

**NORTH MAHARASHTRA UNIVERSITY,
JALGAON (M.S.)**

Second Year Chemical Engineering

**Faculty of Engineering and
Technology**



Teacher and Examiner's Manual

SEM - III

W.E.F 2013 - 2014

Chemical Engineering Materials

Teacher, Paper setter and Examiner should follow the guidelines as given below.

Unit- I

Teacher should facilitate learning of materials and their properties.

1.	Introduction to materials and their properties		Lectures required	Reference No.
	a)	Simple stresses and strains, Concept of stress, strain, shear stress, shear strain	01	1-2
	b)	Hooks law, Elastic limit, stress-strain curve for mild steel and elastomeric materials	01	1-2
	c)	Factor of safety, Poisson's ratio	02	1,3
	d)	Strain energy due to axial load and impact	03	1,3
	e)	Introduction to determination of mechanical properties of materials ASTM methods	01	1-2,4

Unit- II

Teacher should facilitate learning of Metallic Materials.

2.	Metallic Materials		Lectures required	Reference No.
	a)	Cast iron, Wrought iron and steel	01	1-3
	b)	Effect of addition of elements such as Si, C,P, Mn, N to Iron	01	1-2,5
	c)	Elastic and plastic deformation	01	1-2,5
	d)	Heat treatments alloys such as stainless steel, brass, bronze, duralumin, alnico, Nichrome, solder material	02	1-2,5
	e)	Heat treatments alloys such as bronze, duralumin	01	1-2,5
	f)	Heat treatments alloys such as alnico, Nichrome, solder material	02	1,5

Unit- III

Teacher should facilitate learning of testing of materials, crystal structure.

3.	Selection of materials for fabrication and erection of chemical plant:		Lectures required	Reference No.
	a)	Testing of materials	02	1,3,7
	b)	Destructive and nondestructive tests	03	1,3,7

	c)	Structure of atom and chemical bonds	01	1-2
	d)	Crystal structures and their influence on material properties	02	1-2

Unit- IV

Teacher should facilitate learning of Electrical and Magnetic Materials.

4.	Electrical and Magnetic Materials		Lectures required	Reference No.
	a)	Factors affecting the resistivity of conductors	01	1,4
	b)	Properties of materials such as Ag, Cu, Al, Nichrome and Ca as dielectric characteristics	02	1,4
	c)	Insulating materials such as mineral oil, PVC	01	1-3
	d)	Insulating materials such as Mica fibers, glass and asbestos	01	1-3
	e)	Magnetisation	01	1,4-5
	f)	Soft and hard magnetic materials such as a silicon iron, Alnico types alloys and ferrites	02	1-3

Unit- V

Teacher should facilitate learning of Selection of materials and linings.

5.	Selection of materials and linings		Lectures required	Reference No.
	a)	Selection materials of construction for sulfuric acid, Nitric acid	01	5-7
	b)	Selection materials of construction for Phosphoric acid & phosphate fertilizers, Hydrogen & Ammonia plants	02	5-7
	c)	Selection of materials for Urea synthesis reactors and CO ₂ absorption systems	02	5-7
	d)	Metal lining, glass linings, ceramic linings & plastic linings	01	5-7
	e)	Thermomechanical properties of glass lined equipments	01	6-7
	f)	Membrane linings for vessels holding corrosive liquids	01	6-7

References:-

- 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. Shackelford, Introduction to material science, McMillan publishing company, New York ISBN 1990.
5. D.Z. Jestrzebaski, 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 .

Fluid Flow Operation

Teacher, Paper setter and Examiner should follow the following guidelines.

Unit – I

Teacher should facilitate learning of fundamental concepts of fluid flow.

1.	Fundamental concepts of fluid flow	Lectures required	Reference No.
a	Mechanism of compressible and non compressible fluid flow , equation of continuity, Reynolds number	02	1-5
b	Bernoulli's theorem, distribution of velocities and fluid flow profiles	02	1-5
c	Friction factor and friction losses in pipes, roughness factor and its significance, pipe fittings, equivalent length of fittings etc	03	1-5
d	Energy losses due to sudden contraction and expansion	01	1-5

Unit – II

Teacher should facilitate learning of Boundary layer and Dimensional analysis and model studies.

2.	Boundary layer and Dimensional analysis and model studies.	Lectures required	Reference No.
a	Boundary layer theory, Velocity profile and boundary layer growth along a flat plate	02	1-5
b	Thickness of boundary layer (definition and formulae only), separation of boundary, boundary layer calculations for turbulent flows	02	1-5
c	Dimensional analysis, Buckingham's PI theorem	02	1,3
d	Dimensionless numbers, application to fluid flow problem	02	1,3

Unit – III

Teacher should facilitate learning of flow measuring devices.

3.	Flow measuring devices	Lectures required	Reference No.
a	Flow measuring devices for incompressible and compressible fluids	02	1,3
b	Orificemeter, venturimeter, pitot tube	02	1,3
c	Rotameters, notches and weirs	02	1,3

	d	Gas flow meters ,coefficient of discharge and its calculations	02	1,3
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Unit – IV

Teacher should facilitate learning of Transportation of fluids and different types of pumps.

4.	Transportation of fluids and different types of pumps		Lectures required	Reference No.
	a	Transportation of fluids, reciprocating and centrifugal pumps, pump characteristics	02	1,3
	e	Diaphragm pumps, rotary pumps, screw pumps, gear pumps	02	1,3
	d	Pump power calculations, pump selection and trouble shooting of pumps	02	1,3
	e	Priming, cavitation , NPSH of pumps and problems	02	1,3

Unit – V

Teacher should facilitate learning of Fluidization and Packed bed.

5.	Fluidization and Packed bed		Lectures required	Reference No.
	a	Fluidization, aggregate and particulate fluidization, minimum fluidization velocity, entrainment in fluidization	03	3
	b	Packed Bed, pressure drop in packed beds, packing materials and their selection criteria	03	3
	c	Loading and flooding in packed beds	01	3
	d	Kazenger karma equation- Industrial application	01	3

References:-

- 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.

Applied Inorganic Chemistry

Teacher, Paper setter and Examiner should follow the guidelines as given below.

Unit – I

Teacher should facilitate learning of Chemical bonding, Types of Chemical bonds and Theories of Chemical bonding.

1.	Chemical Bonding	Lectures required	Reference No.
a	Ionic bond : The ionic model, Lattice energy, The Born-Haber cycle, Applications of lattice energy	01	1-4
b	Metallic bond: Electron sea model , explanation of metallic properties on the basis of electron sea model	01	1-4
c	Covalent bond: Polarity in covalent bonds, important characteristics of covalent bond : Bond length, bond angle, bond strength	01	1-4
d	Atomic orbital overlap concept, Valence bond Theory	01	1-4
e	Molecular Orbital treatment of covalent bond, VSEPR theory	02	1-4
f	Hybridization , Vander Wall's forces	01	1-4
g	Hydrogen bond: Intramolecular & intermolecular hydrogen bonding	01	1-4

Unit – II

Teacher should facilitate learning of Basic Principles of Metallurgical Operations involved in Metallurgical Industries.

2.	Principal & Processes of Metallurgy & Metallurgical Industries	Lectures required	Reference No.
a	Occurrence of metals, Mineral wealth of India	01	1
b	Ore dressing, Roasting, Calcination	01	1
c	Smelting, Fluxes, Slag	01	1
d	Types of Furnaces, Refining of metals	01	1
e	Iron & Steel Industries: Production of Pig Iron Production of Steel, Heat treatment of steel by annealing, Hardening, Tempering & by normalising	02	6
f	Aluminium Industries: Purification of alumina from bauxite by Bayer process, Production of Aluminium by electrolytic reduction of alumina	02	6

Unit – III

Teacher should facilitate learning of Transition Metal Chemistry, Manufacturing of Transition Metals, and Properties & Applications of Metals.

3.	Transition Metal Chemistry	Lectures required	Reference No.
a	Introduction: General characteristics of d block elements	01	1-2
b	Titanium: Occurrence, Extraction, Properties and Uses Preparation of TiO_2 , $TiCl_4$, Ziegler Natta catalyst	02	1-2,7
c	Vanadium: Occurrence, Extraction, Properties and Uses. Preparation of vanadium metal, V_2O_5 , Ferro vanadium alloy	01	1-2,7
d	Chromium: Occurrence, Extraction, Properties, Industrial applications. Preparation of CrO_3 , $K_2Cr_2O_7$	01	1-2,7
e	Nickel: Occurrence, Extraction, Preparation by Mond process, Electrolytic process, Uses	01	1-2,7
f	Silver :Occurrence, Extraction, Properties, Uses, Silver Plating	01	1-2,7
g	Platinum: Occurrence, Extraction, Properties, Uses	01	1-2,7

Unit – IV

Teacher should facilitate learning of Inorganic Engineering Materials & Composites.

4.	Inorganic Engineering Materials & Composites	Lectures required	Reference No.
a	Abrasives: Introduction, Natural abrasives & synthetic abrasives	01	2
b	Glasses: Introduction, Manufacture of glass	02	2
c	Types of glasses & their applications	02	2
d	Introduction of composite materials, constituents of composites	01	2
e	Types of composites	01	2
f	Processing of fiber-reinforced composites	01	2

Unit – V

Teacher should facilitate learning of basic terms of Phase Rule, Study of Phase Diagrams of Alloy Systems.

5.	Phase Rule & Phase Diagrams	Lectures required	Reference No.
a	Definition of phase rule, definitions of terms used in phase	01	2

	rule		
b	Derivation of phase rule	01	2
c	One component water system	01	2

d	Two component systems	01	2
e	Phase diagrams: Definition, Usefulness of phase diagrams	01	2
f	Classification of phase diagram, Construction of phase diagram	01	2
g	Phase diagram of Steel	01	2
h	Phase diagram of brass , Cu-Ni	01	2

References:-

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

Applied Organic Chemistry

Teacher, Paper setter and Examiner should follow the guidelines as given below.

Unit – I

Teacher should facilitate learning of Types of Intermediate and Reaction Mechanism.

1.	Types of Intermediate & Reaction Mechanism		Lectures required	Reference No.
a	Concept of organic chemistry. Importance of organic chemistry. Sources of Organic Compounds		01	1,3-4
b	Covalent bonds, Bond fission. Structure & formation of Carbonium ion & Carbanion, Free radicals & their stability		01	1,3-4
c	Factors affecting electron availability: Inductive, Resonance Hyperconjugation & Steric effects		01	1,3-4
d	Electrophiles & Nucleophiles, Aldol condensation		01	1,3-4
e	Cannizzaro & cross Cannizzaro reactions, Claisen ester condensation		01	1,3-4
f	Reimer Tiemann reaction, Grignard reactions		01	1,3-4
g	SN ¹ & SN ² reactions			1,3-4
h	Fridel Crafts alkylation & acylations		01	1,3-4

Unit – II

Teacher should facilitate learning of Stereo Chemical aspects of Organic Compounds.

2.	Stereochemistry		Lectures required	Reference No.
a	Basic concept of stereochemistry, Structural Isomerism		01	1,4,7
b	Different methods of representation of three dimensional molecule on paper		01	1,4,7
c	Conformations of Ethane & n-Butane & their relative stability		01	1,4,7
d	Conformations of Cyclohexanes, Geometrical isomerism: Cis-Trans isomerism shown by alkenes		01	1,4,7
e	Optical isomerism: Measurement of Optical activity by Polarimeter, Specific rotation, Enantiomerism, Necessary conditions of optical activity, Optical isomerism of Lactic acid & Tartaric acid		03	1,4,7
f	Distereoisomerism, Baeyer's angle strain concept		01	1,4,7

Unit – III

Teacher should facilitate learning of Heterocyclic Chemistry & Petroleum.

3.	Chemistry of heterocyclic compounds & Petroleum	Lectures required	Reference No.
a	Classification of heterocyclic compounds Furan: Structure, Preparation, Properties, Reactions & Uses	01	1,4,6
b	Pyrrole: Preparation, Properties, Reactions & Uses Thiophene: Preparation, Properties, Reactions & Uses	01	1,4,6
c	Pyridine: Structure, Preparation, Properties, Reactions & Uses	01	1,4,6
d	Quinoline : Skraup synthesis, Properties, Reactions & Uses	01	1,4,6
e	Petroleum: Origin and composition, Petroleum mining, refining, compositions and uses of main petroleum fractions	02	1
f	Cracking & its importance in chemical industries, Octane number, Improving octane number, Chemicals from petroleum	02	1

Unit – IV

Teacher should facilitate learning of Nitration & Sulphonation Reactions & Preparations.

4.	Nitration & Sulphonation	Lectures required	Reference No.
a	Nitration, Mechanism of nitration of benzene	01	1
b	Nitration of benzene with HNO ₃ -fortified spent acid	01	2
c	Preparation of p-Nitroacetanilide, Preparation of α -Nitronaphthalene	02	2
d	Sulphonation, Mechanism of sulphonation of benzene	01	1
e	Continuous partial pressure sulphonation of benzene	01	2
f	Sulfation of : Lauryl Alcohol, Dimethyl ether	02	2

Unit – V

Teacher should facilitate learning of Halogenations, Polymer Chemistry & Polymerization.

1.	Halogenation & Principles of Polymer chemistry & practice	Lectures required	Reference No.
a	Halogenation, mechanism of halogenation	01	1
b	Technical preparation of chloral, DDT, BHC and vinyl chloride from acetylene	03	2
c	Principle of polymer chemistry	01	1,5,8
d	Study of Industrially important polymers with respect to synthesis, properties & applications: Polyethylene, Polypropylene	01	1,5,8
e	Polyvinyl acetate, Urea Formaldehyde, Phenol Formaldehyde, Nylon	02	1,5,8

References:

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

LAB Chemical Engineering Materials

COURSE CONTENT

Teacher should facilitate learning following lab experiments:

(Note: Any eight experiments from the following)

Experiments		Lab hours required
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.	02
2	Study of properties of polymeric materials; impact test and polymeric Tests	02
3	Different types of hardness test on metals. i.e. Rockwell hardness test, Brinell hardness test	02
4	Izod and Charpy impact test on mild steel, copper, brass and aluminum	02
5	Macrostructure observation: (flow lines observation in forging by macro etching sulphur printing of steel.)	02
6	Study experiments based on, i) Dye penetration ii) Rubber lining iii) Heat treatments. iv) Ultrasonic Test	02
7	Tension test on mild steel for studying stress, strain & Young's modulus	02
8	Bending test on steel sheets	02
9	Bending test on copper sheets	02
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.)	02

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.

Guide lines for ICA:

ICA shall be based on continuous evaluation of student performance throughout semester and practical assignment submitted by the student in the form of journal.

LAB Fluid Flow Operation

COURSE CONTENT

Teacher should facilitate learning following lab experiments:

(Note: Any eight experiments from the following)

Experiments		Lab hours required
1	Study of Bernoullis theorem	02
2	Measurement of coefficient of discharge for venturimeter	02
3	Measurement of coefficient of discharge for orificemeter	02
4	Measurement of coefficient of discharge for notch	02
5	Study of Reynolds experiment	02
6	Study of characteristics of centrifugal pump	02
7	Study of characteristics of reciprocating pump	02
8	Study of characteristics of diaphragm pump	02
9	Study of Rotameter	02
10	Study of manometers	02

References for Practicals:

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

Guide lines for ICA:

ICA shall be based on continuous evaluation of student performance throughout semester and practical assignment submitted by the student in the form of journal.

Guide lines for ESE:

ESE will be based on practical assignment submitted by the student in the form of journal. In ESE the student may be asked questions based on the practicals performed during lab work. Evaluation will be based on oral examination related to laboratory course.

LAB Applied Inorganic Chemistry

COURSE CONTENT

Teacher should facilitate learning following lab experiments:

(Note: Any eight experiments from the following)

Experiments		Lab hours required
1	To find strength of solution in g/l & in normal terms	02
2	Determination of the amount of Magnesium volumetrically by using disodium EDTA	02
3	Determination of amount of Manganese by Volhards Method	02
4	Estimation of Manganese dioxide in pyrolusite ore	02
5	Gravimetric determination of Fe as Fe ₂ O ₃	02
6	Gravimetric determination Ni as Ni-DMG	02
7	Determination of amount of Copper(II) volumetrically from the given solution of CuSO ₄	02
8	Preparation of tetramine copper (II) sulphate	02
9	Preparation of tris-ethylenediamine nickel(II) thiosulphate	02
10	Preparation of potassium tri-oxalato aluminate tri-hydrate	02

References for Practicals:

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

Guide lines for ICA:

ICA shall be based on continuous evaluation of student performance throughout semester and practical assignment submitted by the student in the form of journal.

Guide lines for ESE:

ESE will be based on practical assignment submitted by the student in the form of journal. In ESE the student may be asked to perform any one practical out of 8. Evaluation will be based on paper work and performance in the practical.

LAB Applied Organic Chemistry

COURSE CONTENT

Teacher should facilitate learning following lab experiments:

(Note: Any eight experiments from the following)

Experiments		Lab hours required
1	Purification of organic compound by crystallization	02
2	Purification of organic compound by distillation	02
3	Estimation of Acetone	02
4	Estimation of Glucose	02
5	Preparation of p-nitro acetanilide by nitration	02
6	Preparation of Quinone	02
7	Preparation of Urea Formaldehyde resin	02
8	Preparation of acetyl derivative of $-NH_2$ / $-OH$ group	02
9	Preparation of benzoyl derivative of $-NH_2$ / $-OH$ group	02
10	Preparation of 2:4 dinitro-phenyl hydrazone (2,4 DNP) derivative of $-CHO$ / $-CO$ group	02

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.

Guide lines for ICA:

ICA shall be based on continuous evaluation of student performance throughout semester and practical assignment submitted by the student in the form of journal.

Guide lines for ESE:

ESE will be based on practical assignment submitted by the student in the form of journal. In ESE the student may be asked to perform any one practical out of 8. Evaluation will be based on paper work and performance in the practical.

NORTH MAHARASHTRA UNIVERSITY, JALGAON (M.S.)

Second Year Chemical Engineering

Faculty of Engineering and Technology



Teacher and Examiner's Manual

SEM – IV

W.E.F 2013 – 2014

Chemical Engineering Processes-I

Teacher, Paper setter and Examiner should follow the guidelines as given below.

Unit - I

Teacher should facilitate learning of basic raw material, work of chemical engineer and manufacturing of industrial gases.

1.	Fuel & Industrial Gases	Lectures required	Reference No.
a	Introduction of Chemical Processing	01	1-2
b	work of chemical engineer	01	1-2
c	Manufacture of Hydrogen and Oxygen	01	1-3
d	Manufacture of Nitrogen and Carbon Dioxide	02	1-3
e	Manufacture of Acetylene	01	1
e	Manufacture of Producer gas	01	1
f	Manufacture of Synthesis gas	01	1

Unit – II

Teacher should facilitate learning of chlor-alkali industries and electrochemical industries.

2.	Chlor-Alkali Industries and Electrochemical industries	Lectures required	Reference No.
a	Introduction of chlor alkali industries and manufacture of Soda ash	02	1
b	Manufacture of Sodium bicarbonate and caustic soda	01	1-2
c	Manufacture of Chlorine and Bleaching powder	01	1-2
d	Introduction of Electrochemical industries-Fuel cells	02	1
e	Principle& Efficiency of Fuel cells	01	1
f	Kinds of Fuel cells & advantages of Fuel cells	01	1

Unit – III

Teacher should facilitate learning of Phosphorous Industries.

3.	Phosphorous Industries	Lectures required	Reference No.
a	Introduction of Phosphate industries and manufacture of Elemental phosphorous	02	1
b	Wet process & electric furnace process for phosphoric acid production	02	1

c	Manufacturing of ammonium phosphate and Fire retardant chemicals	02	1
d	Introduction and manufacturing of Baking powder	01	2
e	Manufacturing of Superphosphate and Triple Superphosphate	01	1

Unit – IV

Teacher should facilitate learning of Nitrogen industries & Inorganic Acids and Sulfur industries.

4.	Nitrogen industries, Inorganic Acids and Sulfur industries	Lectures required	Reference No.
a	Introduction of Nitrogen industries and manufacture of synthetic ammonia process for ammonia production	02	1
b	Manufacturing of Nitric acid and Ammonium nitrate	01	1
c	Manufacturing of Urea and Hydrochloric acid	02	1-2
d	Manufacturing of elemental sulfur by Frasch & Finnsch process	02	1
e	Manufacturing of sulfuric acid	01	1

Unit – V

Teacher should facilitate learning of Sodium compounds and Chemicals from Sea Water.

5.	Sodium compounds and Chemicals from Sea Water	Lectures required	Reference No.
a	Introduction of Sodium compounds and manufacturing of Sodium sulphate	02	2
b	Manufacturing of Sodium sulfide and Sodium thiosulphate	01	2
c	Manufacturing of Sodium silicate and Sodium peroxide	01	1-2
d	Introduction of Chemicals from Sea Water and manufacturing process	01	1-2
e	Production of common salt by solar evaporation of sea water	01	1-2
f	Production of salt from brine	01	1-2
g	Bromine Manufacture from sea water & by steaming out process	01	1-2

References:-

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

Process Calculations

Teacher, Paper setter and Examiner should follow the guidelines as given below.

Unit – I

Teacher should facilitate learning of properties of gases, liquid and solids.

1.	Properties of Gases ,liquid and solids	Lectures required	Reference No.
a	Units their dimensions and conversions , Mass and volume relations	01	1-3
b	Stoichiometric and composition relations, Excess reactants, Degree of completion	01	1-3
c	Conversion, selectivity and yield	01	1-3
d	Ideal gas law, Dalton's Law, Amagat's Law, and Average molecular weight of gaseous mixtures	01	1-3
e	Effect of temperature on vapour pressure	02	1-3
f	Vapour pressure plot (Cox chart), Vapour pressures of miscible and immiscible liquids and solutions	01	1-3
g	Raoult's Law and Henry's Law	01	1-3

Unit – II

Teacher should facilitate learning of humidity.

1.	Humidity	Lectures required	Reference No.
a	Humidity and saturation	01	1-3
b	Relative Humidity and percent saturation	01	1-3
c	Dew point, Dry bulb temperatures	01	1-3
d	Wet bulb temperatures	01	1-3
e	Use of humidity charts for engineering calculations	02	1-3
f	Problems on psychometric chart	02	1-3

Unit – III

Teacher should facilitate learning of Stoichiometry & Material Balance.

3.	Stoichiometry & Material Balance	Lectures required	Reference No.
a	Material balances for systems with chemical reactions,	01	1-3

	b	Material balances for systems without chemical reactions	02	1-3
	c	Species balance	01	1-3
	d	Elemental balance	01	1-3
	e	Analysis of systems with by-pass	01	1-3
	f	Analysis of systems with recycle	01	1-3
	g	Analysis of systems with purge	01	1-3

Unit – IV

Teacher should facilitate learning of Energy balance.

4.	Energy balance		Lectures required	Reference No.
	a	Energy capacity of gases, liquids and solutions	01	1-5
	b	Heat of fusion and vaporization, Steady state energy balance for systems with and without chemical reactions	02	1-5
	c	Calculations and application of heat of reaction	02	1-5
	d	Calculations and application of heat combustion, formation, neutralisation and solution	01	1-5
	e	Combustion of liquids and gaseous fuels	01	1-5
	f	Calculation of theoretical and actual flame temperatures	01	1-5

Unit – V

Teacher should facilitate learning of Fuels & Combustion

5.	Fuels & Combustion		Lectures required	Reference No.
	a	Heating value of fuels	02	1-5
	b	Calculations involving theoretical and excess air	02	1-5
	c	Heat & material balances of combustion processes	02	1-5
	d	Chemical ,metallurgical and petrochemical processes	02	1-5

References:

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. O.A.Hougen , K.M.Watson, Ragatz, Chemical Process Principles, Vol.I, Asia Publishing House, New Delhi.
4. Himmelblau, D.M. "Basic Principles and Calculations in Chemical Engineering", 6th edition. Prentice Hall .
5. Felder, R.M. & Rousseau, R.W. "Elementary Principles of Chemical Processes" 3rd edition., JohnWiley. (1999).

Mechanical Operation

Teacher, Paper setter and Examiner should follow the guidelines as given below.

Unit – I

Teacher should facilitate learning of Size reduction, size separation, energy utilization and its application with respect to chemical industries.

1.	Introduction to Size Reduction and size analysis	Lectures required	Reference No.
a	Properties of solids. Particle size, shape; mixed particle size & size analysis	01	2,7
b	Specific surface of mixture (Numerical expected) Average particle size; energy utilization, Crushing efficiency	01	7
c	Law of size reduction. (Numerical expected) Laws of crushing. General Laws of settling- Free settling, stokes' law	01	3,5,6
d	Types of equipments:- For coarse, intermediate & fine size reduction; energy and power requirement; open & closed loop circuit	02	1-3
e	Screens:- (Numerical expected) Screening: Equipment, ideal screen. Screen analysis methods	01	3,6-7
f	Standard Screen : Series of std. Screen; capacity	01	6
g	Effectiveness of screen:- Problem based on above unit	01	6-7

Unit – II

Teacher should facilitate learning of Transportation, storage of solids, conveyor systems, mixing and agitation of liquids, paste materials.

2.	Introduction to transportation of solids	Lectures required	Reference No.
a	Handling of transport of Solids- Bins, bunker, Silos	01	2-3
b	Introduction about conveyors, belt conveyors –	01	6

	checking/determining conveyor capacity, belt speed. Belt tension, belt sag, and motor power		
b	Screw conveyor, advantage and disadvantage of screw conveyor. Bucket elevators – types of bucket, Chain conveyor and its type's chain pull conveyor	02	6-7
c	Mixing and Agitation:- Impellers, flow pattern, Calculation of power requirement of mixing equipments	01	6

d	Mixing Index, Types of mixers, paste & plastic masses. Rate of mixing	01	2, 6
e	Mixing & Agitation of Liquids: equipment and circulation velocities. Power consumption in agitated vessel; blending & mixing	01	3-4
f	Problem based on above	01	2, 6-7

Unit - III

Teacher should facilitate learning of Fluid solid system behavior, application in catalytic cracking and pneumatic system.

3. Introduction to Fluid Solid System		Lectures required	Reference No.
a	Drag force, drag coefficient	01	3,6
b	Stokes law, Cozeny- Carman equation. Motion of particles in a fluid	02	4,7
c	Drag force on spherical particle. free settling velocity, & hindered settling	02	3-4
d	Fluidization: Minimum fluidization velocity, types of fluidization. Application of fluidization in catalytic cracking, pneumatic conveying system, spouted beds, etc. problem based on above	03	1-2 , 6

Unit - IV

Teacher should facilitate learning of settling of sedimentation cyclone separator and area of thickener.

4. Introduction to Sedimentations		Lectures required	Reference No.
a	Clarification & thickening, separation ratio; equipment for centrifugal & gravity classification; cyclone separator	02	2-3,6
b	Design: - Hydro cyclones; principle of magnetic and electrostatic separation	02	3,7
c	Kynch theory of sedimentation, Determination of thickener area	01	1,4
d	laboratory batch & continuous sedimentation	01	6
e	Continuous centrifuges, disc type centrifuge	02	3,6

Unit – V

Teacher should facilitate learning of filtration system, washing of cakes, gravity filtration system.

5.	Filtration	Lectures required	Reference No.
a	Objectives of filtration, preparation stages of filtration	01	1
b	Filter aids, classification of filters, selection of filter media. Basic equation of filtration	01	2,6
c	Relation between thickness of cake and volume of filtrate. Principle of batch filtration: constant pressure & constant rate filtration, factors affecting filtration	02	2,7
d	Flow of filtrate through the cloth and cake combined. Compressible filter cake, optimum time cycle, Continuous, centrifugal, vacuum, gravity filtration & related equipments	02	3-4
e	Centrifuge and Washing of filter cake, and numerical based on above	02	2-3,6

References:-

1. Mc Cabe W. L. & Smith J. C. " Unit Operation for Chemical Engg." 5th Edt. McGraw Hill Kogakusha Ltd.
2. Coulson J. M. & Recharadson J. F. " Chemical Engg.- Vol. II" Butterworth Heinemann.
3. Badger W. L. & Banchemo J. T. " Introduction to Chemical Engg." McGraw Hill International Book Co. New Delhi.
4. Narayan & Bhattacharya " 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.

Applied Physical Chemistry

Teacher, Paper setter and Examiner should follow the guidelines as given below.

Unit – I

Teacher should facilitate learning of Kinetic Theory of Gases.

1.	Kinetic Theory of Gases	Lectures required	Reference No.
a	Gas Laws, Graham's law of diffusion	01	1-4
b	Kinetic gas equation	01	1-4
c	Equation of state of ideal & real gases	01	1-4
d	Compressibility factor, critical constants	01	1-4
e	Molecular velocities, probability distribution of velocities	01	1-4
f	Mean free path, collision diameter, collision no	01	1-4
g	Liquefaction of gases	01	1-4
h	Heat capacity of gases: C_p & C_v problems	01	1

Unit – II

Teacher should facilitate learning of Chemical Kinetics.

2.	Chemical kinetics	Lectures required	Reference No.
a	Objective of chemical kinetics, rate of reaction, velocity constant of a reaction, elementary reaction steps & rate expressions, order & molecularity of reaction	02	1-2
b	Factors influencing the reaction rates	01	1-2
c	Rate expressions for 1 st , 2 nd , 3 rd , & zero order reaction (with example)	02	1-2
d	Methods for determining order of reactions	01	1-2
e	Arrhenius equation, Problems	01	1
f	Photochemical reactions, Set up for study of photochemical reactions	01	1-2

Unit – III

Teacher should facilitate learning of Classical Chemical Thermodynamics.

3.	Classical chemical thermodynamics	Lectures required	Reference No.
a	Objective & scope, definition of thermodynamic systems, state property etc, Heat work reversibility, maximum work	02	1-2
b	Isothermal & adiabatic process	01	1-2

c	First law of thermodynamics, thermo chemistry	01	1-2
d	Thermo chemical law, standard heat of formation	01	1-2

e	Second law of thermodynamics, entropy, entropy changes	02	1-2
f	Enthalpy & free energy, Gibbs Helmholtz equation, Third law of thermodynamics	01	1-2

Unit – IV

Teacher should facilitate learning of aspects of Chemical Equilibrium & Catalysis

4.	Chemical Equilibrium & Catalysis	Lectures required	Reference No.
a	Criteria of chemical equilibrium	02	1
b	Le Chatelier's theorem, its application to some systems likes ammonia, sulphuric acid, and nitric acid	02	1
c	Catalysis: Types of catalysis, characteristics of catalytic reactions, Promoters	01	1
d	Catalytic poisoning, Autocatalysis, Negative catalysis	01	1
e	Activation energy & catalysis, Theories of catalysis	01	1
f	Acid-base catalysis & mechanism, Enzyme catalysis: Mechanism & characteristics	01	1

Unit – V

Teacher should facilitate learning of Colligative Properties & their Importance

5.	Colligative properties	Lectures required	Reference No.
a	Colligative properties, lowering of vapour pressure, measurement of vapour pressure lowering determination of molecular weights from vapour pressure, lowering.	02	1
b	Osmosis, osmotic pressure, measurement of osmotic pressure, the law of osmotic pressure, determination of molecular weight from osmotic pressure, osmosis & semipermeability, reverse osmosis.	02	1
c	Elevation in boiling point, determination of molecular weight from boiling point elevation, measurement of boiling point elevation.	02	1
d	Depression in freezing point, determination of molecular weight from freezing point depression, determination of freezing point depression.	02	1

References:

1. B. S.Bahl, G.D.Tuli, Arun Behl, ,Essentials of physical Chemistry: S.Chand & Co.Ltd.Delhi.
2. Maron-Prutton, Principles of Physical chemistry: Oxford & IBH publishing Co.Pvt.Ltd. New Delhi.
3. S. Glasstone & Lewis, Elements of physical chemistry : McMillan India Ltd.
4. B.R.Puri & L.R.Sharma, A textbook of physical chemistry : S. Chand & Co. Delhi.

Chemical Engineering Processes-II

Teacher, Paper setter and Examiners should follow the guidelines as given below.

Unit - I

Teacher should facilitate learning of Oil and Waxes, Soaps, Glycerin and Detergents.

1.	Oil and Waxes, Soaps, Glycerin and Detergents	Lectures required	Reference No.
a	Introduction of oil and manufacturing of vegetable oil extraction	02	1-2
b	Manufacturing of hydrogenation of oils	01	1-2
c	Introduction of Waxes, types & their uses	02	2
d	Introduction of soap and detergents	01	2
e	Raw material and manufacturing process of soap	01	2
f	Raw material and manufacturing process of detergents	01	2

Unit – II

Teacher should facilitate learning of Sugar and Starch Industries, Fermentation Industries Pulp and paper industries.

2.	Sugar and Starch Industries, Fermentation Industries ,Pulp and paper industries	Lectures required	Reference No.
a	Introduction of Sugar and Starch Industries	01	1
b	Manufacturing process of extraction of sucrose from sugarcane, by-products of the sugar industry	01	1
c	Properties & structure of starch, production of starch from maize, production of dextrin by starch hydrolysis	02	1
d	Manufacture of ethyl alcohol by fermentation	01	1-5
e	Production of beer, wines and liquors, vinegar, citric acid ,lactic acid	02	2-5
f	Manufacturing of pulp, manufacturing of paper, and structural boards	01	1

Unit – III

Teacher should facilitate learning of Agrochemical Industries and Pharmaceuticals Industries.

3.	Agrochemical Industries and Pharmaceuticals Industries	Lectures required	Reference No.
a	Introduction of Agrochemical Industries and production of Insecticides, pesticides herbicides, plant growth , nutrients and regulators	03	1-2
b	Manufacturing process of compound fertilizers, bio-fertilizers, complex fertilizers, various grades of N.P.K. fertilizer	02	1-2
c	Introduction of Pharmaceuticals Industries and Classification of pharmaceuticals products	02	1-2

d	Manufacture of penicillin & tetracycline	01	1-2
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Unit – IV

Teacher should facilitate learning of Petrochemicals.

4.	Petrochemicals	Lectures required	Reference No.
a	Introduction of Petrochemicals and manufacturing of Methanol	02	1-3
b	Manufacturing of Formaldehyde and Ethylene dichloride	01	1
c	Manufacturing of Ethylene and Acetylene	01	1
d	Manufacturing process of Ethylene oxide and Isopropanol	02	1
e	Manufacturing process of Acetone and Butadiene	01	1-3
f	Manufacturing process of Isopropyl benzene	01	1-3

Unit – V

Teacher should facilitate learning of Explosives and Plastic industries.

5.	Explosives and Plastic industries	Lectures required	Reference No.
a	Introduction of Explosives and types of Explosives	01	2
b	Explosive characteristics, industrial explosives, propellants	01	2
c	Rockets, missiles, pyrotechnics, matches, toxic chemical weapons	02	2
d	Introduction of Plastic industries and raw material used in industry	02	1-3
e	Manufacturing processes, general polymerization processes, compounding and moulding operation	02	1-3

References:-

1. C.E. Dryden, Outline of Chemical Technology, Affiliated East West Press. 1973.
2. George T. Austin, "Shreeve's Chemical Process Industries", 5th Edition, Mc Graw Hill Book Company.
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.

LAB Computer Applications

COURSE CONTENT

Teacher should facilitate learning following lab experiments.

(Note: Any eight experiments from the following)

Experiments		Lab hours required
1	To solve Matrices using Matrix Inversion Method.	02
2	To solve Matrices using Gauss Elimination method.	02
3	To solve Differential equation of first order by Taylor's series method	02
4	To solve Differential equation of first order by Modified Euler's method	02
5	To solve Differential equation of first order by Picards method	02
6	To solve Differential equation of first order by Runge Kutta's 4 th order method	02
7	To solve Numerical Integration by Weddle's rule.	02
8	To solve Numerical Integration by Trapezoidal Rule	02
9	To solve Numerical Integration by Simpson's 1/3 rd Rule	02
10	To solve Numerical Integration by Simpson's 3/8 th rule	02

References for Practicals:

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, 6th Edition, Tata McGraw Hill.
4. David M. Himmelblau, Basic Principles & Calculations in Chemical Engineering, 6th Edn., Pearson Education Pvt.Ltd., New Delhi.
5. S.S.Sastry, Introductory methods of Numerical Analysis, Prentice Hall.

Guide lines for ICA:

ICA shall be based on continuous evaluation of student performance throughout semester and practical assignment submitted by the student in the form of journal.

LAB Chemical Processes

COURSE CONTENT

Teacher should facilitate learning following lab experiments.

(Note: Any eight experiments from the following)

Experiments		Lab hours required
1	Determination of the Na_2CO_3 content of washing soda.	02
2	To determine the loss per gram and the percentage purity of the given sample of sodium	02
3	Estimation of available chlorine in bleaching powder.	02
4	Preparation of Sodium thiosulphate	02
5	Preparation of biuret from urea	02
6	Preparation of soap	02
7	Preparation of drug aspirin	02
8	Estimation of formaldehyde.	02
9	Determination of TFM in soap	02
10	Preparation of acetaldehyde by the oxidation of ethanol	02

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.

Guide lines for ICA:

ICA shall be based on continuous evaluation of student performance throughout semester and practical assignment submitted by the student in the form of journal.

Guide lines for ESE:

ESE will be based on practical assignment submitted by the student in the form of journal. In ESE the student may be asked to perform any one practical out of 8. Evaluation will be based on paper work and performance in the practical.

LAB Mechanical Operation

COURSE CONTENT

Teacher should facilitate learning following lab experiments.

(Note: Any eight experiments from the following)

Experiments		Lab hours required
1	To study the separation of solids by sedimentation	04
2	To study the differential and cumulative screen analysis of sand.(Sieve analysis)	04
3	To verify the laws of crushing and grinding by ball mill	04
4	To verify the laws of crushing and grinding by Jaw crusher	04
5	To determine the rate of filtration, cake resistance and filter medium resistance	04
6	To determine the rate of filtration by vacuum filter	04
7	To study the behavior of the bed during fluidization	04
8	To study the sigma Kneader Mixer	04
9	To study the operating behavior of cyclone separator and to find out its efficiency	04
10	To study the Ribbon Blender and to find out the mixing index	04

Guide lines for ICA:

ICA shall be based on continuous evaluation of student performance throughout semester and practical assignment submitted by the student in the form of journal.

Guide lines for ESE:

ESE will be based on practical assignment submitted by the student in the form of journal. In ESE the student may be asked questions based on the practicals performed during lab work. Evaluation will be based on oral examination related to laboratory course.

Soft Skills – III

Teacher, Paper setter and Examiners should follow the guidelines as given below.

Unit - I

Teacher should facilitate the learning basic foundation of mathematics.

1.	Arithmetic-1	Lecture required	Reference No
a	Number Systems Basic Formulae, Divisibility Rules, Speed Maths, Remainder Theorem, Different Types of Numbers, Applications	01	01
b	HCF, LCM and Linear Equations HCF – Successive Division and Prime Factorization Methods, LCM – Successive Division and Prime Factorization Methods, Applications, Linear Equations – Elimination Method, Substitution Method, Applications	01	01
c	Averages and Mixtures Concept of Average, Faster Ways of Finding It, The Allegation Method, Applications	01	01

Unit II

Teacher should facilitate the learning basic foundation of mathematics.

2.	Arithmetic-2	Lecture required	Reference No
a	Percentages Concept of Percentage, Working with Percentages Applications	01	01
b	Profit and Loss Difference between Cost and Selling Price, Concept of Profit Percentage and Loss Percentage, Applications	01	01
c	Time and Work Basic Time and Work Formula, Relation between Time and Work, Applications	01	01

Unit III

Teacher should facilitate the learning basic foundation of mathematics.

3.	Arithmetic-3	Lecture required	Reference No
a	Permutations and Combinations Sum Rule of Disjoint Counting, Product Rule of Counting Concept of Factorial, Permutations, Linear Permutations, Combinations, Circular Permutations, Applications	01	01
b	Probability Definition and Laws of Probability, Mutually Exclusive Events, Independent Events, Equally Likely Events, Exhaustive Events, Cards, Dice, Applications	01	01

	c	Time and Distance Speed, Conversion Factors for Speed, Average Speed, Moving Bodies – Passing, Crossing and Overtaking, Relative Speed, Boats and Streams, Applications	01	01

Unit IV

Teacher should facilitate learning of critical thinking.

4.	Non-Verbal Reasoning		Lecture required	Reference No
	a	Analogies Different type of examples of analogies and its Applications	01	02
	b	Classification Different type of examples of analogies and its Applications	01	02
	c	Sequences Different type of examples of analogies and its Applications		02

Unit V

Teacher should facilitate the learning of a deep sense of analysis towards solving a problem

5.	Analytical Reasoning		Lecture required	Reference No
	a	Analytical Puzzles Classification Puzzles, Ordering Puzzles, Assignment puzzles, Applications	01	03
	b	Letter and Number Series Different Types of Letter Series, different types of Number Series, mixed Series	01	03
	c	Coding and Decoding Letter Coding, Number Coding, Mixed Coding, Odd Man Out, Applications	01	03

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.

LAB Applied Physical Chemistry

COURSE CONTENT

Teacher should facilitate learning following lab experiments.

(Note: Any eight experiments from the following)

Experiments		Lab hours required
1	Determination of equivalent weight of metal eudiometrically.	02
2	Determination of atomic weight of the metal using Dulong-Petit law.	02
3	Determination of surface tension of liquids by Stalagmometer.	02
4	Determination of rate constant of hydrolysis of methyl acetate by dilute HCl & to show that the reaction is of first order.	02
5	Determination of rate constant of hydrolysis of ethyl acetate by NaOH & to show that the reaction is of second order.	02
6	Determination of energy of activation for the reaction between potassium persulphate and potassium iodide	02
7	Determination of heat of solution of KNO_3 .	02
8	Determination of water equivalent of copper calorimeter & heat of neutralization of strong acid & strong base by calorimeter.	02
9	To determine ΔH , ΔG , ΔS of a reaction.	02
10	Determination of molecular weight of substance by depression in freezing point method.	02

References for Practicals:

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

Guide lines for ICA:

ICA shall be based on continuous evaluation of student performance throughout semester and practical assignment submitted by the student in the form of journal.

Guide lines for ESE:

ESE will be based on practical assignment submitted by the student in the form of journal. In ESE the student may be asked to perform any one practical out of 8. Evaluation will be based on paper work and performance in the practical.