

# **COURSES OF STUDIES**

FOR

THREE YEAR DEGREE COURSE

IN

**SCIENCE HONOURS**

**CHEMISTRY HONS.**

**Choice Based Credit System(CBCS)**

First & Second Semester Examination – 2017-18

Third & Fourth Semester Examination – 2018-19

Fifth & Sixth Semester Examination – 2019-20



**GOVERNMENT AUTONOMOUS COLLEGE,  
PHULBANI, KANDHAMAL**

### SYLLABI FOR CBCS COURSE

Sem	CORE COURSE (14)	Ability Enhancement Compulsory Course (AECC) (2)	Ability Enhancement Elective Course (AEEC) (2) (Skill Based)	Elective: Discipline Specific DSE (4)	Elective: Generic (GE) (4)
I	CORE-I	M.I.L/English Communication			GE-1 (Minor-1)
	CORE-II				
II	CORE-III	Environmental Studies			GE-2 (Minor-2)
	CORE -IV				
III	CORE-V		SEC-1 (Communicative English and Writing Skill)		GE-3 (Minor-1)
	CORE-VI				
	CORE-VII				
IV	CORE-VIII		SEC-2 (Subject specific Skill)		GE-4 (Minor-2)
	CORE-IX				
	CORE-X				
V	CORE-XI			DSE-1	
	CORE-XII			DSE-2	
VI	CORE-XIII			DSE-3	
	CORE-XIV			DSE-4 (Project)	

SEC-1 : To be offered by English Department.

SEC-2 : This is a subject specific skill to be offered by the respective Department.

GE : Minor-1 and Minor-2 is to be decided by the college Based on Subject.

### QUESTION PATTERN FOR MID SEM

Mid Semester Examination	Full Marks	No. of Short Answer type Questions (2 marks each) (Compulsory)	No. of Long Answer type Questions (8 marks each)	No. of Long Answer type Questions (12marks each)
Practical Subject	20	6	1	*
Non-Practical Subject	20	4	*	1
Non-Practical Subject	10	1	1	*

### QUESTION PATTERN FOR END SEM

End Semester Examination	Full Marks	GROUP – A	GROUP - B									
		No. of Short Answer type Questions (2 marks each) (Compulsory)	No. of Long Answer type Questions (8 marks each)					No. of Long Answer type Questions (12marks each)				
Units-->		All Units	I	II	III	IV	V	I	II	III	IV	V
Non-Practical Subject	80	10	*	*	*	*	*	1	1	1	1	1
Practical Subject	50	5	1	1	1	1	1	*	*	*	*	*
Non-Practical Subject	40	4	1	1	1	1	*	*	*	*	*	*
Practical Subject	20	2	1	1	*	*	*	*	*	*	*	*

- ❖ There is no alternative question (choice) in Group-A questions (Short Answer type questions). All questions are compulsory.
- ❖ There is internal alternative question (choice) in each number in Group-B questions (Long Answer type questions). Examinee has to answer one question out of two alternative questions from each number.
- ❖ There is little deviation in question pattern of AECC-1.4 (Eng Communication) & AECC-3.5 (Soft Skills). Details regarding question pattern of concerned subject is given at appropriate place.)
- ❖ The duration of Mid Sem exam of each paper is 1 hour irrespective of Full marks.
- ❖ The duration of End Sem exam of each paper is 3 hours for 80 marks/50 marks/40 marks & 2 hours for 20 marks.

## YEAR & SEMESTER-WISE PAPERS & CREDITS AT A GLANCE

<b>Three-Year (6-Semester) CBCS Programme (B.Sc. Hons.) (Chemistry Hons.)</b>					
Yr.	Sl.No.	Course Structure	Code	Credit Points	
<b>FIRST YEAR</b>	<b>SEMESTER-I</b>				
	1	Inorganic Chemistry-I	C-1.1	4+2	
	2	Physical Chemistry-I	C-1.2	4+2	
	3	Mechanics (Physics)	GE-1.3	4+2	
	4	MIL Communication- Odia/English Communication	AECC-1.4	2	
	<b>Total</b>			<b>20</b>	
	<b>SEMESTER-II</b>				
	5	Organic Chemistry-I	C-2.1	4+2	
	6	Physical Chemistry-II	C-2.2	4+2	
	7	Calculus and Ordinary Differential Equations (Mathematics)	GE-2.3	6	
8	Environmental Studies	AECC-2.4	2		
<b>Total</b>			<b>20</b>		
<b>SECOND YEAR</b>	<b>SEMESTER-III</b>				
	9	Inorganic Chemistry-II	C-3.1	4+2	
	10	Organic Chemistry-II	C-3.2	4+2	
	11	Physical Chemistry-III	C-3.3	4+2	
	12	Electricity, Magnetism and EMT (Physics)	GE-3.4	4+2	
	13	Soft Skills	AECC-3.5	2	
	<b>Total</b>			<b>26</b>	
	<b>SEMESTER-IV</b>				
	14	Inorganic Chemistry-III	C-4.1	4+2	
	15	Organic Chemistry-III	C-4.2	4+2	
	16	Physical Chemistry-IV	C-4.3	4+2	
	17	Linear Algebra and Advanced Algebra (Mathematics)	GE-4.4	4+2	
	18	Fuel Chemistry	AECC-4.5	2	
	<b>Total</b>			<b>26</b>	
	<b>FINAL YEAR</b>	<b>SEMESTER-V</b>			
		19	Organic Chemistry-IV	C-5.1	4+2
		20	Physical Chemistry-V	C-5.2	4+2
		21	Polymer Chemistry)	DSE-5.3	4+2
22		Industrial Chemicals and Environment	DSE-5.4	4+2	
<b>Total</b>			<b>24</b>		
<b>SEMESTER-VI</b>					
23		Inorganic Chemistry-IV	C-6.1	4+2	
24		Organic Chemistry-V	C-6.2	4+2	
25		Inorganic Materials of Industrial Importance	DSE-6.3	4+2	
26	Dissertation/Project Work	DSE-6.4	6		
<b>Total</b>			<b>24</b>		
<b>Grand Total</b>			<b>140</b>		

**Notes:**

- C- Core Course
- GE- Generic Elective Course
- DSE- Discipline Specific Elective Course
- AECC- Ability Enhancement Compulsory Course
- AECC- Ability Enhancement Elective Course (Skill Based)
- For a 6 credit course, the total teaching hours are: Minimum- 50 Hours, Maximum-65 Hours
- For a 2 credit course, the total teaching hours are: Minimum- 20 Hours, Maximum-30 Hours

**SEMESTER-I****C-1.1: INORGANIC CHEMISTRY-I**

Full Marks – 100

Mid Sem – 20/1 hr

End Sem Theory – 50/3 hrs

**UNIT-I : Atomic Structure :**

Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of  $\psi$  and  $\psi^2$ , Quantum numbers and their significance, Normalized and orthogonal wave functions, Sign of wave functions, Radial and angular wave functions for hydrogen atom (derivation not required), Radial and angular distribution curves, Shapes of s, p, d and f orbitals, Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau principle and its limitations

**UNIT-II : Periodicity of Elements :**

Periodicity of Elements: s, p, d, f block elements, the long form of periodic table, Detailed discussion of the following properties of the elements, with reference to s & p-block, (a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table, (b) Atomic radii (van der Waals), (c) Ionic and crystal radii, (d) Covalent radii (octahedral and tetrahedral), (e) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy, (f) Electron gain enthalpy, trends of electron gain enthalpy, (g) Electronegativity, Pauling's/Mulliken's/Allred Rachow's and Mulliken-Jaffé's electronegativity scales, Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity, Sanderson's electron density ratio

**UNIT-III : Chemical Bonding-I :**

Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations, Packing of ions in crystals, Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy, Madelung constant, Born-Haber cycle and its application, Solvation energy, (ii) Covalent bond: Lewis structure, Valence Bond theory (Heitler-London approach), Energetics of hybridization, equivalent and non-equivalent hybrid orbitals, Bent's rule, Resonance and resonance energy,

**UNIT-IV: Chemical Bonding-II**

Molecular orbital theory, Molecular orbital diagrams of diatomic and simple polyatomic molecules  $N_2$ ,  $O_2$ ,  $C_2$ ,  $B_2$ ,  $F_2$ ,  $CO$ ,  $NO$ , and their ions;  $HCl$ ,  $BeF_2$ ,  $CO_2$ , (idea of s-p mixing and orbital interaction to be given), Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding ( $\sigma$  and  $\pi$  bond approach) and bond lengths, Covalent character in ionic compounds, polarizing power and polarizability, Fajan's rules and consequences of polarization, Ionic character in covalent compounds: Bond moment and dipole moment, Percentage ionic character from dipole moment and electronegativity difference

**UNIT-V : Chemical Bonding:-III**

- Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.
- Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment) Effects of chemical force, melting and boiling points.

**Reference Books:**

- Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991
- Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970
- Atkins, P.W. & Paula, J. Physical Chemistry, Oxford Press, 2006
- Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962

**PRACTICAL**

End Sem Practical – 30/3 hrs

**Expt. -15, Viva Voce- 5 & Lab. Record- 10****(A) Titrimetric Analysis**

- Calibration and use of apparatus
- Preparation of solutions of different Molarity/Normality of titrants

**(B) Acid-Base Titrations**

- Estimation of carbonate and hydroxide present together in mixture
- Estimation of carbonate and bicarbonate present together in a mixture
- Estimation of free alkali present in different soaps/detergents

**(C) Oxidation-Reduction Titrimetry**

- Estimation of Fe(II) and oxalic acid using standardized  $KMnO_4$  solution
- Estimation of oxalic acid and sodium oxalate in a given mixture

Estimation of Fe(II) with  $K_2Cr_2O_7$  using internal (diphenylamine, anthranilic acid) and external indicator

**Reference text:**

- Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS

**C-1.2: PHYSICAL CHEMISTRY-I**

**Full Marks – 100**  
**Mid Sem – 20/1 hr**  
**End Sem Theory – 50/3 hrs**

**UNIT-I : Gaseous State-I**

Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of  $\sigma$  from  $\eta$ ; variation of viscosity with temperature and pressure

Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities.

**UNIT-II: Gaseous State-II**

Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor,  $Z$ , and its variation with pressure for different gases. Causes of deviation from ideal behaviour. vander Waals equation of state, its derivation and application in explaining real gas behaviour, mention of other equations of state (Berthelot, Dietrici); virial equation of state; van der Waals equation expressed in virial form and calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states

**UNIT-III : Liquid State**

(i) Qualitative treatment of the structure of the liquid state; Radial distribution function; physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases. Qualitative discussion of structure of water

**Ionic Equilibria-I**

(ii) Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono-, di- and triprotic acids (exact treatment)

**UNIT- IV: Solid State**

Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Defects in crystals. Glasses and liquid crystals.

**UNIT-V : Ionic Equilibria-II**

Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications; buffer capacity, buffer range, buffer action and applications of buffers in analytical chemistry and biochemical processes in the human body. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of acid–base indicators; selection of indicators and their limitations.

**Reference Books:**

1. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13 (2006)
2. Ball, D. W. Physical Chemistry Thomson Press, India (2007)
3. Castellán, G. W. Physical Chemistry 4th Ed. Narosa (2004).
4. Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009)

**PRACTICAL**

**End Sem Practical – 30/3 hrs**

**Expt. -15, Viva Voce- 5 & Lab. Record- 10**

**1. Surface tension measurements.**

- a. Determine the surface tension by (i) drop number (ii) drop weight method.
- b. Study the variation of surface tension of detergent solutions with concentration.

**2. Viscosity measurement using Ostwald's viscometer.**

- a. Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room temperature.
- b. Study the variation of viscosity of sucrose solution with the concentration of solute.

**3. pH metry**

- a. Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.
- b. Preparation of buffer solutions of different pH i. Sodium acetate-acetic acid ii. Ammonium chloride-ammonium hydroxide
- c. pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base.
- d. Determination of dissociation constant of a weak acid.

**Reference Books :**

1. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011)
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003)

**GE-1.3 : MECHANICS**

**Full Marks - 100**  
**Mid Sem – 20/1 hr**  
**End Sem Theory – 50/3 hrs**

**UNIT-I****Vectors:**

Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter.

**Ordinary Differential Equations:**

1st order homogeneous differential equations. 2nd order homogeneous differential equations with constant coefficients.

**UNIT-II****Laws of Motion:**

Frames of reference. Newton's Laws of motion. Dynamics of a system of particles. Centre of Mass.

**Momentum and Energy:**

Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets.

**Rotational Motion:**

Angular velocity and angular momentum. Torque. Conservation of angular momentum.

**UNIT-III****Gravitation:**

Newton's Law of Gravitation. Motion of a particle in a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant). Kepler's Laws (statement only). Satellite in circular orbit and applications. Geosynchronous orbits. Basic idea of global positioning system (GPS). Weightlessness. Physiological effects on astronauts

**Oscillations:**

Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Damped oscillations.

**UNIT-IV****Elasticity:**

Hooke's law - Stress-strain diagram - Elastic moduli-Relation between elastic constants - Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants - Work done in stretching and work done in twisting a wire - Twisting couple on a cylinder - Determination of Rigidity modulus by static torsion - Torsional pendulum-Determination of Rigidity modulus and moment of inertia -  $q$ ,  $\eta$  and  $\sigma$  by Searles method.

**UNIT-V****Special Theory of Relativity:**

Constancy of speed of light. Postulates of Special Theory of Relativity. Length contraction. Time dilation. Relativistic addition of velocities.

*Note: Students are not familiar with vector calculus. Hence all examples involve differentiation either in one dimension or with respect to the radial coordinate.*

**Reference Books:**

1. University Physics. F.W. Sears, M.W. Zemansky and H.D. Young, 13/e, 1986. Addison-Wesley
2. Mechanics Berkeley Physics, Vol.1: Charles Kittel, et. al. 2007, Tata McGraw-Hill.
3. Physics – Resnick, Halliday & Walker 9/e, 2010, Wiley
4. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
5. Properties of Matter - D.S. Mathur (S. Chand publication) 2013
6. Mechanics- D.C. Tayal (Himalaya Publication) 2013
7. Analytical Mechanics-Fowles (Cengage Learnings) 2014
8. Classical Mechanics-M. Das,P.K. Jena, M. Bhuyan and R.N. Mishra (Srikrishna Publication)

**PRACTICAL**

**End Sem Practical – 30/3 hrs**

1. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.
2. To determine the Height of a Building using a Sextant.
3. To determine the Moment of Inertia of a Flywheel.
4. To determine the Young's Modulus of a Wire by Optical Lever Method.
5. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
6. To determine the Elastic Constants of a Wire by Searle's method.
7. To determine  $g$  by Bar Pendulum.
8. To determine  $g$  by Kater's Pendulum.
9. To study the Motion of a Spring and calculate (a) Spring Constant, (b)  $g$ .

**Reference Books:**

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
3. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

**AECC-1.4 : ଯୋଗାଯୋଗମୂଳକ ମାତୃଭାଷା- ଓଡ଼ିଆ**

**Full Marks - 50**  
**Mid Sem – 10/1 hr**  
**End Sem – 40/3hrs**

- ୟୁନିଟ୍-୧ : ବିଜ୍ଞାପନ କଳା ଓ ସାହିତ୍ୟ / ବିଜ୍ଞାପନର ଆବଶ୍ୟକତା ଓ ଉପକାରିତା
- ୟୁନିଟ୍-୨ : ଗଳ୍ପ- କୃଷ୍ଣଚୂଡ଼ା- ସୁରେନ୍ଦ୍ର ମହାନ୍ତି  
ପାଟଦେଇ- ବୀଣାପାଣି ମହାନ୍ତି  
ବୁଢ଼ା ଶଙ୍ଖାରୀ- ଲକ୍ଷ୍ମୀକାନ୍ତ ମହାପାତ୍ର
- ୟୁନିଟ୍-୩ : କବିତା- ଶ୍ରୀରାଧା- ରମାକାନ୍ତ ରଥ  
ପ୍ରତିମା ନାୟକ- ସଚ୍ଚି ରାଉତରାୟ  
ଦୁର୍ଯ୍ୟୋଧନ- ସୀତାକାନ୍ତ ମହାପାତ୍ର
- ୟୁନିଟ୍-୪ : ପ୍ରବନ୍ଧ- ଗାଡ଼ି ଛାଡ଼ିଦେଲା- ଚନ୍ଦ୍ର ଶେଖର ରଥ  
ଆମେରିକାରେ ଲୋକଚରିତ୍ର- ଗୋଲୋକ ବିହାରୀ ଧଳ  
ସ୍ଵାଧୀନ ଚିନ୍ତା- ବିଶ୍ଵନାଥ କର

**AECC-1.4 : ENGLISH COMMUNICATION**

**Full Marks - 50**  
**Mid Sem – 10/1 hr**  
**End Sem – 40/3hrs**  
**[15 marks]**

**UNIT-I : Reading Comprehension**

1. Locate and remember the most important points in the reading
2. Interpret and evaluate events, ideas, and information
3. Read “between the lines” to understand underlying meanings
4. Connect information to what they already know

**UNIT-II : Writing**

1. Expanding an Idea
2. Writing a Memo
3. Report Writing
4. Creative Writing
5. News Story
6. Setting in Creative Writing
7. Writing a Business Letter
8. Letters to the Editor
9. Précis Writing
10. CV & Resume Writing
11. Dialog writing
12. Covering Letter
13. Writing Formal Email
14. Elements of Story Writing
15. Note Making
16. Information Transfer
17. Interviewing for news papers

**[15 marks]**

**UNIT-III: Language functions in listening and conversation**

1. Discussion on a given topic in pairs
2. Speaking on a given topic individually  
(Practice to be given using speaking activities from the prescribed textbooks)

**Grammar and Usage**

1. Simple and Compound Sentences
2. Complex Sentences
3. Noun Clause
4. Adjective Clause
5. Adverb Clause
6. The Conditionals in English
7. The Second Conditional
8. The Third Conditional
9. Words and their features
10. Phrasal Verbs
11. Collocation
12. Using Modals

**[10 marks]**



13. Use of Passives
14. Use of Prepositions
15. Subject-verb Agreement
16. Sentence as a system
17. Common Errors in English Usage

**Book Prescribed :**

1. *Vistas and Visions: An Anthology of Prose and Poetry.* (Ed.)KalyaniSamantray, Himansu S. Mohapatra, Jatindra K. Nayak, GopaRanjan Mishra, Arun Kumar Mohanty. OBS

**Texts to be studied**

**Prose**

1. Pleasures of Ignorance
2. Ecology and Society
3. Lifestyle English
4. Playing the English gentleman

**Poetry**

1. Lover's Infiniteness
2. Last Sonnet
3. The Felling of the Banyan Tree

All grammar and writing activities in the textbook

**Scheme of Evaluation :**

**Mid Semester Examination : 10 marks**

Writing	: 1 question	04 x 01qn= 04 marks
Speaking	: 2 questions	03x02 qns = 06 marks

**End Semester Examination: 80 marks**

Unit 1	Reading: 05 questions (3 prose and two poetry questions)	03x 05 qns= 15 marks
Unit 2	Writing: 03 questions	05 x 03 qns= 15 marks
Unit 3	Grammar & usage: 10 qns	01x 10 qns = 10 marks

## SEMESTER-II

### C-2.1: ORGANIC CHEMISTRY-I

**Full Marks – 100**  
**Mid Sem – 20/1 hr**  
**End Sem Theory – 50/3 hrs**

**UNIT –I : Basics of Organic Chemistry :**

Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties.

Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength.

Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophilicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes.

Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

**UNIT – II : Stereochemistry**

Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations with C.I.P rules.

Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations.

**UNIT – III : Chemistry of Aliphatic Hydrocarbons**

**Carbon-Carbon pi bonds:**

Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations.

Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroborationoxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1,2-and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene. Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

**UNIT – IV : Aromatic Hydrocarbons**

Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups.

**UNIT-V: A. Carbon-Carbon Sigma Bonds**

Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.

**B. Cycloalkanes and Conformational Analysis**

Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of alkanes: Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy diagrams.

**Reference Books:**

1. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994.
5. Kalsi, P. S. Stereochemistry Conformation and Mechanism; New Age International, 2005.

**PRACTICAL**

**End Sem Practical – 30/3 hrs**

**Expt. -15, Viva Voce- 5 & Lab. Record- 10**

1. Checking the calibration of the thermometer
2. Purification of organic compounds by crystallization using the following solvents:
  - a. Water
  - b. Alcohol
  - c. Alcohol-Water
3. Determination of the melting points of above compounds and unknown organic compounds (Kjeldahl method and electrically heated melting point apparatus)
4. Effect of impurities on the melting point – mixed melting point of two unknown organic compounds
5. Determination of boiling point of liquid compounds. (boiling point lower than and more than 100 °C by distillation and capillary method)
6. Chromatography
  - a. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography
  - b. Separation of a mixture of two sugars by ascending paper chromatography
  - c. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC)
7. Estimation of Aniline

**Reference Books :**

1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)

**C-2.2: PHYSICAL CHEMISTRY-II**

**Full Marks – 100**

**Mid Sem – 20/1 hr**

**End Sem Theory – 50/3 hrs**

**UNIT-I : Chemical Thermodynamics**

Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics

First law: Concept of heat, q, work, w, internal energy, U, and statement of first law; enthalpy, H, relation between heat capacities, calculations of q, w, U and H for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions

**UNIT-II :**

Second Law: Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy, Calculation of entropy change for reversible and irreversible processes.

Third Law: Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules.

Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state.

**UNIT-III : Chemical Equilibrium**

Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases, concept of fugacity, Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Coupling of exoergic and endoergic reactions. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration. Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants  $K_p$ ,  $K_c$  and  $K_x$ . Le Chatelier principle (quantitative treatment); equilibrium between ideal gases and a pure condensed phase.

**UNIT-IV : Solutions and Colligative Properties :**

Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Excess thermodynamic functions. Thermodynamic derivation using chemical potential to derive relations between the four colligative properties [(i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure] and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution.

**UNIT-V: A. Thermochemistry:**

Heats of reactions: standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions. Adiabatic flame temperature, explosion temperature

**B. Systems of Variable Composition :**

Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases

**Reference Books :**

1. Peter, A. & Paula, J. de. Physical Chemistry 9th Ed., Oxford University Press (2011).
2. Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
3. Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
4. Levine, I.N. Physical Chemistry 6th Ed., Tata Mc Graw Hill (2010).
5. Metz, C.R. 2000 solved problems in chemistry, Schaum Series (2006)

**PRACTICAL**

**End Sem Practical – 30/3 hrs**

**Expt. -15, Viva- 5 & Lab. Record- 10**

**THERMOCHEMISTRY**

- (a) Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution or enthalpy of neutralization).
- (b) Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
- (c) Calculation of the enthalpy of ionization of ethanoic acid.
- (d) Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts.
- (e) Determination of basicity/proticity of a polyprotic acid by the thermochemical method in terms of the changes of temperatures observed in the graph of temperature versus time for different additions of a base. Also calculate the enthalpy of neutralization of the first step.
- (f) Determination of enthalpy of hydration of copper sulphate.
- (g) Study of the solubility of benzoic acid in water and determination of  $\Delta H$ .
- (h) Kinetics of pseudo-unimolecular reaction to determine the pseudo first order hydrolysis rate constant of methyl acetate/ethyl acetate at room temperature in 0.5N  $H_2SO_4$  & 0.5 N HCl media.

**Reference Books :**

1. Khosla, B. D.; Garg, V. C. & Gulati, A., Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011)
2. Athawale, V. D. & Mathur, P. Experimental Physical Chemistry New Age International: New Delhi (2001)

**GE-2.3: CALCULUS AND ORDINARY DIFFERENTIAL EQUATIONS**

**Full Marks – 100  
Mid Sem – 20/1 hr  
End Sem – 80/3 hrs**

**UNIT-I**

Asymptotes, curvature and curve tracing, length, volume and area of surface of revolution

**UNIT-II**

Sphere, cone, cylinder and central conicoids

**UNIT-III**

Explicit and Implicit functions, limit and continuity of functions of several variables, partial derivatives, partial derivative of higher orders, homogeneous functions, change of variables mean value theorem, Taylor's theorem and Maclaurin's theorem for function of two variables, maxima and minima of functions of two and three variables, implicit functions

**UNIT-IV**

Ordinary Differential equation 1st order and 1st degree (variable separable, homogeneous exact, linear), Equation of 1st order but not 1st degree

**UNIT-V**

Second order linear equations (homogeneous and non-homogeneous) with constant coefficients, second order equations with variable coefficients, variation of parameters, Laplace transform, and its applications to solution of differential equation

**Books Recommended:**

1. Text book of Calculus, part-II Shanti Narayan and P.K. Mittal, S. Chand and Co.
2. A course of ordinary and partial differential equations by J. Sinha and S. Padhy, Kalyani Publication, New Delhi Chapter :1, 2(2.1-2.7), 3 4(4.1-4.7), 5, 7(7.1-7.4), 9(9.1-9.5, 9.10, 9.11, 9.13).
3. Text book of Calculus, part-III Shanti Narayan and P.K. Mittal, S. Chand and Co.
4. Analytical Geometry of Quadratic surfaces, B.P. Acharya and D.C. Sahu, Kalyani Publishers, New Delhi, Ludhina
5. S.C. Malik and S. Aroro-Mathematical Analysis, New age International publications,
6. Advanced Calculus by Santosh K. Sengar chapter: 2,4,5,6,7,11,12,13
7. Advanced differential Equations by M.D. Raisinghania, S. Chand & Company Ltd. New Delhi.
8. Analytical Solid Geometry by Shanti Narayan and P.K.Mittal, S. Chand and Co.
9. Advanced Calculus by David V. Weider, Dover Publication.

**AECC-2.4 : ENVIRONMENTAL STUDIES**

**Full Marks – 50**  
**Mid Sem – 10/1 hr**  
**End Sem – 40/3 hrs**

**UNIT-I :**

**Concept of environment :** Ecology; Ecosystem; types and components of the ecosystem. Ecological adaptations of plants and animals

**UNIT-II :**

**Functional aspects of ecosystem :** Trophic level, food chain, food web, energy flow in the ecosystem, ecological pyramids, Biogeochemical cycles: Water cycle and Nitrogen cycle

**UNIT-III :**

**Environmental Pollution:** Source, causes and concept of air, water, noise, soil, pollution, Sewage & Sewage treatment, green house effect, Acid rain, Ozone layer depletion

**UNIT-IV :**

**Conservation of Natural Resources :** Resources, renewable & non renewable resources; soil, soil erosion and its conservation; Forest, deforestation; afforestation, conservation of Forest

**Suggested Readings :**

1. Shukla, R.S and Chandel, P.S : Plant Ecology and soil science, S. Chand & Company Ltd, New Delhi
2. Sharma, P.D. : Ecology and Environment, Rastogi Publication, Meerut.
3. Singh, J.S. Singh, S.P and Gupta, R.S (2006). Environmental Science, Kalyani Publishers, New Delhi

**SEMESTER-III**

**C-3.1: INORGANIC CHEMISTRY-II**

**Full Marks – 100**  
**Mid Sem – 20/1 hr**  
**End Sem Theory – 50/3 hrs**

**UNIT-I : General Principles of Metallurgy**

Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent. Electrolytic Re-duction, Hydrometallurgy. Methods of purification of metals: Electrolytic Kroll process, Parting process, van Arkel-de Boer process and Mond's process, Zone refining

**UNIT-II: Chemistry of s and p Block Elements-I**

Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of s and p block elements. Hydrides and their classification ionic, covalent and interstitial. Basic beryllium acetate and nitrate

**UNIT-III: Chemistry of s and p Block Elements-II**

Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses. Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes. Oxides and oxoacids of nitrogen, Phosphorus and chlorine. Peroxo acids of sulphur, interhalogen compounds, polyhalide ions, pseudohalogens and basic properties of halogens.

**UNIT-IV: Noble Gases**

Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF<sub>2</sub>; XeF<sub>4</sub> and XeF<sub>6</sub>; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF<sub>2</sub>). Molecular shapes of noble gas compounds (VSEPR theory)

**UNIT-V: a. Acids and Bases**

Brønsted-Lowry concept of acid-base reactions, solvated proton, relative strength of acids, types of acid-base reactions, Lewis acid-base concept, Classification of Lewis acids, Hard and Soft Acids and Bases (HSAB) Application of HSAB principle

**b. Inorganic Polymers:**

Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes, and polysulphates.

**Reference Books :**

1. Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
2. Cotton, F.A. & Wilkinson, G. Advanced Inorganic Chemistry, Wiley, VCH, 1999.
3. Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. Concepts & Models of Inorganic Chemistry 3<sup>rd</sup> Ed., John Wiley Sons, N.Y. 1994.
4. Miessler, G. L. & Donald, A. Tarr. Inorganic Chemistry 4th Ed., Pearson, 2010.

**PRACTICAL**

**End Sem Practical – 30/3 hrs**

**Expt. -15, Viva- 5 & Lab. Record- 10**

**(A) Iodo / Iodimetric Titrations**

- (i) Estimation of Cu(II) and  $K_2Cr_2O_7$  using sodium thiosulphate solution (Iodimetrically)
- (ii) Estimation of available chlorine in bleaching powder iodometrically

**(B) Inorganic preparations**

- (i) Cuprous chloride,  $Cu_2Cl_2$ :
- (ii) Preparation of Manganese(III) phosphate,  $MnPO_4.H_2O$
- (iii) Preparation of Aluminium potassium sulphate  $K_2SO_4:Al_2(SO_4)_2.24H_2O$  (Potash alum)

**Reference Books :**

1. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS. 1978

**C-3.2: ORGANIC CHEMISTRY-II**

**Full Marks – 100**

**Mid Sem – 20/1 hr**

**End Sem Theory – 50/3 hrs**

**UNIT-I: Chemistry of Halogenated Hydrocarbons**

*Alkyl halides:* Methods of preparation, nucleophilic substitution reactions  $SN_1$ ,  $SN_2$  and  $SN_i$  mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination.

*Aryl halides:* Preparation, including preparation from diazonium salts, nucleophilic aromatic substitution;  $SN_{Ar}$ , Benzyne mechanism.

Relative reactivity of alkyl, allyl/benzyl, vinyl and arylhalides towards nucleophilic substitution reactions.

Organometallic compounds of Mg and Li- Use in synthesis of organic compounds.

**UNIT-II: Alcohols, Phenols, Ethers and Epoxides**

*Alcohols:* preparation, properties and relative reactivity of  $1^0$ ,  $2^0$ ,  $3^0$  alcohols, Bouvaelt-Blanc Reduction; Preparation and properties of glycols: Oxidation by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement;

*Phenols:* Preparation and properties; Acidity and factors effecting it, Ring substitution reactions, Reimer Tiemann and Kolbes Schmidt Reactions, Fries and Claisen rearrangements with mechanism;

**UNIT-III: Carbonyl Compounds**

Structure, reactivity and preparation: Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisan-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements,  $\alpha$  haloform reaction and Baeyer Villiger oxidation, substitution reactions, oxidations and reductions (Clemmensen, Wolf-Kishner,  $LiAlH_4$ ,  $NaBH_4$ , MPV, PDC and PCC).; Addition reactions of unsaturated carbonyl compounds: Michael addition.

**UNIT-IV: Carboxylic Acids and their Derivatives**

Preparation, physical properties and reactions of monocarboxylic acids: Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic/phthalic, lactic, malic, tartaric, citric, maleic and fumaric acids; Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparative study of nucleophilic substitution at acyl group -Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann-bromamide degradation and Curtius rearrangement.

**UNIT-V: Ethers and Epoxides:** Preparation and reactions with acids. Reactions of epoxides with alcohols, ammonia derivatives and  $LiAlH_4$

**Active methylene compounds:** Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

**Sulphur containing compounds :**

Preparation and reactions of thiols, thioethers and sulphonic acids.

**Reference Books :**

1. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.

## PRACTICAL

End Sem Practical – 30/3 hrs

**Expt. -15, Viva- 5 & Lab. Record- 10**

- Functional group tests for alcohols, phenols, carbonyl and carboxylic acid group.
- Organic preparations:
  - Acetylation of one of the following compounds: amines (aniline, o-, m-, p-toluidines and o-, m-, p-anisidine) and phenols (-naphthol, vanillin, salicylic acid) by any one method:
    - Using conventional method.
    - Using green approach.
  - Benzoylation of one of the following amines (aniline, o-, m-, p-toluidines and o-, m-, p-anisidine) and one of the following phenols (-naphthol, resorcinol, p-cresol) by Schotten-Baumann reaction.
  - Bromination of any one of the following:
    - Acetanilide by conventional methods.
    - Acetanilide using green approach (Bromate-bromide method).
  - Nitration of any one of the following:
    - Acetanilide/nitrobenzene by conventional method.
    - Salicylic acid by green approach (using ceric ammonium nitrate).
  - Preparation of Iodoform

The above derivatives should be prepared using 0.5-1 gm. of the organic compound. The solid samples must be collected and may be used for recrystallization, melting point and TLC.

**Reference Books :**

- Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).
- Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5<sup>th</sup> Ed., Pearson (2012).
- Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).
- Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000).

**C-3.3 : PHYSICAL CHEMISTRY-III**

Full Marks – 100

Mid Sem – 20/1 hr

End Sem Theory – 50/3 hrs

**UNIT-I : Phase Equilibria-I**

Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems; Clausius-Clapeyron equation and its applications to solid-liquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems, with applications.

**UNIT-II : Phase Equilibria-II**

Three component systems, water-chloroform-acetic acid system, triangular plots.

*Binary solutions:* Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and non-ideal), azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation.

**UNIT-III : Chemical Kinetics-I**

Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods of the determination of rate laws (orders of reaction), kinetics of complex reactions (integrated rate expressions up to first order only): (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions.

**UNIT-IV : Catalysis**

Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces; effect of particle size and efficiency of nanoparticles as catalysts. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.

**Surface chemistry**

Physical adsorption, chemisorption, adsorption isotherms, nature of adsorbed state.

**UNIT-V: Phase Equilibria-III**

Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points, solid solutions.

**Nernst distribution law:** its derivation and applications.

**Chemical Kinetics-II**

**Temperature dependence of reaction rates;** Arrhenius equation; activation energy. Collision theory of reaction rates, qualitative treatment of the theory of absolute reaction rates

**Reference Books :**

- Peter Atkins & Julio De Paula, Physical Chemistry 9th Ed., Oxford University Press (2010).
- Castellan, G. W. Physical Chemistry, 4th Ed., Narosa (2004).
- McQuarrie, D. A. & Simon, J. D., Molecular Thermodynamics, Viva Books Pvt. Ltd.: New Delhi (2004).
- Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).

- Zundhal, S.S. Chemistry concepts and applications Cengage India (2011).
- Ball, D. W. Physical Chemistry Cengage India (2012).
- Levine, I. N. Physical Chemistry 6th Ed., Tata McGraw-Hill (2011).
- Metz, C. R. Physical Chemistry 2nd Ed., Tata McGraw-Hill (2009).

### PRACTICAL

End Sem Practical – 30/3 hrs

#### Expt. -15, Viva- 5 & Lab. Record- 10

- Distribution of acetic/ benzoic acid between water and cyclohexane.
- Study the equilibrium of at least one of the following reactions by the distribution method:
 
$$I_2(aq) + I^- \rightarrow I_3^-(aq)$$

$$Cu^{2+}(aq) + nNH_3 \rightarrow Cu(NH_3)_n$$
- Study the kinetics of the following reactions.
  - Integrated rate method:
    - Acid hydrolysis of ethyl acetate with hydrochloric acid.
    - Saponification of ethyl acetate.
  - Compare the strengths of HCl and H<sub>2</sub>SO<sub>4</sub> by studying kinetics of hydrolysis of methyl acetate.

#### Adsorption

- Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.

#### Reference Books :

- Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
- Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
- Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

### GE-3.4 : ELECTRICITY, MAGNETISM AND EMT

Full Marks - 100

Mid Sem – 20/1 hr

End Sem Theory – 50/3 hrs

#### UNIT-I

##### Vector Analysis:

Scalar and Vector product, gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only).

#### UNIT-II

##### Electrostatics:

Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem- Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Dielectric medium, Polarisation, Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric.

#### UNIT-III

##### Magnetism:

Magnetostatics: Biot-Savart's law and its applications- straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law. Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia-, para-and ferromagnetic materials.

#### UNIT-IV

##### Electromagnetic Induction:

Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M of two coils. Energy stored in magnetic field.

#### UNIT-V

##### Maxwell's equations and Electromagnetic wave propagation:

Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, polarization.

#### Reference Books:

- Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education
- Electricity & Magnetism, J.H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press
- Electricity and Magnetism, D C Tayal, 1988, Himalaya Publishing House.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- D.J. Griffiths, Introduction to Electrodynamics, 3rd Edn, 1998, Benjamin Cummings.
- Electricity and Magnetism- K.K. Tewari (S. Chand Higher Academics)2013

## PRACTICAL

End Sem Practical – 30/3 hrs

1. To use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, and (d) checking electrical fuses.
2. Ballistic Galvanometer:
  - (i) Measurement of charge and current sensitivity
  - (ii) Measurement of CDR
  - (iii) Determine a high resistance by Leakage Method
  - (iv) To determine Self Inductance of a Coil by Rayleigh's Method.
3. To compare capacitances using De'Sauty's bridge.
4. Measurement of field strength B and its variation in a Solenoid (Determine dB/dx)
5. To study the Characteristics of a Series RC Circuit.
6. To study a series LCR circuit LCR circuit and determine its (a) Resonant frequency, (b) Quality factor
7. To study a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q
8. To determine a Low Resistance by Carey Foster's Bridge.
9. To verify the Thevenin and Norton theorems
10. To verify the Superposition, and Maximum Power Transfer Theorems

### Reference Books

1. Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed.2011, Kitab Mahal

## AEEC-3.5(SEC-I) : SOFT SKILLS

Full Marks - 50

Mid Sem – 10/1 hr

End Sem – 40/3hrs

### UNIT-I: Soft skills and why they are important

What are soft skills? Soft skills in communication; soft skills and intercultural communication

### UNIT-II: Soft skills in preparing for a career

1. Competency in Oral and written communication skills: active listening, interactive speaking, reading different types of texts, writing for formal and business contexts
2. Using the Microsoft Office: word, excel, PowerPoint; working online and offline, Telephone and face-to-face etiquette in professional communication

### UNIT-III: Job-related Soft skills

1. CV Writing, writing job applications; GD Skills and interview taking skills; getting another job
2. Emotional Intelligence; time and stress management; team work and net-working; presentation skills; making meeting work: preparing, executing, following up; negotiation skills and crisis management

### Prescribed Readings :

1. Kalyani Samantray, Soft Skills for your Career, OUP
2. Himansu S. Mohapatra, Model of the Middle (Pieces to read: "Our Literature Their Literature", "Life style English", "Writing it Right", "The Vinglish way to English")

### Suggested Readings :

1. JayashriMohanraj, Skill Sutras
2. Marian K Woodal, *How to Communicate under Pressure*

### Scheme of Evaluation :

Mid Semester Examination : 10 marks

Unit 1: 02 questions x 05 marks=10 marks

End Semester Examination: 40 marks

Unit 2: 1 long answer question+ 2 short notes (10+(5x2) =20 marks

Unit 3: 1 long answer question+ 2 short notes (10+(5x2) =20 marks

## SEMESTER-IV

### C-4.1: INORGANIC CHEMISTRY-III

Full Marks – 100

Mid Sem – 20/1 hr

End Sem Theory – 50/3 hrs

### UNIT-I : Coordination Chemistry

Werners theory, valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. Crystal field theory, measurements of CFSE weak and strong fields, pairing energies, factors affecting the magnitude



of 10 Dq in octahedral vs. tetrahedral coordination, square planar geometry. IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers. Chelate effect

#### UNIT-II: Transition Elements-I

General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer & Bsworth diagrams). Difference between the first, second and third transition series.

#### UNIT-III: Transition Elements-II

Chemistry of Ti, V, Cr Mn, Fe and Co in various oxidation states (excluding their metallurgy).

#### UNIT-IV: Lanthanoids and Actinoids

Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only)

#### UNIT-V: Bioinorganic Chemistry

Metal ions present in biological systems, classification of elements according to their action in biological system. Na/K-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine.

Iron and its application in bio-systems, Haemoglobin; Storage and transfer of iron.

#### Reference Books :

1. Purcell, K.F & Kotz, J.C. Inorganic Chemistry W.B. Saunders Co, 1977
2. Huheey, J.E., Inorganic Chemistry, Prentice Hall, 1993
3. Cotton, F.A. & Wilkinson, G, Advanced Inorganic Chemistry. Wiley-VCH, 1999
4. Basolo, F, and Pearson, R.C., Mechanisms of Inorganic Chemistry, John Wiley & Sons, NY, 1967
5. Greenwood, N.N. & Earnshaw A., Chemistry of the Elements, Butterworth-Heinemann, 1997

### PRACTICAL

End Sem Practical – 30/3 hrs

#### Expt. -15, Viva- 5 & Lab. Record- 10

##### Gravimetric Analysis :

- i. Estimation of nickel(II) using Dimethylglyoxime (DMG).
- ii Estimation of copper as CuSCN.
- iii. Estimation of iron as Fe<sub>2</sub>O<sub>3</sub> by precipitating iron as Fe(OH)<sub>3</sub>:
- iv. Estimation of Al(III) by precipitating with oxine and weighing as Al(oxine)<sub>3</sub> (aluminium oxinate).

##### Chromatography of metal ions

1. Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions:
  - i. Ni(II) and Co(II)
  - ii. Fe(III) and Al(III)
2. Estimation of Mn in pyrolusite
3. Estimate the amount of Fe<sup>2+</sup> & Fe<sup>3+</sup> in a mixture using standard K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>.

##### Reference Book :

1. Vogel, A.I. A text book of Quantitative Analysis, ELBS 1986

### C-4.2 : ORGANIC CHEMISTRY-III

Full Marks – 100

Mid Sem – 20/1 hr

End Sem Theory – 50/3 hrs

#### UNIT-I : Nitrogen Containing Functional Groups

Preparation and important reactions of nitro and compounds, nitriles & isonitriles

Amines: Effect of substituent and solvent on basicity; Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmanns exhaustive methylation, Hofmann-elimination reaction; Distinction between 1, 2 and 3 amines with Hinsberg reagent and nitrous acid.

#### UNIT-II: Diazonium Salts

Preparation and their synthetic applications.

##### Polynuclear Hydrocarbons :

Reactions of naphthalene phenanthrene and anthracene structure, Preparation and structure elucidation and important derivatives of naphthalene and anthracene, Polynuclear hydrocarbons.

#### UNIT-III: Heterocyclic Compounds-I

Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom; Synthesis, reactions and mechanism of substitution reactions of: Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis), Pyrimidine, Structure elucidation of indole, Fischer indole synthesis and Madelung synthesis,

#### UNIT-IV: Alkaloids

Natural occurrence, General structural features, Isolation and their physiological action Hoffmanns exhaustive methylation, Emdes modification, Structure elucidation and synthesis of Hygrine and Nicotine. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine. .

### UNIT-V: Heterocyclic Compounds-II

Structure of quinoline and isoquinoline.

Derivatives of furan: Furfural and furoic acid (preparation only).

#### Terpenes :

Occurrence, classification, isoprene rule; Elucidation of structure and synthesis of Citral, Neral and  $\alpha$ -terpineol

#### Reference Books :

1. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
3. Acheson, R.M. Introduction to the Chemistry of Heterocyclic compounds, John Welly & Sons(1976)
4. Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc
5. Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd. Pub
6. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press
7. Singh, J.; Ali, S.M. & Singh, J. Natural Product Chemistry, Prajati Parakashan (2010)

## PRACTICAL

End Sem Practical – 30/3 hrs

### Expt. -15, Viva- 5 & Lab. Record- 10

1. Detection of extra elements (N, X, S)
2. Functional group test for nitro, amine and amide groups
3. Qualitative analysis of unknown organic compounds containing simple functional groups (alcohols, carboxylic acids, phenols and carbonyl compounds)
4. Identification of organic compounds containing C,H,O & C,H,N, halogens and sulphur (confirmation through preparation of derivative is included).

#### Reference Books :

1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5<sup>th</sup> Ed., Pearson (2012)
3. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000)
4. Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000)

## C-4.3 : PHYSICAL CHEMISTRY-IV

Full Marks – 100

Mid Sem – 20/1 hr

End Sem Theory – 50/3 hrs

### UNIT-I: Conductance-I

Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions. Debye-Hckel-Onsager equation, Wien effect, Walden's rules

### UNIT-II: Conductance-II

Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods. Applications of conductance measurement: (i) degree of dissociation of weak electrolytes, (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts, (iv) conductometric titrations, and (v) hydrolysis constants of salts

### UNIT-III: Electrochemistry-I

Quantitative aspects of Faradays laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry. Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells.

### UNIT-IV: Electrochemistry-II

Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation)

### UNIT-V: Electrochemistry-III

Application of EMF measurements in determining free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone, glass electrodes.

Dipole moment and molecular polarizabilities and their measurements. Diamagnetism, paramagnetism, magnetic susceptibility and its measurement, molecular interpretation.

#### Reference Books :

1. Atkins, P.W & Paula, J.D. Physical Chemistry, 9th Ed., Oxford University Press (2011)
2. Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004)
3. Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: NOIDA, UP (2009)
4. Barrow, G. M., Physical Chemistry 5th Ed., Tata McGraw Hill: New Delhi (2006)
5. Rogers, D. W. Concise Physical Chemistry Wiley (2010)
6. Silbey, R. J.; Alberty, R. A. & Bawendi, M. G. Physical Chemistry 4th Ed., John Wiley & Sons, Inc. (2005)

**PRACTICAL**

End Sem Practical – 30/3 hrs

**Expt. -15, Viva- 5 & Lab. Record- 10****Conductometry**

- I. Determination of cell constant.
- II. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
- III. Perform the following conductometric titrations:
  - i. Strong acid vs. strong base
  - ii. Weak acid vs. strong base
  - iii. Strong acid vs. weak base

**Potentiometry**

- I. Perform the following potentiometric titrations:
  - i. Strong acid vs. strong base
  - ii. Weak acid vs. strong base
  - iii. Dibasic acid vs. strong base
- II. Determination of partition coefficient of  $I_2$  between  $H_2O$  &  $CCl_4$ .

**Reference Books :**

1. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
3. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

**GE-4.4: LINEAR ALGEBRA AND ADVANCED ALGEBRA**

Full Marks – 100

Mid Sem – 20/1 hr

End Sem – 80/3 hrs

**UNIT-I**

Vector space, subspace, span of a set, linear independence and dependence, dimension and basis Linear transformation, range kernel, rank, and nullity, Inverse of a linear map, rank-nullity theorem

**UNIT-II**

Matrices and linear maps, rank and nullity of a matrix, transpose of a matrix, types of matrices, elementary row operations, System of linear equations, Matrix inversion using row operations, determinant and rank of matrices, Eigen values, Eigen vectors, quadratic forms

**UNIT-III**

Group theory : Definition and examples, subgroups, normal subgroups, cyclic groups, cosets, quotients groups, permutation groups, homomorphism

**UNIT-IV**

Ring theory : Definition and examples, some special classes of rings, ideals, quotients rings, ring homomorphism, isomorphism theorems

**UNIT-V**

Theory of equations : roots of an equation, relation between roots and coefficients, sum of power of roots, symmetric functions transformation of equations

**Books Recommended :**

1. An introduction to linear algebra by V. Krishna Murty, V.P. Mainra, J.L Arora, Affiliated –east-west press Pvt. Ltd. New Delhi, Chapter:3, 4(4.1-4.7), 5(except5.3), 6(6.1,6.2,6.5,6.6,6.8), 7(7.4)
2. Abstract Algebra, by I.H. Seth, Prentice Hall of India Pvt. Ltd, New Delhi, Chapter: 13, 14, 15, 16, 17, 18, 19, 20
3. A text book of Algebra –Rabindra Kumar and Sri Krishna Washna, Pitamber Publication
4. Joseph A. Gallian, Contemporary Abstract Algebra (4<sup>th</sup> Edn.), Narosa publishing House, New delhi.
5. A course in abstract algebra by V.K.Khana and S.K. Bhamri, Vikash Pub. House New Delhi.
6. Abstract Algebra, M. Artin, 2<sup>nd</sup> Ed. Pearson, 2011.
7. Introduction to linear algebra, S. Lang, 2<sup>nd</sup> Ed. Springer, 2005
8. Topics in Algebra, I.N. Herstein, Wiley Easten Limited, India, 1975.
9. Linear algebra by S. Kumar, A Geometric Approach, Prentice Hall of India, 1999.

**AEEC-4.5 (SEC-II) : FUEL CHEMISTRY**

Full Marks – 50

Mid Sem – 10/1 hr

End Sem – 40/3 hrs

**UNIT-I : Basic Concept :**

Review of energy sources (renewable and non-renewable), Classification of fuels and their calorific value. Lubricants: Classification of lubricants, lubricating oils (conducting and non-conducting) solid and semisolid lubricants, synthetic lubricants

**UNIT-II : Solid Fuel-Coal-I**

Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal. coal gas, producer gas and water gas-composition and uses. Fraction of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke,

**UNIT-III : Liquid Fuel : Petroleum -I**

composition of crude petroleum, Refining and different types of petroleum products and their applications. Fractional Distillation- Principle and process, Thermal and catalytic cracking, Reforming Petroleum and non-petroleum fuels : LPG, CNG, LNG, Bio-gas,

**UNIT-IV: Solid Fuel-Coal-II**

Coal gasification (Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent Refining

**Liquid Fuel : Petroleum –II**

Fuels derived from biomass, fuel from waste, synthetic gaseous and liquids fuels, clean fuels. Petrochemicals : Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene

**Reference Books :**

1. E. Stocchi : Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK
2. P.C. Jain, M. Jain : Engineering Chemistry, Dhanpat Rai & Sons, Delhi
3. B.K. Sharma : Industrial Chemistry, Goel Publishing House, Meerut

## SEMESTER-V

### C-5.1: ORGANIC CHEMISTRY-IV

Full Marks – 100  
Mid Sem – 20/1 hr  
End Sem Theory – 50/3 hrs

**UNIT-I : Nucleic Acids**

Structure, synthesis and reactions of: Adenine, Guanine, Cytosine, Uracil and Thymine

**UNIT-II: Enzymes**

Introduction, classification and characteristics of enzymes. Salient features of active site of enzymes.

Mechanism of enzyme action (taking trypsin as example), factors affecting enzyme action, coenzymes and cofactors and their role in biological reactions, specificity of enzyme action (including stereospecificity), enzyme inhibitors and their importance, phenomenon of inhibition (competitive, uncompetitive and non-competitive inhibition including allosteric inhibition).

**UNIT-III : Amino Acids, Peptides and Proteins**

Amino acids, peptides and their classification.

$\alpha$ -Amino acids - Synthesis, ionic properties and reactions. Zwitterions, pKa values, isoelectric point and electrophoresis.

Study of peptides: determination of their primary structures-end group analysis, methods of peptide synthesis. Synthesis of peptides using N-protecting, C-protecting and C-activating groups -Solid-phase synthesis

**UNIT-IV: Name Reactions**

Principle, mechanism & applications : Michael Condensation, Reformatsky reaction, Benzidine rearrangement, Wagner-Meerwien rearrangement, Houben-Hoesch reaction, Lossen rearrangement, Demjanov rearrangement, Favorskii rearrangement

**Synthetic Reagents :**

Synthesis & application : Aluminium t-butoxides, DCC,  $\text{OSO}_4$ ,  $\text{HIO}_4$ , PCC, Diborane

**UNIT-V : Pharmaceutical Compounds: Structure and Importance**

Classification, structure and therapeutic uses of antipyretics: Paracetamol (with synthesis), Analgesics: Ibuprofen (with synthesis), Antimalarials: Chloroquine (with synthesis). An elementary treatment of Antibiotics and detailed study of chloramphenicol, Medicinal values of curcumin (haldi), azadirachtin (neem), vitamin C and antacid (ranitidine)

**Reference Books :**

1. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2006) Biochemistry. VIth Edition. W.H. Freeman and Co.
2. Nelson, D.L., Cox, M.M. and Lehninger, A.L. (2009) Principles of Biochemistry. IV Edition. W.H. Freeman and Co.
3. Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009) Harpers Illustrated Biochemistry. XXVIII edition. Lange Medical Books/ McGraw-Hill.

### PRACTICAL

End Sem Practical – 30/3 hrs

**Expt. -15, Viva- 5 & Lab. Record- 10**

1. Preparations of the following compounds:
  - i. Aspirine,
  - ii. Phenacetin,
  - iii. Milk of magnesia,
  - iv. Aluminium hydroxide gel,
  - v. Divol,
  - vi. Picric acid,
  - vii. Benzophenone (from Benzene),
  - viii. Phenyl Benzoate
2. Saponification value of an oil or a fat.
3. Determination of Iodine number of an oil/ fat.

**Reference Books :**

1. Manual of Biochemistry Workshop, 2012, Department of Chemistry, University of Delhi.
2. Arthur, I. Vogel, Quantitative Organic Analysis, Pearson.

**C-5.2: PHYSICAL CHEMISTRY-V**

**Full Marks – 100**

**Mid Sem – 20/1 hr**

**End Sem Theory – 50/3 hrs**

**UNIT-I : Elementary Quantum Mechanics-I**

Black body radiation, Planck's radiation law, photoelectric effect, heat capacity of solids, Bohr's model of hydrogen atom (derivation not required) and its limitations, Compton effect, de-Broglie equation, Heisenberg's uncertainty principle,

**UNIT-II: Elementary Quantum Mechanics-II**

Hamiltonian operator, Schrodinger wave equation and its derivation, physical interpretation of the wave function, Postulates of quantum mechanics (Problems based on algebra of operators excluded), particle in an one dimensional box, electron in a ring

**UNIT-III : Photochemistry**

Difference between thermal and photochemical reaction; laws of photochemistry; Grotthus Draper law; Start-Einstein law; Beer-Lambert's law; Quantum yield and its determination-actinometry, mechanism and kinetics of decomposition of HI; Photochemical combination of hydrogen and bromine & hydrogen and chlorine reactions; Jablonski diagram; Radiative and non-radiative processes; Fluorescence, phosphorescence, resonance fluorescence, chemiluminescence, bioluminescence, photosensitization and photosynthesis (elementary idea)

**UNIT-IV : Molecular Spectroscopy**

Scope; Molecular spectra; Born-Oppenheimer approximation; Brief idea about various types of molecular spectra; Rotational (Micro wave) spectra of diatomic molecules, energy levels of a rigid rotator, selection rules, spectral intensities, vibrational spectra (IR) of diatomic molecules, energy levels of a simple harmonic oscillator, Anharmonicity, Electronic spectra of diatomic molecules, Franck-Condon principle

**UNIT-V :**

**Kinetics of Fast Reactions**

General features of fast reactions, Study of fast reactions by flow and relaxation method

**Macromolecules**

Types of polymers, mechanism of polymerization, kinetics of addition polymerization

**Micelles**

Surface active agents, classification of surface active agents, micellization, critical micellar concentration (CMC), factors affecting the CMC of surfactants

**Reference Books :**

1. Puri, Sharma & Pathania, Principles of Physical Chemistry Revised Ed.
2. Chandra, A. K. Introductory Quantum Chemistry Tata McGraw-Hill (2001).
3. Lowe, J. P. & Peterson, K. Quantum Chemistry, Academic Press (2005).
4. Kakkar, R. Atomic & Molecular Spectroscopy, Cambridge University Press (2015).
5. Acharya & Sharma, Modern College Chemistry, Physical
6. Physical Chemistry, Atkins

**PRACTICAL**

**End Sem Practical – 30/3 hrs**

**Expt. -15, Viva- 5 & Lab. Record- 10**

**Colourimetry**

1. Determine the concentration of HCl against 0.1 N NaOH spectrophotometrically.
2. To find the strength of given ferric ammonium sulfate solution of (0.05 M) by using EDTA spectrophotometrically.
3. To find out the strength of CuSO<sub>4</sub> solution by titrating with EDTA spectrophotometrically.
4. To determine the concentration of Cu(II) and Fe(III) solution photometrically by titrating with EDTA.
5. Estimation of Ca & Mg in a mixture by EDTA Titration.

**Reference Books :**

1. Khosla, B. D.; Garg, V. C. & Gulati, A., Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
3. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).
4. Experimental Physical Chemistry by J. N. Gurtu, R. Kapoor.

**DSE-5.3: POLYMER CHEMISTRY**

**Full Marks – 100**  
**Mid Sem – 20/1 hr**  
**End Sem Theory – 50/3 hrs**

**UNIT-I: Introduction and history of polymeric materials:**

Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers.

**Functionality and its importance:**

Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bi-functional systems, Polyfunctional systems.

**UNIT-II: Kinetics of Polymerization:**

Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques.

**Crystallization and crystallinity:**

Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point.

**UNIT-III:**

**Nature and structure of polymers**-Structure property relationships.

**Determination of molecular weight of polymers** ( $M_n$ ,  $M_w$ , etc.) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index.

**Glass transition temperature ( $T_g$ ) and determination of  $T_g$**

Free volume theory, WLF equation, Factors affecting glass transition temperature ( $T_g$ ).

**UNIT-IV: Polymer Solution**

Criteria for polymer solubility, Solubility parameter, Thermodynamics of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions. Flory-Huggins theory, Lower and Upper critical solution temperatures.

**UNIT-V:**

**Properties of Polymers** (Physical, thermal & mechanical properties)

Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride) and related polymers, poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers, phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes, Polycarbonates, Conducting Polymers [polyacetylene, polyaniline, poly(p-phenylene sulphide polypyrrole, polythiophene)].

**Reference Books :**

1. Seymours Polymer Chemistry, Marcel Dekker, Inc.
2. G. Odian: Principles of Polymerization, John Wiley.
3. F.W. Billmeyer: Text Book of Polymer Science, John Wiley.
4. P. Ghosh: Polymer Science & Technology, Tata Mcgraw-Hill.
5. R.W. Lenz: Organic Chemistry of Synthetic High Polymers.

**PRACTICAL**

**End Sem Practical – 30/3 hrs**

**Expt. -15, Viva- 5 & Lab. Record- 10**

**Polymer synthesis**

1. Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA) / Methyl Acrylate (MA) / Acrylic acid (AA).
  - (a) Purification of monomer.
  - (b) Polymerization using benzoyl peroxide (BPO) / 2,2-azo-bis-isobutyronitrile (AIBN).
2. Preparation of nylon 66/6.
3. Interfacial polymerization, preparation of polyester from isophthaloyl chloride (IPC) and phenolphthalein.
  - (a) Preparation of IPC.
  - (b) Purification of IPC.
  - (c) Interfacial polymerization.
4. Redox polymerization of acrylamide.
5. Precipitation polymerization of acrylonitrile.
6. Preparation of urea-formaldehyde resin.
7. Preparations of novalac resin/resold resin.
8. Microscale Emulsion Polymerization of poly(methylacrylate).

**Polymer characterization**

1. Determination of molecular weight by viscometry:
  - (a) Polyacrylamide-aq.  $\text{NaNO}_2$  solution
  - (b) (Poly vinyl propylidene (PVP) in water
2. Determination of the viscosity-average molecular weight of poly(vinyl alcohol) (PVOH) and the fraction of head-to-head monomer linkages in the polymer.
3. Determination of molecular weight by end group analysis : Polyethylene glycol (PEG) (OH group)

4. Testing of mechanical properties of polymers.
4. Determination of hydroxyl number of a polymer using colorimetric method.

#### **Polymer analysis**

1. Estimation of the amount of HCHO in the given solution by sodium sulphite method
2. Instrumental Techniques
3. IR studies of polymers
4. DSC analysis of polymers
5. Preparation of polyacrylamide and its electrophoresis

\* at least 7 experiments to be carried out.

#### **Reference Books :**

1. Malcohm P. Stevens, Polymer Chemistry: An Introduction, 3rd Ed.
2. Fred W. Billmeyer, Textbook of Polymer Science, 3rd ed. Wiley-Interscience (1984).
3. Joel R. Fried, Polymer Science and Technology, 2nd ed. Prentice-Hall (2003).
4. Petr Munk and Tejraj M. Aminabhavi, Introduction to Macromolecular Science, 2nd ed. John Wiley & Sons (2002).
5. L.H. Sperling, Introduction to Physical Polymer Science, 4th ed. John Wiley & Sons (2005).
6. Malcolm P. Stevens, Polymer Chemistry: An Introduction, 3rd ed. Oxford University Press (2005).
7. Seymour/ Carrahers Polymer Chemistry, 9th ed. by Charles E. Carraher, Jr. (2013).

### **DSE-5.4: INDUSTRIAL CHEMICALS AND ENVIRONMENT**

**Full Marks – 100**

**Mid Sem – 20/1 hr**

**End Sem Theory – 50/3 hrs**

#### **UNIT-I : Industrial Gases and Inorganic Chemicals**

Industrial Gases: Large scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene.

Inorganic Chemicals: Manufacture, application analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.

#### **UNIT-II : Environment and its segments-I**

Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur. Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone. Major sources of air pollution. Pollution by SO<sub>2</sub>;CO<sub>2</sub>;CO;NO<sub>x</sub>; and H<sub>2</sub>S and other foul smelling gasses.

#### **UNIT-III : Water Pollution:**

Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems. Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluents from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, fertilizer.

#### **UNIT-IV : Energy & Environment**

Sources of energy: Coal, petrol and natural gas. Nuclear fusion/fission, solar energy, hydrogen, geothermal, tidal and hydel. Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management.

**Biocatalysis:** Introduction to biocatalysis: Importance in green chemistry and chemical industry.

#### **UNIT-V: Environment and its segments-II**

**a.** Methods of estimation of CO, NO<sub>x</sub>, SO<sub>x</sub> and control procedures. Effects of air pollution on living organisms and vegetation. Greenhouse effect and global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and halogens, removal of sulphur from coal, Control of particulates.

**b.** Sludge disposal. Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, ion exchange). Water quality parameters for waste water, industrial water and domestic water.

#### **Reference Books :**

1. E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
2. R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
3. J.A. Kent: Riegels Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
4. S. S. Dara: A Textbook of Engineering Chemistry, S. Chand & Company Ltd. New Delhi.
5. K. De, Environmental Chemistry: New Age International Pvt., Ltd, New Delhi.
6. S. M. Khopkar, Environmental Pollution Analysis: Wiley Eastern Ltd, New Delhi.
7. S.E. Manahan, Environmental Chemistry, CRC Press (2005).
8. G.T. Miller, Environmental Science 11th edition. Brooks/ Cole (2006).
9. A. Mishra, Environmental Studies. Selective and Scientific Books, New Delhi (2005).

### **PRACTICAL**

**End Sem Practical – 30/3 hrs**

#### **Expt. -15, Viva- 5 & Lab. Record- 10**

1. Determination of dissolved oxygen in water.

- Determination of Chemical Oxygen Demand (COD).
- Determination of Biological Oxygen Demand (BOD).
- Percentage of available chlorine in bleaching powder.
- Measurement of chloride, sulphate and salinity of water samples by simple titration method ( $\text{AgNO}_3$  and potassium chromate).
- Estimation of total alkalinity of water samples ( $\text{CO}_3^{2-}$ ,  $\text{HCO}_3^-$ ) using double titration method.
- Measurement of dissolved  $\text{CO}_2$
- Study of some of the common bio-indicators of pollution.
- Estimation of SPM in air samples.
- Preparation of borax/ boric acid.

**Reference Books :**

- E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
- R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
- J.A. Kent: Riegels Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
- S. S. Dara: A Textbook of Engineering Chemistry, S. Chand & Company Ltd. New Delhi.
- S. M. Khopkar, Environmental Pollution Analysis: Wiley Eastern Ltd, New Delhi.

## SEMESTER-VI

### C-6.1: INORGANIC CHEMISTRY-IV

Full Marks – 100  
Mid Sem – 20/1 hr  
End Sem Theory – 50/3 hrs

#### UNIT-I : Non-Aqueous Solvents :

Properties of non-aqueous solvent, classification of solvents, liquid  $\text{NH}_3$ , solutions of metal in liquid  $\text{NH}_3$ , Reactions in liquid  $\text{NH}_3$ .

**Metal carbides :** Classification, some important carbides, Preparations, properties, Calcium carbide, Aluminium carbide, Silicon carbide

#### UNIT-II: Organometallic Compounds-I

Definition and classification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands.

Metal carbonyls : 18 electron rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series. Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT.  $\pi$ -acceptor behaviour of CO (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding.

#### UNIT-III: Group Theory

Basic idea about group & classes, symmetry elements, symmetry operations present in a molecule, point groups

**Ferrocene :** Preparation and reactions (acetylation, alkylation, metallation, Mannich condensation), Structure and aromaticity, Comparison of aromaticity and reactivity with that of benzene

#### UNIT-IV: Reaction Kinetics and Mechanism

Introduction to inorganic reaction mechanisms. Substitution reactions in square planar complexes, Trans-effect, theories of trans effect, Mechanism of nucleophilic substitution in square planar complexes. Thermodynamic and kinetic stability, Kinetics of octahedral substitution, General mechanism of substitution in octahedral complexes, Ligand field effects & Reaction rates

#### UNIT-V: Catalysis by Organometallic Compounds

Study of the following industrial processes and their mechanism:

- Alkene hydrogenation (Wilkinsons Catalyst), 2. Hydroformylation (Co salts), 3. Wacker Process, 4. Synthetic gasoline (Fischer Tropsch reaction) 5. Synthesis gas by metal carbonyl complexes.
- Zeise's salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls

**Reference Books :**

- Vogel, A.I. Qualitative Inorganic Analysis, Longman, 1972.
- Svehla, G. Vogel's Qualitative Inorganic Analysis, 7th Edition, Prentice Hall, 1996-03-07.
- Huheey, J. E.; Keiter, E.A. & Keiter, R.L. Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed., Harper Collins 1993, Pearson, 2006.
- Sharpe, A.G. Inorganic Chemistry, 4th Indian Reprint (Pearson Education) 2005.
- Douglas, B. E.; McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic Chemistry, 3rd Ed., John Wiley and Sons, NY, 1994.
- Greenwood, N.N. & Earnshaw, A. Chemistry of the Elements, Elsevier 2nd Ed, 1997 (Ziegler Natta Catalyst and Equilibria in Grignard Solution).



- Lee, J.D. Concise Inorganic Chemistry 5th Ed., John Wiley and sons 2008.
- Powell, P. Principles of Organometallic Chemistry, Chapman and Hall, 1988.
- Shriver, D.D. & P. Atkins, Inorganic Chemistry 2nd Ed., Oxford University Press, 1994.
- Spessard, Gary O., & Gary L. Miessler. Organometallic Chemistry. Upper Saddle River, NJ: Prentice-Hall, 1996.
- Mehrotra R.C. and Singh, A. Organometallic Chemistry, New Age International Publishers, 2<sup>nd</sup> Edn, 2000.

### PRACTICAL

End Sem Practical – 30/3 hrs

#### Expt. -15, Viva- 5 & Lab. Record- 10

Qualitative semimicro analysis of mixtures containing 3 anions and 3 cations. Emphasis should be given to the understanding of the chemistry of different reactions. The following radicals are suggested:

$\text{CO}_3^{2-}$ ,  $\text{NO}_2^-$ ,  $\text{S}^{2-}$ ,  $\text{SO}_3^{2-}$ ,  $\text{CH}_3\text{COO}^-$ ,  $\text{F}^-$ ,  $\text{Cl}^-$ ,  $\text{Br}^-$ ,  $\text{I}^-$ ,  $\text{NO}_3^-$ ,  $\text{BO}_3^{3-}$ ,  $\text{C}_2\text{O}_4^{2-}$ ,  $\text{PO}_4^{3-}$ ,  $\text{NH}_4^+$ ,  $\text{K}^+$ ,  $\text{Pb}^{2+}$ ,  $\text{Cu}^{2+}$ ,  $\text{Cd}^{2+}$ ,  $\text{Bi}^{3+}$ ,  $\text{Sn}^{2+}$ ,  $\text{Sb}^{3+}$ ,  $\text{Fe}^{3+}$ ,  $\text{Al}^{3+}$ ,  $\text{Cr}^{3+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Mn}^{2+}$ ,  $\text{Co}^{2+}$ ,  $\text{Ni}^{2+}$ ,  $\text{Ba}^{2+}$ ,  $\text{Sr}^{2+}$ ,  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$

Mixtures should preferably contain one interfering anion, or insoluble component ( $\text{BaSO}_4$ ,  $\text{SrSO}_4$ ,  $\text{PbSO}_4$ ,  $\text{CaF}_2$  or  $\text{Al}_2\text{O}_3$ ) or combination of anions e.g.  $\text{CO}_3^{2-}$  and  $\text{SO}_3^{2-}$ ,  $\text{NO}_2^-$  and  $\text{NO}_3^-$ ,  $\text{Cl}^-$  and  $\text{Br}^-$ ,  $\text{Cl}^-$  and  $\text{I}^-$ ,  $\text{Br}^-$  and  $\text{I}^-$ ,  $\text{NO}_3^-$  and  $\text{Br}^-$ ,  $\text{NO}_3^-$  and  $\text{Br}^-$  and  $\text{NO}_3^-$  and  $\text{I}^-$ .

Spot tests should be done whenever possible.

#### Reference Books :

- Vogels Qualitative Inorganic Analysis, Revised by G. Svehla.
- Marr & Rockett Inorganic Preparations.

### C-6.2: ORGANIC CHEMISTRY-V

Full Marks – 100

Mid Sem – 20/1 hr

End Sem Theory – 50/3 hrs

#### UNIT-I : Organic Spectroscopy-I

General principles, Introduction to absorption and emission spectroscopy.

**UV Spectroscopy:** Types of electronic transitions,  $\lambda$  max, Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; Application of Woodward rules for calculation of  $\lambda$  max for the following systems:  $\alpha$ ,  $\beta$  - unsaturated aldehydes: ketones, carboxylic acids and esters; Conjugated dienes: alicyclic, homoannular and heteroannular; Extended conjugated systems (aldehydes, ketones and dienes); distinction between cis and trans isomers.

#### UNIT-II:

**IR Spectroscopy:** Fundamental and non-fundamental molecular vibrations; IR absorption positions of O, N and S containing functional groups; Effect of H-bonding, conjugation, resonance and ring size on IR absorptions; Fingerprint region and its significance; application in functional group analysis.

#### UNIT-III: Organic Spectroscopy-II

**NMR Spectroscopy:** Basic principles of Proton Magnetic Resonance, chemical shift and factors influencing it; Spin-spin coupling and coupling constant; Anisotropic effects in alkene, alkyne, aldehydes and aromatics; Interpretation of NMR spectra of simple compounds. Ethanol, Propanol, Ethyl bromide, 1,3-dichloropropane, Acetaldehyde, Toluene, Acetone, Applications of IR, UV and NMR for identification of simple organic molecules.

#### UNIT-IV: Carbohydrates

Occurrence, classification and their biological importance. Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, determination of ring size of glucose and fructose, Haworth projections and conformational structures; Interconversions of aldoses and ketoses; Killiani-Fischer synthesis and Ruff degradation;

Disaccharides Structure elucidation of maltose, lactose and sucrose

Polysaccharides Elementary treatment of starch, cellulose & glycogen

#### UNIT-V : Dyes

Classification, colour and constitution; Mordant and Vat dyes; Chemistry of dyeing. Synthesis and applications of: Azo dyes Methyl orange, Triphenyl methane dyes - Malachite Green, and Rosaniline; Phthalein dyes – Phenolphthalein, Natural dyes – Structure elucidation and synthesis of Alizarin and Indigotin; Edible dyes with examples.

#### Reference Books :

- Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd. Pub.
- Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Billmeyer, F. W. Textbook of Polymer Science, John Wiley & Sons, Inc.
- Gowariker, V. R.; Viswanathan, N. V. & Sreedhar, J. Polymer Science, New Age International (P) Ltd. Pub.
- Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.
- Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.
- Singh, J.; Ali, S.M. & Singh, J. Natural Product Chemistry, Pragati Prakashan (2010).
- Kemp, W. Organic Spectroscopy, Palgrave.

**PRACTICAL**

**End Sem Practical – 30/3 hrs**

**Expt. -15, Viva- 5 & Lab. Record- 10**

1. Extraction of caffeine from tea leaves.
2. Preparation of urea formaldehyde resin.
3. Qualitative analysis of unknown organic compounds containing mono-functional groups (carbohydrates, aryl halides, aromatic hydrocarbons, nitro compounds, amines and amides) and simple bifunctional groups, for e.g. salicylic acid, cinnamic acid, nitrophenols etc.
4. Identification of simple organic compounds by IR spectroscopy and NMR spectroscopy (Spectra to be provided).
5. Preparation of methyl orange.
6. Estimation of Glucose.

**Reference Books :**

1. Vogel, A.I. Quantitative Organic Analysis, Part 3, Pearson (2012).
2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).
3. Furniss, B.S., Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5<sup>th</sup> Ed., Pearson (2012).
4. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).
5. Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000).

**DSE-6.3: INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE**

**Full Marks – 100**

**Mid Sem – 20/1 hr**

**End Sem Theory – 50/3 hrs**

**UNIT-I : Silicate Industries**

**Glasses :** Glassy state and its properties, classification (silicate and non-silicate glasses), Manufacture and processing of glass, Composition and properties of the following types of glasses -fluorosilicate, coloured glass, photosensitive glass, sodalime glass, lead glass, armoured glass, safety glass, borosilicate glass.

**Ceramics :** Important clays and feldspar, ceramic, their types and manufacture, High technology ceramics and their applications, superconducting and semiconducting oxides, fullerenes carbon nanotubes and carbon fibre.

**UNIT-II : Fertilizers**

Different types of fertilizers, Manufacture of the following fertilizers : Urea, Ammonium nitrate, Calcium ammonium nitrate, Ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate.

**UNIT-III : Alloys**

Classification of alloys, ferrous and non-ferrous alloys, Specific properties of elements in alloys, Manufacture of Steel (removal of silicon decarbonization, demanganization, desulphurization dephosphorisation) and surface treatment (argon treatment, heat treatment, nitriding, carburizing), composition and properties of different types of steels.

**UNIT-IV : Batteries**

Primary and secondary batteries, battery components and their role, characteristics of battery, working of following batteries : Pb acid, Li-battery, solid state electrolyte battery, fuel cells, solar cell and polymer cell

**Chemical explosives :**

Origin of explosive properties in organic compounds, preparation and explosive properties of lead azide, PETN cyclonite (RDX), Introduction to rocket propellants

**UNIT-V: a. Cements :**

Classification of cement, ingredients and their role, Manufacture of cement and the setting process, quick setting cements.

**b. Catalysis :**

General principles and properties of catalysts, homogenous catalysis (catalytic steps and examples) and heterogenous catalysis (catalytic steps and examples) and their industrial applications, Deactivation or regeneration of catalysts, Phase transfer catalysts, application of zeolites as catalysts.

**Reference Books :**

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. P.C. Jain, M. Jain : *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi
4. R. Gopalan, D. Venkappayya, S. Nagarajan : *Engineering Chemistry*, Vikas Publications, New Delhi
5. Sharma, B.K. & Gaur, H. *Industrial Chemistry*, Goel Publishing House, Meerut (1996)

**PRACTICAL**

**End Sem Practical – 30/3 hrs**

**Expt. -15, Viva- 6 & Lab. Record- 4**

1. Determination of free acidity in ammonium sulphate fertilizer
2. Estimation of Calcium in Calcium ammonium nitrate fertilizer

3. Estimation of phosphoric acid in superphosphate fertilizer
4. Electroless metallic coatings on ceramic and plastic material
5. Determination of composition of dolomite (by complexometric titration)
6. Analysis of (Cu, Ni); (Cu, Zn) in alloy or synthetic samples
7. Analysis of Cement
8. Preparation of pigment (zinc oxide)

**Reference Books :**

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. W.D. Kingery, H.K. Bowen, R.R. Uhlmann : *Introduction to Ceramics*, Wiley Publishers, New Delhi.
3. J.A. Kent: *Riegels Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
4. P.C. Jain, M. Jain : *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi
5. R. Gopalan, D. Venkappayya, S. Nagarajan : *Engineering Chemistry*, Vikas Publications, New Delhi
6. Sharma, B.K. & Gaur, H. *Industrial Chemistry*, Goel Publishing House, Meerut (1996)

**DSE-6.4 : DISSERTATION/PROJECT WORK**

**Full Marks – 100**  
**End Sem Project– 100**

To be announced by HOD.

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