Improving octane number, Chemicals from petroleum.

UNIT-IV **No. of Lect. – 08, Marks: 16**

Nitration

Nitration, Mechanism of nitration of benzene.

Typical Industrial Nitration Processes: Nitration of benzene with HNO_3-fortified spent acid, Prepation of p-Nitroacetanilide, Preparation of α-Nitronaphthalene

Sulphonation

Sulphonation , Mechanism of sulphonation of benzene

Technical indusrial sulphonation processes: Continuous partial pressure sulphonation of benzene, Sulfation of : Lauryl Alcohol, Dimethyl ether.

UNIT-V **No. of Lect. – 08, Marks: 16**

Halogenation

Halogenation, mechanism of halogenation.

Technical preparation of chloral, DDT, BHC and vinyl chloride from acetylene.

Principle of Polymer chemistry & practice:

Principle of polymer chemistry, Study of Industrially important polymers with respect to synthesis, properties & applications: Polyethylene, Polypropylene, Polyvinyl acetate, Urea Formaldehyde, Phenol Formaldehyde, Nylon

Textbooks:

1) Arun Bahl & B.S.Bahl, Textbook of organic chemistry: S.Chand & Co.Ltd. New Delhi.
2) P. H. Groggins, Unit Processes in Organic Synthesis- , Tata McGraw-Hill

References:

1) Stanley H. Pine, Organic Chemistry: McGraw Hill Int.Co.
2) Morrison & Boyd, Organic Chemistry: Allyn Bacon Inc.
3) V.R. Gowarikar, N.V.Vishwanathan, Jayadev Sreedhar, Polymer Science: Wiely Eastern Ltd., New Delhi
4) John McMurry, Organic Chemistry, 5th Edn., Brooks/Cole Thomas Learning
5) P.S.Kalsi, Stereochemistry: Conformation & Mechanism, 4th Edn., New Age International Publishers
6) G.S.Mishra, Introductory Polymer Chemistry, New Age International Publishers

Course Outline

Lab Chemical Engineering Materials **Lab CEM** **CHP 305**
Course Title Short Title Course Code

Course Description: This course intended to fulfill the need for comprehensive laboratory course in Chemical Engineering Materials

	Hours per Week	No. of Weeks	Total Hours	Semester Credits
Laboratory	**02**	**15**	**16**	**01**

Prerequisite Course(S): Engineering Mechanics, Engineering Chemistry-I & II

General Objectives:

1 To induce knowledge of properties of materials through experimentation.
2. To impart practical knowledge of study of metals and alloys.
2 To train the students for studying the strength of materials which are used in chemical Industries.

Learning Outcomes:

Students completing this laboratory course will be able to apply the knowledge of testing of materials for identification of materials for fabrication of different chemical process equipments and also linings of vessels.

Course Content:

(Any eight experiments from the following)

List of Experiments:

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.
3. Different types of hardness test on metals. i.e. Rockwell hardness test, Brinell hardness test.
4. Izod and Charpy impact test on mild steel, copper, brass and aluminum.
5. Macrostructure observation: (flow lines observation in forging by macro etching sulphur printing of steel.)
6. Study experiments based on, i) Dye penetration ii) Rubber lining iii) Heat treatments. iv) Ultrasonic Test
7.Tension test on mild steel for studying stress, strain & Young's modulus
8. Bending test on steel sheets
9. Bending test on copper sheets
10.Chemical analysis of metals and alloys (Any one element to be analysed e.g.molybdenum from stainless steel, carbon from steel, copper from brass etc.)

References for Practicals:

1. Don W. Green, Perry's Chemical Engineers Handbook, 8th Edn., McGraw-Hill
2. V.D. Kodgire and S.V. Kodgire "Material Science & Metallurgy" Everest Publisher, Pune

Course Outline

Lab Fluid Flow Operation — Course Title
Lab FFO — Short Title
CHP 306 — Course Code

Course Description: This course intended to fulfill the need for comprehensive laboratory course in. Unit Operation-I

	Hours per Week	No. of Weeks	Total Hours	Semester Credits
Laboratory	**02**	**15**	**16**	**01**

Prerequisite Course(S): Engineering Mechanics, Mathematics

General Objectives:

1. To induce knowledge of flow of fluids through experimentation.
2. To impart practical knowledge of study of measurement of flow of fluids.

Learning Outcomes:

Students completing this laboratory course will be able to apply the knowledge of fluid flow for controlling heat and mass transfer. They will also get knowledge about properties of fluids. They will also able to design piping , pumping systems .Also they will also know the measurement of the flow rate of fluids which is important in chemical industries.

Course Content:

(Any eight experiments from the following)

List of Experiments:

1. Study of Bernouillis theorem
2. Measurement of coefficient of discharge for venturimeter
3. Measurement of coefficient of discharge for orificemeter
4. Measurement of coefficient of discharge for notch
5. Study of Reynolds experiment
6. Study of characteristics of centrifugal pump
7. Study of characteristics of reciprocating pump
8. Study of characteristics of diaphragm pump
9. Study of Rotameter.
10. Study of manometers

References for Practicals :

R.K.Bansal "A textbook of fluid mechanics and hydraulic machines" Firewall Media, 2005

Course Outline

Lab Applied Inorganic Chemistry — Course Title
Lab AIOC — Short Title
CHP 307 — Course Code

Course Description: This course dealing with the fundamentals of quantitative chemical analysis both on volumetric and gravimetric basis.

	Hours per Week	No. of Weeks	Total Hours	Semester Credits
Laboratory	**02**	**15**	**16**	**01**

Prerequisite Course(S): Engineering Chemistry-I & II

General Objectives:

1. To expertise the students in proper techniques for making solutions of different concentrations.
2. To train the students in analyzing techniques used for presence of compounds in solutions.
3. To develop skills in students for gravimetric analysis.
4. To induce proficiency amongst students in finding strength of solutions.

Learning Outcomes:

Students completing this course will be capable of making solutions of desired concentrations required for analysis. They will also study the safety precautions for handling the chemical reagents in analysis, estimation and in preparation. After finishing the laboratory course they will also have proficiency in volumetric and in gravimetric analysis.

Course Content:

(Any eight experiments from the following)

List of Experiments:

1. To find strength of solution in g/l & in normal terms
2. Determination of the amount of Magnesium volumetrically by using disodium EDTA
3. Determination of amount of Manganese by Volhards Method
4 Estimation of Manganese dioxide in pyrolusite ore
5. Gravimetric determination of Fe as Fe_2O_3
6. Gravimetric determination Ni as Ni-DMG
7 Determination of amount of Copper(II) volumetrically from the given solution of $CuSO_4$
8. Preparation of tetramine copper (II) sulphate
9. Preparation of tris-ethylenediamine nickel(II) thiosulphate.
10.Preparation of potassium tri-oxalato aluminate tri-hydrate

References for Practicals:

Vogel's. , Text book of Quantitative Chemical Analysis : ELBS with Longman

Course Outline

Lab Applied Organic Chemistry — Course Title
Lab AOC — Short Title
CHP 308 — Course Code

Course Description: This course intended to fulfill the need for comprehensive laboratory course in organic chemistry.

	Hours per Week	No. of Weeks	Total Hours	Semester Credits
Laboratory	**02**	**15**	**16**	**01**

Prerequisite Course(S): Engineering Chemistry-I & II

General Objectives:

1. To introduce the basics of qualitative and quantitative analysis techniques for organic compounds and its importance in chemical process industry.
2. To induce knowledge of estimation of organic compounds through experimentation.
3. To impart practical knowledge of single stage preparation of chemical compounds and preparation of derivatives on laboratory scale.
4. To train the students for analysis of chemical compounds with due care and precautions.

Learning Outcomes:

Students completing this laboratory course will able to apply the knowledge of organic qualitative and quantitative analysis for identification of unknown chemical compounds. They would also study and can apply the laboratory techniques in preparation of organic compound and their derivatives along with estimation of physical constants of chemical compounds.

Course Content:

(Any eight experiments from the following)

List of Experiments:

1. Purification of organic compound by crystallization
2. Purification of organic compound by distillation
3. Estimation of Acetone
4. Estimation of Glucose
5. Preparation of p-nitro acetanilide by nitration.
6. Preparation of Quinone.
7. Preparation of Urea Formaldehyde resin
8. Preparation of acetyl derivative of $-NH_2$ / -OH group.
9. Preparation of benzoyl derivative of $-NH_2$ / -OH group.
10. Preparation of 2:4 dinitro-phenyl hydrazone (2,4 DNP) derivative of –CHO / -CO group.

References for Practicals:

1) Kulkarni , A laboratory handbook of organic quantitative analysis & separation, Dastane Ramchandra & Co., Pune
2) S.K.Bhasin, Laboratory manual on engg. Chemistry: Dhanpat Rai Pub.New Delhi
3) B.S.Furniss,A.J.Hannaford, P.W.G.Smith,A.R.Tatchell, Vogels textbook of practical organic chemistry, Pearson Edn.

S.E. Chemical Engineering

Semester-IV

Faculty of Engineering and Technology

North Maharashtra University, Jalgaon

Course Outline

Chemical Engineering Processes-I **CEP -I** **CHL 401**
Course Title Short Title Course Code

Course Description:

This course provide the students basic understanding of unit operations & unit processes involved in inorganic chemical process industries thus they can understand the value of chemicals, the type of problems met in their production and the effective measures for solving these problems.

	Hours per Week	No. of Weeks	Total Hours	Semester Credits
Lecture	03	15	40	03

Prerequisite Course(S): Applied Inorganic Chemistry

General Objectives:

1. To know the basics of manufacturing of chemicals and work of chemical engineer in chemical process industries.
2. To learn the unit processes and unit operations with symbols involved in manufacturing of useful inorganic chemical products.
3. To study the techniques of drawing of flow diagram for conversion of reactants into products.
4. To identify the engineering problems encountered during production of chemicals with achievable best appropriate solutions.
5. To learn the proper techniques of storage, transportation and handling of raw materials as well as finished products.

Learning Outcomes:

Students finishing this course will learn the drawing techniques of symbols of unit operation and flow diagram and its importance in manufacturing procedures for various industrially important inorganic chemicals. They will also identify the major engineering problems involved in manufacturing operations and best possible solutions for the same.

SE Chemical Engineering **Semester – IV**

Chemical Engineering Processes-I
(Course Content)

Teaching Scheme
Theory : 3 hours/ week

Examination Scheme
End Semester Examination (ESE) : 80 Marks
Paper Duration (ESE) : 03 Hours
Internal Sessional Examination (ISE) : 20 Marks

UNIT-I **No. of Lect. – 08, Marks: 16**

Fuel & Industrial Gases:
Chemical Processing and work of chemical engineer.
Industrial Gases: Hydrogen, Oxygen, Nitrogen, Carbon Dioxide, Acetylene.
Fuels and Fuel gases: Producer gas, Synthesis gas

UNIT-II **No. of Lect. – 08, Marks: 16**

Chlor-Alkali Industries:
Soda ash, Sodium bicarbonate ,caustic soda, Chlorine , Bleaching powder.
Electrochemical industries:
Fuel Cells: Principle& Efficiency of Fuel cells, Kinds of Fuel cells & advantages of Fuel cells.

UNIT-III **No. of Lect. – 08, Marks: 16**

Phosphorous Industries:
Phosphate industries: Elemental phosphorous, Wet process & electric furnace process for phosphoric acid production, Manufacturing of ammonium phosphate, Baking powder, Fire retardant chemicals. Manufacturing of Superphosphate & Triple Superphosphate

UNIT-IV **No. of Lect. – 08, Marks: 16**

Nitrogen industries & Inorganic Acids : Synthetic ammonia process for ammonia production , Nitric acid, Ammonium nitrate, Urea.,Hydrochloric acid manufacture.
Sulfur industries: Manufacture of elemental sulfur by Frasch & Finnisch process, sulfuric acid.

UNIT-V **No. of Lect. – 08, Marks: 16**

Sodium compounds: Sodium sulphate, Sodium sulfide, Sodium thiosulphate, Sodium silicate, Sodium peroxide.

Chemicals from Sea Water:
Production of common salt by solar evaporation of sea water, production of salt from brine, Bromine Manufacture from sea water & by steaming out process.

References:

1) George T. Austin, “Shreeve’s Chemical Process Industries”, 5th Edition , Mc Graw Hill Book Company
2) C.E. Dryden, Outlines of Chemical Technology, Affiliated East WestPress.1973
3) G.N.Pandey, A textbook of chemical technology, Vol.I, Vikas publishing house pvt.ltd.

Course Outline

Process Calculation **PCAL** **CHL 402**
Course Title Short Title Course Code

Course Description:

This course provide the students basic understanding of Industrial Process Calculations and to apply this in designing the various chemical process equipments.

	Hours per Week	No. of Weeks	Total Hours	Semester Credits
Lecture	**03**	**15**	**40**	**03**
Tutorial	**01**	**15**	**13**	**01**

Prerequisite Course(S): Engineering Chemistry-I & II

General Objectives:

1. To present fundamentals of chemical engineering in a simple manner.
2. To provide broad background for applying principles to industrial and theoretical problems.

Learning Outcomes:

Students completing this course will be able to analyze a particular process in whole or part. They will also in a position in evaluating the economics of the various processes. Using elemental & material balances & energy balances students will be able to design various equipments. Thus they will also study how to increase the efficiency of the chemical processes.

SE Chemical Engineering **Semester – IV**

Process Calculations
(Course Content)

Teaching Scheme		**Examination Scheme**	
Theory	: 3 hours/ week	End Semester Examination (ESE)	: 80 Marks
Tutorial	: 1 hour/ week	Paper Duration (ESE)	: 03 Hours
		Internal Sessional Examination (ISE)	: 20 Marks

UNIT-I **No. of Lect. – 08, Marks: 16**

Properties of Gases ,liquid and solids:

Units their dimensions and conversions , Mass and volume relations, Stoichiometric and composition relations, Excess reactants, Degree of completion, Conversion, selectivity and yield.
Ideal gas law, Dalton's Law, Amagat's Law, and Average molecular weight of gaseous mixtures.
Effect of temperature on vapour pressure, Vapour pressure plot (Cox chart), Vapour pressures of miscible and immiscible liquids and solutions, Raoult's Law and Henry's Law

UNIT-II **No. of Lect. – 08, Marks: 16**

Humidity
Humidity and saturation, Relative Humidity and percent saturation, Dew point, Dry and Wet bulb temperatures, Use of humidity charts for engineering calculations, problems on psychometric chart.

UNIT-III **No. of Lect. – 08, Marks: 16**

Stoichiometry & Material Balance

Material balances for systems with and without chemical reactions, species and elemental balance. Analysis of systems with by-pass, recycle and purge.

UNIT-IV **No. of Lect. – 08, Marks: 16**

Energy balance
Energy capacity of gases, liquids and solutions, Heat of fusion and vaporization, Steady state energy balance for systems with and without chemical reactions. Calculations and application of heat of reaction, combustion, formation, neutralisation and solution. Enthalpy-concentration charts. Combustion of solids, liquids and gaseous fuels, Calculation of theoretical and actual flame temperatures.

UNIT-V: **No. of Lect. – 08, Marks: 16**

Fuels & Combustion

Heating value of fuels, calculations involving theoretical and excess air. Heat & material balances of combustion processes. Chemical ,metallurgical and petrochemical processes.

Textbook:

1) Bhatt., B.I. and Vora S.M. "Stoichiometry" IInd edition, Tata McGraw Hill (1984)
2) K.A.Gavhane "Introduction to process calculations" Nirali Publications
3) Felder, R.M. & Rousseau, R.W**.** "Elementary Principles of Chemical Processes ", 3rd edition. JohnWiley. (1999).
4) O.A.Hougen , K.M.Watson, Ragatz, Chemical Process Principles, Vol.I, Asia Publishing House, New Delhi.

References:

1. Don W. Green, Perry's Chemical Engineers Handbook, 8th Edn., McGraw-Hill
2. Shekhar Pandharipande and Samir Musharaf "Process Calculations" Pune Vidyarthi Griha Prakashan, Pune
3. R.W. Gaikwad "Chemical Process Calculations" Dennet & Co. Nagpur
4. Richard M. Felde,Ronald W. Rousseau, John Wiley & sons, New Delhi
5. S. N. Ghosh, Bidisha Khatua "A textbook of Chemical Calculations" Dhanpat Rai & Co., Delhi
6. Himmelblau, D.M**.** "Basic Principles and Calculations in Chemical Engineering", 6th edition. Prentice Hall .

Course Outline

Mechanical Operation **MO** **CHL 403**
Course Title Short Title Course Code

Course Description: This course provides the knowledge and concept of mechanical operations to undergraduate engineering students, and is designed to strengthen the preliminary operation so that it can provide the platform for the further operation of machines with industrial applications in the branch of chemical engineering.

	Hours per Week	No. of Weeks	Total Hours	Semester Credits
Lecture	**03**	**15**	**40**	**03**
Tutorial	**01**	**15**	**13**	**01**

Prerequisite Course(S): Fluid Flow Operation

General Objectives:

1. To study the importance of size reduction and its laws and significance in chemical process industry.
2. To recognize the factors influencing the size of the product, difference between crushing and grinding.
3. To study the size of the balls required for grinding.
4. To study sedimentation of suspended solids and design of continuous thickener.
5. The students should know the working of filter presses, its operation at constant rate filtration and constant pressure filtrations.
6. To familiar the students with typical industrial manufacturing processes through diagram and design procedures for cyclone separator.
7. To study the various mixing operations, and flow pattern of mixing. Baffles, impeller action during mixing.
8. To study characteristics of fluidized system and its types.
9. To study industrially importance of mechanical operations and its utilizations for handling bulk solids and its conveying system.
10. To study the power utilization of conveyors, mixing operations, and design of belt and screw conveyors.

Learning Outcomes:

Students shall be able to understand the importance of screening equipments in the industry point of view and will able to visualize, analyze and solve basic engineering problems for designing chemical engineering equipments. They shall understand scientific principles and apply them to the practice of engineering problems during maintenance. Students will predict the applications of filtration processes and its working principle to carry out the designs at constant rate of filtration and constant pressure filtrations. After completing the course students shall be able to design and fabricate the screw conveyor, chain and flight as per capacity of equipments.

SE Chemical Engineering **Semester-IV**

Mechanical Operation
(Course Content)

Teaching Scheme

Theory : 3 hours/ week
Practical : 4 hour/ week
Tutorial : 1 hour/week

Examination Scheme

End Semester Examination (ESE) : 80 Marks
Paper Duration (ESE) : 03 Hours
Internal Sessional Examination (ISE) : 20 Marks
Internal Continuous Assessment (ICA) :50 Marks
End Semester Examination (ESE) (OR) :25 Marks

UNIT-I **No. of Lect. – 08, Marks: 16**

Size Reduction: Properties of solids , Particle size, shape; mixed particle size & size analysis, specific surface of mixture, average particle size; energy utilization, Crushing efficiency, Laws of crushing, Types of equipments for coarse, intermediate & fine size reduction; energy & power requirement; open & closed loop circuit. Screening: Equipment, ideal screen. Screen analysis methods & std. screen series; capacity & effectiveness of screen Problem based on above.

UNIT-II **No. of Lect. – 08, Marks: 16**

Handling of transport of Solids- Bins, bunker, Silos. Introduction about conveyors, belt conveyors – checking/determining conveyor capacity, belt speed. Belt tension, belt sag, motor power. Screw conveyor, advantage and disadvantage of screw conveyor. Bucket elevators – types of bucket,Chain conveyor and its type's chain pull conveyor.
Mixing and Agitation:- Necessity of mixing and agitation in chemical industries. Impellers, flow pattern , Calculation of power requirement of mixing equipments, Mixing Index, Types of mixers, paste & plastic masses, rate of mixing. Mixing & Agitation of Liquids: Agitation equipment &; circulation velocities & power consumption in agitated vessel; blending & mixing. problem based on above.

UNIT-III **No. of Lect. – 08, Marks: 16**

Fluid Solid System: Drag force, drag coefficient, Stokes law, Cozeny- Carman equation. Motion of particles in a fluid. Drag force on spherical particle. free settling velocity, & hindered settling. Fluidization: Minimum fluidization velocity, types of fluidization, application of fluidization in catalytic cracking, pneumatic conveying system, spouted beds , etc. problem based on above.

UNIT-IV **No. of Lect. – 08, Marks: 16**

Sedimentation: Clarification & thickening, separation ratio; equipment for centrifugal & gravity classification; cyclone separator & design; hydro cyclones; principle of magnetic & electrostatic separation. Kynch theory of sedimentation, Determination of thickener area Gravity; laboratory batch & continuous sedimentation, Continuous centrifuges, disc type centrifuge.

UNIT-V **No. of Lect. – 08, Marks: 16**

Filtration: Objectives of filtration, preparation stages of filtration Filter aids, classification of filters, selection of filter media. Basic equation of filtration, Relation between thickness of cake and volume of filtrate. Principle of batch filtration: constant pressure & constant rate filtration, factors affecting filtration. Flow of filtrate through the cloth and cake combined. Compressible filter cake, optimum time cycle, Continuous, centrifugal,vacuum, gravity filtration & related equipments. Washing of filter cake, and numerical based on above.

References:

1.Mc Cabe W. L. & Smith J. C. " Unit Operation for Chemical Engg." 5th Edt. McGraw Hill Kogakusha Ltd.

2. Coulson J. M. & Rechardson J. F. " Chemical Engg.- Vol. II" Butterworth Heinemann

3. Badger W. L. & Banchero J. T. " Introduction to Chemical Engg." McGraw Hill International Book Co. New Delhi

4.Narayan & Bhatacharya " Mechanical Operation In Chemical Engg." NCBA Calcutta

5.P. Chattopadhaya " Unit Operation In Chemical Engg. Vol. I " Khanna Publication Delhi

6.R.S.Hiremath and A.P.Kulkarni, Unit Operation of Chemical Engineering. Everest publishing House

7.Shrikant S.Barkade , Sunita S. Desai, “Mechanical Operations” , Denett and Co.

Course Outline

Applied Physical Chemistry **APC** **CHL 404**
Course Title Short Title Course Code

Course Description:

For undergraduate students this course provides the significant understanding of physical chemistry principles and thus they can relate the concepts for sustainable development in operations encountered in chemical process industries.

	Hours per Week	No. of Weeks	Total Hours	Semester Credits
Lecture	03	15	40	03

Prerequisite Course(S): Engineering Chemistry-I & II

General Objectives:

1. To introduce the ideal and real gas concept and causes of deviation of gases from ideal behavior.
2. To study the role of critical constants in liquefaction of gases.
3. To study the rate expressions and order of reactions.
4. To understand the influence of various parameters on rate of reactions.
5. To study the basics of chemical thermodynamics and thermochemistry.
6. To learn the chemical equilibrium and applications of Le Chatelier's principle on reaction equilibrium.
7. To study the significance of change in vapor pressure of a solution and colligative properties of dilute solutions.
8. To study the changes in colligative properties of dilute solutions and their role in molecular weight determination.
9. To study the catalysis phenomenon and its influence on activation energy.

Learning Outcomes:

Students finishing this course will be capable to use fundamental physical chemistry principles to make predictions about ideal and real gases. Learners will apply chemical kinetics principles to investigate the order of reaction, effect of temperature and catalysts on reaction kinetics and time taken by reactants to change their initial concentration. They will also learn how the measurable changes in colligative properties of solutions used for determination of molecular mass of solute.

SE Chemical Engineering **Term – II**

Applied Physical Chemistry
(Course Content)

Teaching Scheme
Theory : 3 hours/ week
Practical : 2 hour/ week

Examination Scheme
End Semester Examination (ESE) : 80 Marks
Paper Duration (ESE) : 03 Hours
Internal Sessional Examination (ISE) : 20 Marks
Internal Continuous Assessment (ICA) :25 Marks
End Semester Examination (ESE) (PR) :25 Marks

UNIT-I **No. of Lect. – 08, Marks: 16**

Kinetic theory of gases: Gas Laws, Kinetic gas equation, Equation of state of ideal & real gases, compressibility factor, critical constants, mol. velocities, probability distribution of velocities, mean free path, collision diameter, collision no., diffusion, Graham's law of diffusion, liquefaction of gases, Heat capacity of gases: C_p & C_v problems.

UNIT-II **No. of Lect. – 08, Marks: 16**

Chemical kinetics: Objective of chemical kinetics, rate of reaction, velocity constant of a reaction, elementary reaction steps & rate expressions, order & molecularity of reaction, factors influencing the reaction rates, integrated rate expressions for 1^{st}, 2^{nd} , 3^{rd} , & zero order reaction (with example), methods for determining order of reactions. Arrhenius equation. Problem based on above topics.
Photochemical reactions, Set up for study of photochemical reactions.

UNIT-III **No. of Lect. – 08, Marks: 16**

Classical chemical thermodynamics:
Objective & scope, definition of thermodynamic systems, state property etc.
Heat work reversibility, maximum work, isothermal & adiabatic process, first law of thermodynamics, thermo chemistry, thermo chemical law, standard heat of formation, second law of thermodynamics, entropy, entropy changes, enthalpy & free energy, Gibbs Helmholtz equation, Third law of thermodynamics. Problems based on above topics.

UNIT-IV **No. of Lect. – 08, Marks: 16**

Chemical Equilibrium
Criteria of chemical equilibrium, Le Chatelier's theorem, its application to some systems likes ammonia, sulphuric acid, and nitric acid.
Catalysis:
Catalysis: Types of catalysis, characteristics of catalytic reactions, Promoters, Catalytic poisoning, Autocatalysis, Negative catalysis, Activation energy & catalysis, Theories of catalysis, Acid-base catalysis & mechanism, Enzyme catalysis: Mechanism & characteristics.

UNIT-V **No. of Lect. – 08, Marks: 16**

Colligative properties:

Colligative properties, lowering of vapour pressure, measurement of vapour pressure lowering determination of molecular weights from vapour pressure, lowering.

Osmosis, osmotic pressure, measurement of osmotic pressure, the law of osmotic pressure, determination of molecular weight from osmotic pressure, osmosis & semipermeability, reverse osmosis.

Elevation in boiling point, determination of molecular weight from boiling point elevation, measurement of boiling point elevation.

Depression in freezing point, determination of molecular weight from freezing point depression, determination of freezing point depression.

Textbook:

1) B. S.Bahl,, G.D.Tuli, Arun Behl, ,Essentials of physical Chemistry: S.Chand & Co.Ltd.Delhi.

References:

1) Maron-Prutton, Principles of Physical chemistry: Oxford & IBH publishing Co.Pvt.Ltd. New Delhi
2) S. Glasstone & Lewis, Elements of physical chemistry : McMillan India Ltd.
3) B.R.Puri & L.R.Sharma, A textbook of physical chemistry : S. Chand & Co. Delhi

Soft Skills – III

COURSE OUTLINE

Course Title	Short Title Course Code
Soft Skills – III	**SK-III**

Course Description: Through this course we have tried to prepare the students for the industry. Most companies test mathematical and logical ability through an aptitude test. This subject aims at working on these skills of a student through strategies formulae and practice exercises.

Lecture	Hours per Week	No. Of Weeks	Total Hours	Semester Credits
	1	14	14	2

Prerequisite Course(s): Fundamental knowledge of High School Mathematics.

COURSE CONTENT

Soft Skills – III **Semester-III**

Teaching Scheme **Examination Scheme**

Lecture: 1 hour / week **Internal Continuous Assessment (ICA): 50 Marks**

Unit-I: Arithmetic-1 **No. of Lect. – 3, Marks: 10**

a. Basic Formulae

i. Divisibility Rules.
ii. Speed Maths.
iii. Remainder Theorem.
iv. Different Types of Numbers.
v. Applications.

b. HCF, LCM and Linear Equations

i. HCF – Successive Division and Prime Factorization Methods.
ii. LCM – Successive Division and Prime Factorization Methods.
iii. Applications.
iv. Linear Equations – Elimination Method.
v. Substitution Method.
vi. Applications.

c. Averages and Mixtures

i. Concept of Average.
ii. Faster Ways of Finding It.
iii. The Allegation Method.
iv. Applications.

Unit-II: Arithmetic–II **No of Lect. – 3, Marks: 10**

a. Percentages

i. Concept of Percentage.
ii. Working with Percentages.
iii. Applications.

b. Profit and Loss

i. Difference between Cost and Selling Price.
ii. Concept of Profit Percentage and Loss Percentage.
iii. Applications.

c. Time and Work

i. Basic Time and Work Formula.
ii. Relation between Time and Work.
iii. Applications.

Unit-III: Arithmetic–III **No of Lect. –3, Marks: 10**

a. Permutations and Combinations

i. Sum Rule of Disjoint Counting.

ii. Product Rule of Counting.
iii. Concept of Factorial.
iv. Permutations.
v. Linear Permutations.
vi. Combinations.
vii. Circular Permutations.
viii. Applications.

b. Probability

i. Definition and Laws of Probability.
ii. Mutually Exclusive Events.
iii. Independent Events.
iv. Equally Likely Events.
v. Exhaustive Events.
vi. Cards.
vii. Dice.
viii. Applications.

c. Time and Distance

i. Speed.
ii. Conversion Factors for Speed.
iii. Average Speed.
iv. Moving Bodies – Passing, Crossing and Overtaking.
v. Relative Speed.
vi. Boats and Streams.
vii. Applications.

Unit-IV: Non-Verbal Reasoning **No of Lect. 2, Marks: 10**

a. Analogies

i. Examples.
ii. Applications.

b. Classification

i. Examples.
ii. Applications.

c. Sequences

i. Examples.
ii. Applications.

Unit-V: Analytical Reasoning **No of Lect. – 3, Marks: 10**

a. Analytical Puzzles

i. Classification Puzzles.
ii. Ordering Puzzles.
iii. Assignment Puzzles.
iv. Applications.

b. Letter and Number Series

i. Different Types of Letter Series.
ii. Different Types of Number Series.
iii. Mixed Series.

c. Coding and Decoding

i. Letter Coding.
ii. Number Coding.
iii. Mixed Coding.
iv. Odd Man Out.
v. Applications.

Guide lines for ICA:

ICA will be based on credit tests and assignments submitted by the student in the form of journal.

Reference Books:

1. R. S. Aggarwal, "Quantitative Aptitude", S. Chand Publication, New Delhi, 2012.
2. R. S. Aggarwal, "A Modern Approach to Verbal Reasoning", S. Chand Publication, New Delhi, 2012.
3. R. S. Aggarwal, "A Modern Approach to Non-Verbal Reasoning", S. Chand Publication, New Delhi, 2012.

Course Outline

Chemical Engineering Processes-II **CEP -II** **CHL 405**
Course Title Short Title Course Code

Course Description:

This course provide the students basic understanding of unit operations & unit processes involved in organic chemical process industries thus they can understand the flowcharts which gives great deal of information to be collected and examined and which represents an overall viewpoint for industrial manufacturing processes.

	Hours per Week	No. of Weeks	Total Hours	Semester Credits
Lecture	**03**	**15**	**40**	**03**

Prerequisite Course(S): Applied Organic Chemistry

General Objectives:

1. To know the basics of manufacturing of organic chemicals.
2. To learn the unit processes and unit operations with symbols involved in manufacturing of industrially important organic chemical products.
3. To identify the major engineering problems encountered during production of organic chemicals with achievable best appropriate solutions.
4. To learn the proper techniques of storage, transportation and handling of raw materials as well as finished products.
5. To study the manufacturing steps involved in the production of important chemicals.

Learning Outcomes:

Students finishing this course will learn the drawing techniques of symbols of unit operation and flow diagram and its importance in manufacturing procedures along with major engineering problems & solutions for them involved in the manufacturing of industrially important organic chemicals. Apart from this they will gain knowledge and can apply the same in the manufacturing steps involved in the production of important chemicals.

SE Chemical Engineering **Semester – IV**

Chemical Engineering Processes-II
(Course Content)

Teaching Scheme
Theory : 3 hours/ week

Examination Scheme
End Semester Examination (ESE) : 80 Marks
Paper Duration (ESE) : 03 Hours
Internal Sessional Examination (ISE) : 20 Marks

UNIT-I **No. of Lect. – 08, Marks: 16**

Oil and Waxes:
Vegetable oil extraction, hydrogenation of oils
Waxes: Introduction, types & their uses.
Soaps , Glycerin and Detergents: Introduction, Raw materials for production of soap & detergents, method of soap production, manufacture of detergents, glycerin production & its uses.

UNIT-II **No. of Lect. – 08, Marks: 16**

Sugar and Starch Industries: Extraction of sucrose from sugar cane, by-products of the sugar industry, properties & structure of starch, production of starch from maize, production of dextrin by starch hydrolysis.
Fermentation Industries:
Manufacture of ethyl alcohol by fermentation, production of beer, wines and liquors, vinegar, citric acid ,lactic acid.
Pulp and paper industries: Manufacturing of pulp, manufacturing of paper, and structural boards.

UNIT-III **No. of Lect. – 08, Marks: 16**

Agrochemical Industries: Insecticides, pesticides, herbicides, plant growth , nutrients and regulators, compound fertilizers, bio-fertilizers, complex fertilizers, various grades of N.P.K. fertilizer.
Pharmaceuticals Industries: Classification of pharmaceuticals products, manufacture of penicillin & tetracycline.

UNIT-IV **No. of Lect. – 08, Marks: 16**

Petrochemicals : Manufacturing of Methanol , Formaldehyde , Ethylene and Acetylene , Ethylene dichloride, Ethylene oxide, Isopropanol, Acetone, Isopropyl benzene ,Butadiene.

UNIT-V **No. of Lect. – 08, Marks: 16**

Explosives: Types of Explosives, explosive characteristics, industrial explosives, propellants, rockets, missiles, pyrotechnics, matches, toxic chemical weapons.
Plastic industries: Raw Materials, manufacturing processes, general polymerization processes, compounding and moulding operation.

References:
1) George T. Austin, "Shreeve's Chemical Process Industries", 5th Edition , Mc Graw Hill Book Company
2) C.E. Dryden, Outline of Chemical Technology, Affiliated East WestPress.1973
3) G.N.Pandey, A textbook of chemical technology, Vol.II, Vikas publishing house pvt.ltd.
4) Casida, Jr. L.E., Industrial Microbiology, New Age International, New Delhi.
5) Reed G., Prescott & Dunn Industrial Microbiology, CBS Publisher, New Delhi.

Course Outline

Lab Computer Applications **Lab CA** **CHP 406**
Course Title Short Title Course Code

Course Description: This laboratory course is dealing with applications of computers for designing the various formulas required for chemical engineering programme with a comprehensive study of the C++ programming language.

	Hours per Week	No. of Weeks	Total Hours	Semester Credits
Lecture	**01**	**15**	**10**	**01**
Laboratory	**02**	**15**	**16**	**01**

Prerequisite Course(S): Computer Programming, Engineering Mathematics I and II.

General Objectives:

1. Students will learn to solve matrix equations using Matrix Inversion method.
2. Students will learn to solve Differential equation of first order by various methods like Taylor's series method, Modified Euler's method, Runge Kutta's 4^{th} order method.
3. Students will also learn to solve Numerical Integrations by various methods like, by Picards method, Trapezoidal Rule, by Simpson's $1/3^{rd}$ Rule, Simpson's $3/8^{th}$ rule.

Learning Outcomes:

Students completing this course will able to apply knowledge of Basic Science using knowledge of C and C++ language in Chemical Engineering Problems. Students will demonstrate their ability to solve Chemical Engineering Problems using computer interface. Students will be able to provide a definite solution to various designing problems in Chemical Engineering field.

SE Chemical Engineering **Semester – IV**

Lab Computer Applications
(Course Content)

Teaching Scheme
Theory : 1 hours/ week
Practical : 2 hours/ week

Examination Scheme
Internal Continuous Assessment (ICA): 50 Marks

Theory:

Introduction to object oriented programming

(a) Structure of C++ programming.
(b) Tokens, keywords, constant in C++.
(c) Derived data types, operators, expression in C++.
(d) Function in C++.
(e) Classes and objects in C++.

Introduction to Polymath and Chemical Engineering problems based softwares.
Fundamental concepts of Matrices, Numerical Differentiation & Numerical Integration.

Lab Work: (Any Eight from the following)

1. To solve Matrices using Matrix Inversion Method.
2. To solve Matrices using Gauss Elimination method.
3. To solve Differential equation of first order by Taylor's series method
4. To solve Differential equation of first order by Modified Euler's method
5. To solve Differential equation of first order by Picards method
6. To solve Differential equation of first order by Runge Kutta's 4^{th} order method
7. To solve Numerical Integration by Weddle's rule.
8. To solve Numerical Integration by Trapezoidal Rule
9. To solve Numerical Integration by Simpson's $1/3^{rd}$ Rule
10. To solve Numerical Integration by Simpson's $3/8^{th}$ rule

Reference Books:

1. E Balagurusamy "Object Oriented Programming with C++", Tata McGraw Hill, 4/E,2008.
2. Yashavant Kanetkar, "Let Us C" , BPB Publications ,10/E, 2010.
3. Steven C. Chapra, Raymond P. Canale, Numerical Methods for Engineers, 6^{th} Edition, Tata McGraw Hill.
4. David M. Himmelblau, Basic Principles & Calculations in Chemical Engineering, 6^{th} Edn., Pearson Education Pvt.Ltd., New Delhi.
5. S.S.Sastry, Introductory methods of Numerical Analysis, Prentice Hall

Course Outline

Lab Chemical Processes **Lab CP** **CHP 407**
Course Title Short Title Course Code

Course Description: This laboratory course is dealing with manufacturing procedures of industrially important organic and inorganic chemicals on laboratory scale and safe analysis of the same.

	Hours per Week	No. of Weeks	Total Hours	Semester Credits
Laboratory	**02**	**15**	**16**	**01**

Prerequisite Course(S): Lab Engineering Chemistry-I & II

General Objectives:

1. To induce importance of unit operations & unit processes in chemical process industries through experimental work.
2. To make the students capable of handling chemicals with due care & precautions.
3. To create confidence amongst students for safe synthesis of industrially important chemicals on laboratory scale.
4. To induce proficiency in students for preparation, purification, analysis of chemical compounds on laboratory scale.

Learning Outcomes:

Students finishing this laboratory course will understand importance of unit operations & unit processes in manufacturing of chemicals through experimentation. They will also acquire necessary knowledge of safe handling, synthesis and analysis of industrially important chemicals with due care and precautions.

SE Chemical Engineering **Semester – IV**

Lab Chemical Processes

Teaching Scheme
Practical : 2 hours/ week

Examination Scheme
Internal Continuous Assessment (ICA): 50 Marks
End Semester Examination (ESE)(PR): 25 Marks

Course Content:

(Any Eight experiments from the following)

1. Determination of the Na_2CO_3 content of washing soda.
2. To determine the loss per gram and the percentage purity of the given sample of sodium bicarbonate by heating.
3. Estimation of available chlorine in bleaching powder.
4. Preparation of Sodium thiosulphate
5. Preparation of biuret from urea
6. Preparation of soap
7. Preparation of drug aspirin
8. Estimation of formaldehyde.
9. Determination of TFM in soap
10. Preparation of acetaldehyde by the oxidation of ethanol

References for Practicals:

1) Vogel's. , Text book of Quantitative Chemical Analysis : ELBS with Longman
2) F.G.Mann & B.C.Saunders, Practical Organic Chemistry, Orient Longman

Course Outline

Lab – Mechanical Operation **Lab MO** **CHP 408**
Course Title Short Title Course Code

Course Description: This course intended to fulfill the need for comprehensive laboratory course in unit operations.

	Hours per Week	No. of Weeks	Total Hours	Semester Credits
Laboratory	**04**	**15**	**32**	**02**

Prerequisite Course(S): Fluid Flow Operation

General Objectives:

1. To understand and apply engineering experimentation techniques and safety procedures common to the chemical industry.
2. To apply principles developed in chemical engineering courses to the analysis of chemical engineering processes and unit operations.
3. To improve technical skills for particle size reduction and screening during process.
4. To study various Laws of crushing, Energy utilization, crushing Efficiency, Energy for size reduction.
5. To give the knowledge of various equipment for classification of particulate matter such as Gravity settling tank, Cyclone separator, Magnetic separators, Electrostatic separator, Equipment etc.

Learning Outcomes:

At the end of the laboratory course students will be able to apply the principles of unit operations through experimentation and will demonstrate the ability to design various equipments used in chemical and allied process industry.

Course Content:

(Any eight experiments from the following)

List of Experiments:

1.To study the separation of solids by sedimentation.
2.To study the differential and cumulative screen analysis of sand.(Sieve analysis)
3.To verify the laws of crushing and grinding by ball mill
4.To verify the laws of crushing and grinding by Jaw crusher
5.To determine the rate of filtration, cake resistance and filter medium resistance.
6.To determine the rate of filtration by vacuum filter.
7.To study the behavior of the bed during fluidization and to calculate minimum fluidization velocity.
8.To study the sigma Kneader Mixer.
9.To study the operating behavior of cyclone separator and to find out its efficiency.
10To study the Ribbon Blender and to find out the mixing index.

Course Outline

Lab Applied Physical Chemistry **Lab APC** **CHP 409**
Course Title Short Title Course Code

Course Description: This course is planned to induce proficiency in students for experimental planning, data analyzing and drawing logical conclusions based on the fundamentals principles of physical chemistry.

	Hours per Week	No. of Weeks	Total Hours	Semester Credits
Laboratory	**02**	**15**	**16**	**01**

Prerequisite Course(S): Engineering Chemistry-I & II

General Objectives:

1. To teach basic manipulative skills. Skills, including the proper techniques for making solutions, weighing, and statistical data analysis.
2. To study the rate expressions and order of reactions through experimentation.
3. To induce knowledge of thermochemistry through experimental work.
4. To develop skills in students for determination of molecular weight by experimently measuring changes in colligative properties.
5. To develop skills for the determination of atomic weight , equivalent weight of metals.

Learning Outcomes:

Students completing the laboratory course will be capable of applying knowledge for investigations of order of simple chemical reactions, heat of neutralization. They would also in a position to estimate molecular weight through changes in colligative properties of dilute solution due to addition of non volatile solute in it.

Course Content:

(Any Eight experiments from the following)

1) Determination of equivalent weight of metal eudiometrically.
2) Detrmination of atomic weight of the metal using Dulong-Petit law.
3) Determination of surface tension of liquids by Stalagmometer.
4) Determination of rate constant of hydrolysis of methyl acetate by dilute HCl & to show that the reaction is of first order.
5) Determination of rate constant of hydrolysis of ethyl acetate by NaOH & to show that the reaction is of second order.
6) Determination of energy of activation for the reaction between potassium pursulphate and potassium iodide.
7) Determination of heat of solution of KNO_3.
8) Determination of water equivalent of copper calorimeter & heat of neutralization of strong acid & strong base by calorimeter.
9) To determine ΔH, ΔG, ΔS of a reaction.
10) Determination of molecular weight of substance by depression in freezing point method.

References for Practicals:

S.K.Bhasin, Laboratory manual on Engineering Chemistry: Dhanpat Rai Pub.New Delhi