SYLLABUS

FOR

COMPLEMENTARY COURSES

CHEMISTRY COMPLEMENTARY COURSE STRUCTURE

Total Credits: 12 (Internal: 20%; External: 80%)

Semester	*Code No*	*Course Title*	*Hrs/ Week*	*Total Hrs*	*Credit*	*Marks*
I	CHE1C01	Complementary Course I: General Chemistry	2	32	2	75
	-	Complementary Course V: Chemistry Practical	2	32	-*	-
II	CHE2C02	Complementary Course II: Physical Chemistry	2	32	2	75
	-	Complementary Course V: Chemistry Practical	2	32	-*	-
III	CHE3C03	Complementary Course III: Organic Chemistry	3	48	2	75
	-	Complementary Course V: Chemistry Practical	2	32	-*	-
IV	CHE4C04	Complementary Course IV: Physical and Applied Chemistry	3	48	2	75
	CHE4C05(P)	Complementary Course V: Chemistry Practical	2	32	4*	100
Total					**12**	400

* Examination will be held at the end of semester IV.

SEMESTER I

Course Code: CHE1C01

Complementary Course I: GENERAL CHEMISTRY

Total Hours: 32; Credits: 2; Hours/Week: 2; Total Marks 75 (Internal 15 & External 60)

CHE1C01	**GENERAL CHEMISTRY**	L	T	P	C
		2	0	0	2
Objective(s)	To provide the students a thorough knowledge about the chemistry of quantitative and qualitative analysis and the theories of chemical bonding. It will also impart the ideas about atomic nucleus and the importance of metals in biological systems.				
Course outcome (s)					
CO1	To understand and to apply the theories of quantitative and qualitative analysis.				
CO2	To understand the theories of chemical bonding.				
CO3	To appreciate the uses of radioactive isotopes.				
CO4	To understand the importance of metals in biological systems.				

Module I: Analytical Chemistry (10 hrs)

Atomic mass - Molecular mass - Mole concept – Molar volume - Oxidation and reduction – Oxidation number and valency - Equivalent mass. Methods of expressing concentration: Molality, molarity, normality and mole fraction. Calculation of concentration on dilution of given solution (problems).

Theory of volumetric analysis – Acid-base, redox and complexometric titrations – Acid-base, redox and complexometric indicators. Double burette method of titration: Principle and advantages.

Principles in the separation of cations in qualitative analysis - Applications of common ion effect and solubility product - Microanalysis and its advantages.

Accuracy & Precision (mention only).

References

1. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Edn., Pearson Education, Noida, 2013.

2. G. Svehla, *Vogel's Qualitative Inorganic Analysis*, 7th Edn., Prentice Hall, New Delhi, 1996.

Module II: Atomic Structure and Chemical Bonding (10 hrs)

Atomic Structure: Bohr atom model and its limitations, de Broglie equation - Heisenberg uncertainty principle - Schrödinger wave equation (mention only) - Atomic orbitals -

Quantum numbers and their significance - Pauli's Exclusion principle - Hund's rule of maximum multiplicity - Aufbau principle – Electronic configuration of atoms.

Chemical Bonding: Introduction – Type of bonds.

Ionic bond: Factors favouring the formation of ionic bonds - Lattice energy of ionic compounds and its application.

Covalent bond: Lewis theory – Coordinate bond.

VSEPR theory: Shapes of $BeCl_2$, BF_3, $SnCl_2$, CH_4, NH_3, H_2O, NH_4^+, SO_4^{2-}, PCl_5, SF_4, ClF_3, XeF_2, SF_6, IF_5, XeF_4, IF_7 and XeF_6.

Valence Bond theory - Hybridisation involving s, p and d orbitals: sp (acetylene), sp^2 (ethylene), sp^3 (CH_4), sp^3d (PCl_5), sp^3d^2 (SF_6).

Molecular Orbital theory: LCAO – Electronic configuration of H_2, B_2, C_2, N_2, O_2 and CO – Calculation of bond order – determination of HOMO and LUMO – Explanation of bond length and bond strength.

Intermolecular forces - Hydrogen bonding in H_2O - Dipole-dipole interactions.

References

1. C. N. R. Rao, *Understanding Chemistry*, Universities Press India Ltd., Hyderabad, 1999.

2. R. K. Prasad, *Quantum Chemistry*, 4th Edn., New Age International (P) Ltd., New Delhi, 2012.

3. Manas Chanda, *Atomic Structure and Chemical Bonding*, 4th Edn., Tata McGraw Hill Publishing Company, Noida, 2007.

4. R. Puri, L. R. Sharma K. C. Kalia, *Principles of Inorganic Chemistry*, 31st Edn., Milestone Publishers and Distributors, New Delhi, 2013.

Module III: Nuclear Chemistry (6 hrs)

Natural radioactivity – Modes of decay – Group displacement law.

Nuclear forces - n/p ratio - Nuclear stability - Mass Defect - Binding energy. Isotopes, isobars and isotones with examples.

Nuclear fission - Atom bomb - Nuclear fusion – Hydrogen bomb - Nuclear reactors

Application of radioactive isotopes – ^{14}C dating, Rock dating, Isotopes as tracers, Radio diagnosis, Radiotherapy.

References

1. H. J. Arnikar, *Essentials of Nuclear Chemistry*, 4th Edn., New Age International (P) Ltd., New Delhi, 2005.

2. R. Gopalan, *Elements of Nuclear Chemistry*, Vikas Publ. House, 2000.

Module IV: Bioinorganic Chemistry (6 hrs)

Metal ions in biological systems - Biochemistry of iron – Haemoglobin and myoglobin - O_2 and CO_2 transportation (mechanism not required) - Chlorophyll and photosynthesis (mechanism not expected) – Elementary idea of structure and mechanism of action of sodium potassium pump - Biochemistry of zinc and cobalt.

References

1. B. R. Puri, L. R. Sharma, K. C. Kalia, *Principles of Inorganic Chemistry*, Milestone Publishers, New Delhi, 2010.
2. G. L. Meissler, D. A. Tarr, *Inorganic Chemistry*, 3rd Edn. Pearson Education, 2004.
3. J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, *Inorganic Chemistry*, 5th Edn., Pearson, 2009.
4. F. A. Cotton, G. Wilkinson, P. L. Gaus, *Basic Inorganic Chemistry*, 3rd Edn., John – Wiley, 1995.

Mark Distribution	
Module I	22 Marks
Module II	25 Marks
Module III	16 Marks
Module IV	16 Marks

SEMESTER II

Course Code: CHE2C02

Complementary Course II: PHYSICAL CHEMISTRY

Total Hours: 32; Credits: 2; Hours/Week: 2; Total Marks 75 (Internal 15 & External 60)

CHE2C02	**PHYSICAL CHEMISTRY**	L	T	P	C
		2	0	0	2
Objective(s)	To provide the students a thorough knowledge about different terminologies in thermodynamics and the continuity between different states of matter. To impart an idea about the basic principles of electrochemistry.				
Course outcome (s)					
CO1	To understand the importance of free energy in defining spontaneity.				
CO2	To realise the theories of different states of matter and their implication.				
CO3	To understand the basic principles of electrochemistry.				

Module I: Thermodynamics (6 hrs)

Definition of thermodynamic terms - System – Surroundings - Types of systems.
First law of Thermodynamics - Internal energy - Significance of internal energy change – Enthalpy. Second law of Thermodynamics - Entropy and spontaneity - Statement of second law based on entropy. Entropy change in phase transitions (derivation not required) - Entropy of fusion, vaporization and sublimation. The concept of Gibbs free energy - Physical significance of free energy - Conditions for equilibrium and spontaneity based on ΔG values - Effect of temperature on spontaneity of reaction. Third law of Thermodynamics.

References

1. B. R. Puri, L. R. Sharma, M. S. Pathania, *Principles of Physical Chemistry*, 46th Edn., Vishal Publishing Company, New Delhi, 2013.
2. J. Rajaram, J. C. Kuriacose, *Chemical Thermodynamics*, Pearson Education, New Delhi, 2013.

Module II: Gaseous and Solid States (10 hrs)

Gaseous State: Introduction - Kinetic molecular model of gases – Maxwell distribution of velocities and its use in calculating molecular velocities – Average velocity, RMS velocity and most probable velocity (derivations not required) – Boyle's law – Charles's law – Ideal gas equation – Behaviour of real gases – Deviation from ideal behavior - van der Waals equation (derivation not required).

Solid State: Introduction - Isotropy and anisotropy - Symmetry elements in crystals - The seven crystal systems – Miller indices - Bravais lattices – Bragg's equation (derivation required) and its applications (mention only). Defects in crystals: Non-stoichiometric and stoichiometric defects - Extrinsic and intrinsic defects.

References

1. K. L. Kapoor, *A Textbook of Physical chemistry*, Vol. 1, 4th Edn., Macmillan India Ltd., 2011.
2. B. R. Puri, L. R. Sharma, M. S. Pathania, *Elements of Physical chemistry*, Vishal Pub. Co., 2013.

Module III: Liquid State and Solutions (6 hrs)

Liquid State: Introduction - Vapour pressure, surface tension and viscosity – Explanation of these properties on the basis of intermolecular attraction.
Solutions: Kinds of solutions - Solubility of gases in liquids – Henry's law and its applications - Colligative properties - Osmotic pressure - Laws of osmotic pressure - Reverse osmosis and its applications - Determination of molecular mass using colligative properties.

References

1. K. L. Kapoor, *A Textbook of Physical chemistry*, Vol. 1, 4th Edn., Macmillan India Ltd., 2011.
2. B. R. Puri, L. R. Sharma, M. S. Pathania, *Elements of Physical chemistry*, Vishal Pub. Co., 2013.

Module IV: Electrochemistry (10 hrs)

Specific conductance, equivalent conductance and molar conductance - Variation of conductance with dilution - Kohlrausch's law - Degree of ionization of weak electrolytes - Application of conductance measurements – Conductometric titrations.
Galvanic cells - Cell and electrode potentials - IUPAC sign convention – Reference electrodes – Standard Hydrogen electrode – Calomel electrode - Standard electrode potential - Nernst equation - H_2-O_2 fuel cell.
Ostwald's dilution law – Buffer solutions – Buffer action [acetic acid/sodium acetate & NH_4OH/NH_4Cl], applications of buffers.

References

1. P. Atkins, J. Paula Atkins, *Physical Chemistry*, 8th Edn., Oxford University Press, 2006.
2. K. K. Sharma, L. K. Sharma, *A Textbook of Physical Chemistry*, 5th Edn., Vikas Publishing House, New Delhi, 2012.

3. Gordon M. Barrow, *Physical Chemistry*, 5th Edn., Tata McGraw Hill Education, New Delhi, 2006.

4. F. Daniels, R. A. Alberty, *Physical Chemistry*, 5th Edn., John Wiley and Sons, Canada, 1980.

Mark Distribution	
Module I	16 Marks
Module II	23 Marks
Module III	16 Marks
Module IV	24 Marks

SEMESTER III

Course Code: CHE3C03

Complementary Course III: ORGANIC CHEMISTRY

Total Hours: 48; Credits: 2; Hours/Week: 3; Total Marks 75 (Internal 15 & External 60)

CHE3C03	**ORGANIC CHEMISTRY**	L	T	P	C
		3	0	0	2
Objective(s)	To provide the students a thorough knowledge about basic theory and concepts of organic chemistry.				
Course outcome (s)					
CO1	To understand the basic concepts involved in reaction intermediates.				
CO2	To realise the importance of optical activity and chirality.				
CO3	To appreciate the importance of functional groups and aromatic stability.				
CO4	To understand the basic structure and importance of carbohydrates, nucleic acids, alkaloids and terpenes.				

Module I: Organic Chemistry – Some Basic Concepts (10 hrs)

Introduction: Homolysis and heterolysis of bonds – Electrophiles and nucleophiles.

Reaction Intermediates: Carbocations, carbanions and free radicals (types, hybridization and stability).

Types of organic reactions: Addition, elimination, substitution and rearrangement reactions (definition and one example each).

Electron Displacement Effects: Inductive effect: Definition – Characteristics - +I and –I groups.

Applications: Explanation of substituent effect on the acidity of aliphatic carboxylic acids. Mesomeric effect: Definition – Characteristics - +M and –M groups. Applications: Comparison of electron density in benzene, nitrobenzene and aniline. Hyperconjugation: Definition – Characteristics. Example: Propene.

Applications: Comparison of stability of 1-butene & 2-butene. Electromeric effect: Definition – Characteristics - +E effect (addition of H^+ to ethene) and –E effect (addition of CN^- to acetaldehyde). Steric effect (causes and simple examples).

References

1. Peter Sykes, *A Guide book to Mechanism in Organic Chemistry*, 6th Edn., Pearson Education, New Delhi, 2013.

2. P. S. Kalsi, *Organic Reactions, Stereochemistry and Mechanisms*, 4th Edn., New Age International Publishers, New Delhi, 2006.

3. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edn., Vikas Publishing House, New Delhi, 2004.

4. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co., 2010.

5. R. T. Morrison, R. N. Boyd, *Organic Chemistry*, 7th Edn., Pearson Education, New Delhi, 2013.
6. I. L. Finar, *Organic Chemistry*, Vol. I, 5th Edn., Pearson Education, New Delhi, 2013.

Module II: Stereochemistry (6 hrs)

Conformations: Conformations of ethane, cyclohexane and methylcyclohexane – Explanation of stability.
Geometrical Isomerism: Definition – Condition – Geometrical isomerism in but-2-ene and but-2-ene-1,4-dioic acid – Methods of distinguishing geometrical isomers using melting point and dipole moment.
Optical Isomerism: Optical activity – Chirality – Enantiomers – Meso compounds – Diastereoisomers – Optical isomerism in lactic acid and tartaric acid.

References

1. R. T. Morrison, R. N. Boyd, *Organic Chemistry*, 7th Edn., Pearson Education, New Delhi, 2013.
2. I. L. Finar, *Organic Chemistry*, Vol. I, 5th Edn., Pearson Education, New Delhi, 2013.
3. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co., 2010.
4. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edn., Vikas Publishing House, New Delhi, 2004.

Module III: Aromatic Hydrocarbons (5 hrs)

Nomenclature and isomerism in substituted benzene. Structure and stability of benzene: Kekule, resonance and molecular orbital description.
Mechanism of aromatic electrophilic substitution: Halogenation, nitration, sulphonation and Friedel-Craft's reactions – orientation effect of substituents.
Aromaticity and Huckel's rule: Application to benzenoid (benzene, naphthalene and anthracene) and nonbenzenoid (pyrrole, pyridine and indol) aromatic compounds.

References

1. R. T. Morrison, R. N. Boyd, *Organic Chemistry*, 7th Edn., Pearson Education, New Delhi, 2013.
2. I. L. Finar, *Organic Chemistry*, Vol. I, 5th Edn., Pearson Education, New Delhi, 2013.
3. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co., 2010.
4. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edn., Vikas Publishing House, New Delhi, 2004.

Module IV: Chemistry of Functional Groups – I (8 hrs)

Halogen Compounds: Preparation of alkyl halides from alkanes and alkenes – Wurtz reaction and Fittig's reaction – Mechanism of S_N1 and S_N2 reactions of alkyl halides – Effect of substrate and stereochemistry.
Alcohols: Preparation from Grignard reagent – Preparation of ethanol from molasses – Wash, rectified spirit, absolute alcohol, denatured spirit, proof spirit and power alcohol (mention only) – Comparison of acidity of ethanol, isopropyl alcohol and *tert*-butyl alcohol – Haloform reaction and iodoform test – Luca's test – Chemistry of methanol poisoning – Harmful effects of ethanol in the human body.
Phenols: Preparation from chlorobenzene – Comparison of acidity of phenol, *p*-nitrophenol and *p*-methoxyphenol – Preparation and uses of phenolphthalein.

Module V: Chemistry of Functional Groups – II (8 hrs)

Aldehydes & Ketones: Preparation from alcohols – Nucleophilic addition reactions (HCN and bisulphite) – Comparison of nucleophilic addition rate of aliphatic aldehydes and ketones.
Carboxylic Acids: Preparation from Grignard reagent – Decarboxylation – Kolbe electrolysis.
Amines: Preparation from nitro compounds – Hofmann's bromamide reaction – Hofmann's carbylamines reaction. Basicity: Comparison of basicity of ammonia, methyl amine and aniline.
Diazonium Salts: Preparation and synthetic applications of benzene diazonium chloride – Preparation and uses of methyl orange.

References

1. R. T. Morrison, R. N. Boyd, *Organic Chemistry*, 7th Edn., Pearson Education, New Delhi, 2013.
2. I. L. Finar, *Organic Chemistry*, Vol. I, 5th Edn., Pearson Education, New Delhi, 2013.
3. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co., 2010.
4. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edn., Vikas Publishing House, New Delhi, 2004.

Module VI: Biomolecules (8 hrs)

*Carbohydrates: C*lassification with examples - cyclic structures of glucose and fructose - Applications of carbohydrates.

Proteins: Amino acids – Classification – Zwitter ion formation – Peptide linkage – Polypeptides and proteins – Primary, secondary and tertiary structure of proteins – Globular and fibrous proteins – Denaturation of proteins.

Enzymes: Characteristics and examples.

Nucleic acids: Structure of pentose sugar, nitrogenous base, nucleoside and nucleotide – Double-helical structure of DNA – Difference between DNA and RNA – DNA fingerprinting and its applications.

References

1. R. T. Morrison, R. N. Boyd, *Organic Chemistry*, 7th Edn., Pearson Education, New Delhi, 2013.

2. I. L. Finar, *Organic Chemistry*, Vol. I, 5th Edn., Pearson Education, New Delhi, 2013.

3. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co., 2010.

4. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edn., Vikas Publishing House, New Delhi, 2004.

Moldule VII: Alkaloids and Terpenes (3 hrs)

Alkaloids: Classification – Source, structure and physiological functions of nicotine, coniine and piperine.

Terpenes: Classification with examples – Isoprene rule – Isolation of essential oils by steam distillation – Uses of lemongrass oil, eucalyptus oil and sandalwood oil – Source, structure and uses of citral and menthol – Natural rubber – Vulcanization and its advantages.

Note: Structural elucidation not expected in any case.

References

1. R. T. Morrison, R. N. Boyd, *Organic Chemistry*, 7th Edn., Pearson Education, New Delhi, 2013.

2. I. L. Finar, *Organic Chemistry*, Vol. I, 5th Edn., Pearson Education, New Delhi, 2013.

3. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co., 2010.

4. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edn., Vikas Publishing House, New Delhi, 2004.

Mark Distribution	
Module I	15 Marks
Module II	10 Marks
Module III	10 Marks
Module IV	14 Marks
Module V	13 Marks
Module VI	12 Marks
Module VII	5 Marks

SEMESTER IV

Course Code: CHE4C04

Complementary Course IV: PHYSICAL AND APPLIED CHEMISTRY

Total Hours: 48; Credits: 2; Hours/Week: 3; Total Marks 75 (Internal 15 & External 60)

CHE4C04	**PHYSICAL AND APPLIED CHEMISTRY**	L	T	P	C
		3	0	0	2
Objective (s)	To provide the students a thorough knowledge about colloidal chemistry, nanochemistry and the importance of chemistry in daily life. It also provides a basic idea related to separation and spectral techniques. It also imparts the idea of green processes with special emphasis on environment.				
Course outcome (s)					
CO1	To understand the basic concepts behind colloidal state and nanochemistry.				
CO2	To understand the importance of green chemistry and pollution prevention.				
CO3	To appreciate the importance of different separation methods and spectral techniques.				
CO4	To understand the extent of chemistry in daily life.				

Module I: Colloidal Chemistry (6 hrs)

True solution, colloidal solution and suspension. Classification of colloids: Lyophilic, lyophobic, macromolecular, multimolecular and associated colloids with examples. Purification of colloids by electrodialysis and ultrafiltration. Properties of colloids: Brownian movement – Tyndall effect – Electrophoresis. Origin of charge and stability of colloids – Coagulation - Hardy Schulze rule – Protective colloids - Gold number. Emulsions. Applications of colloids: Delta formation, medicines, emulsification, cleaning action of detergents and soaps.

References

1. B. R. Puri, L. R. Sharma, M. S. Pathania, *Principles of Physical Chemistry*, 46th Edn., Vishal Publishing Company, New Delhi, 2013.
2. F. Daniels, R. A. Alberty, *Physical Chemistry*, 5th Edn., John Wiley and Sons, Canada, 1980.

Module II: New Vistas in Chemistry (6 hrs)

Nanochemistry: Introduction – classification of nanomaterials (0D, 1D, 2D) - size dependence of material properties (optical, electrical and catalytic) - surface to volume ratio and its significance - application of nanomaterials in electronics, optics, catalysis and medicine (detailed discussion not expected).

Green Chemistry: Definition and need of green chemistry - principles (detailed discussion not expected) - atom economy - green solvents - green synthesis of Ibuprofen.

References

1. M. A. Shah, Tokeer Ahmad, *Principles of Nanoscience and Nanotechnology*, Narosa Publishing House, New Delhi, 2010.
2. T. Pradeep, *A Textbook of Nanoscience and Nanotechnology*, McGrawhill, New Delhi, 2012.
3. V. K. Ahluwaliya, *Green Chemistry*, Narosa Publishing House, New Delhi, 2011.

Module III: Chromatography (6 hrs)

Chromatography- Introduction - Adsorption and partition chromatography - Principle and applications of column, thin layer, paper and gas chromatography - Rf value – Relative merits of different techniques.

References

1. R. A. Day Junior, A. L. Underwood, *Quantitative Analysis*, 5th Edn., Prentice Hall of India Pvt. Ltd., New Delhi, 1988.
2. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, *Vogel's Text Book of Quantitative Chemical Analysis*, 6th Edn., Pearson Education, 2003.
3. R. Gopalan, P.Subramanian, K Rengarajan, *Elements of Analytical Chemistry*, S. Chand and Co., New Delhi, 2004.
4. R. P. Budhiraja, *Separation chemistry*, New Age International (P) Ltd., 2007.

Module IV: Spectroscopy (10 hrs)

Origin of spectra - Interaction of electromagnetic radiation with matter. Different types of energy levels in molecules: Rotational, vibrational and electronic levels. Statement of Born-Oppenheimer approximation - Fundamental laws of spectroscopy and selection rules (derivations not required).

IR Spectroscopy: Introduction - Group frequency concept - Characteristic stretching frequencies of O-H, N-H, C-H, C=C, C=N and C=O functional groups - Fingerprint region in IR spectra.

UV-Visible Spectroscopy: Introduction - Beer-Lambert's law - Electronic transitions in molecules ($\sigma\rightarrow\sigma^*$, $n\rightarrow\sigma^*$, $\pi\rightarrow\pi^*$ and $n\rightarrow\pi^*$) - Chromophore and auxochrome - Red shift and blue shift.

NMR Spectroscopy: Introduction - Chemical shift and spin-spin coupling - Application in elucidating the structure of ethanol, dimethyl ether, propanal and acetone (detailed study not required).

References

1. P. S. Kalsi, *Applications of Spectroscopic Techniques in Organic Chemistry*, 6th Edn., New Age International (P) Ltd., New Delhi, 2004.

2. C. N. Banwell, E. M. Mc Cash, *Fundamentals* of *Molecular Spectroscopy*, 4th Edn., McGraw–Hill publishing Company Limited, New Delhi, 2002.

Module V: Polymers (4 hrs)

Classification of polymers - Addition and condensation polymers – Thermoplastics and thermosetting plastics - Structure and applications of synthetic rubbers (Buna-S, Buna-N and neoprene), synthetic fibres (Nylon 66, Nylon 6 and dacron), thermoplastics (polyethene, polystyrene, PVC and teflon) and thermosetting plastics (bakelite and melmac). Uses of kevlar, nomex and lexan – Biodegradable polymers (PGA, PLA and PHBV) and their applications.

References

1. V. R. Gowarikar, *Polymer Chemistry*, New Age International Pvt. Ltd., New Delhi, 2010.
2. Fred. W. Billmeyer, *Textbook of Polymer Science*, 3rd Edn., Wiley India, Delhi, 2008.

Module VI: Environmental Pollution (6 hrs)

Definition – Types of pollution.

Air pollution: Pollution by oxides of nitrogen, carbon and sulphur. Effects of air pollution: Depletion of ozone, green house effect and acid rain.

Water pollution: Pollution due to sewage, industrial effluents, soaps, detergents, pesticides, fertilizers and heavy metals – Eutrophication - Biological magnification and bioaccumulation - Effects of water pollution. Water quality parameters – DO, BOD and COD (elementary idea only).

Soil pollution – Pollution due to plastics.

Thermal pollution and radioactive pollution: Sources, effects and control measures.

References

1. A. K. De, *Environmental Chemistry*, 6th Edn., New Age International Pvt. Ltd., New Delhi, 2006.
2. A. K. Ahluwalia, *Environmental Chemistry*, Ane Books India, New Delhi, 2008.

Module VII: Chemistry in Daily Life (10 hrs)

Petrochemicals: Name, carbon range and uses of fractions of petroleum distillation – Octane number - Cetane number – Flash point. LPG and CNG: Composition and uses.

Pharmaceuticals: Drug - Chemical name, generic name and trade names with examples. Antipyretics, analgesics, antibiotics, antacids, antiseptics (definition and examples, structure not expected).

Dyes: Definition – Requirements of a dye - Theories of colour and chemical constitution – Structure and applications of martius yellow, indigo and alizarin.

Food: Food additives: Food preservatives, artificial sweeteners and antioxidants (definition and examples, structures not required) Commonly used permitted and non-permitted food colours (structures not required).

Cement: Manufacture, composition and setting.

Glass: Types of glasses and uses.

References

1. Gurdeep R. Chatwal, *Synthetic Drugs*, Himalaya Publishing House, Bombay, 1995.

2. Jayashree Ghosh, *A Textbook of Pharmaceutical Chemistry*, 3rd Edn., S. Chand and Company Ltd., New Delhi, 1999.

3. B. Sivasankar, *Food processing and preservation*, Prentice – Hall of India Pvt. Ltd., New Delhi, 2002.

4. Srinivasan Damodaran, Kirk L. Parkin, Owen R. Fennema, *Food Chemistry*, 4th Edn., CRC Press, New York, 2007.

Mark Distribution	
Module I	10 Marks
Module II	10 Marks
Module III	10 Marks
Module IV	15 Marks
Module V	7 Marks
Module VI	10 Marks
Module VII	17 Marks

SEMESTER IV

Course Code: CHE4C05(P)

Complementary Course V: CHEMISTRY PRACTICAL

Total Hours: 128; Credits: 4; Hours/Week: 2 (I, II, III & IV Semesters); Total Marks 100 (Internal 20 & External 80)

CHE4C05(P)	**CHEMISTRY PRACTICAL**	L	T	P	C
		0	0	2	4
Objective (s)	To develop proficiency in quantitative and qualitative analysis and expertise in organic preparation and determination of physical constants.				
Course outcome (s)					
CO1	To understand the basic concepts of inter group separation.				
CO2	To enable the students to develop analytical and preparation skills.				

General Instructions

1. Semi micro analysis may be adopted for inorganic qualitative analysis.
2. For weighing, either electronic balance or chemical balance may be used.
3. For titrations, double burette titration method must be used.
4. Standard solution must be prepared by the student.
5. Use safety coat, gloves, shoes and goggles in the laboratory.
6. A minimum of 7 inorganic mixtures and 9 volumetric estimations must be done to appear for the examination.
7. Practical examination will be conducted at the end of semester IV.

Module I: Laboratory Safety, First Aid and Treatment of Fires

Importance of lab safety – Burns – Eye accidents – Cuts – Gas poisoning – Electric shocks –Treatment of fires – Precautions and preventive measures.

Module II: Volumetric Analysis

1. Weighing using chemical balance and electronic balance.
2. Preparation of standard solutions.
3. Neutralization Titrations (i) Strong acid – strong base. (ii) Strong acid – weak base. (iii) Weak acid – strong base.
4. Redox Titrations

Permanganometry:

(i) Estimation of oxalic acid.

(ii) Estimation of Fe^{2+}/$FeSO_4.7H_2O$/Mohr's salt.

Dichrometry:

(i) Estimation of Fe^{2+}/$FeSO_4.7H_2O$/Mohr's salt using internal indicator.

(ii) Estimation of Fe^{2+}/$FeSO_4.7H_2O$/Mohr's salt using external indicator.

Iodimetry and Iodometry:

(i) Estimation of iodine. (ii) Estimation of copper. (iii) Estimation of chromium.

5. Complexometric Titrations (i) Estimation of zinc. (ii) Estimation of magnesium. (iii) Determination of hardness of water.

Module III: Gravimetric Analysis

1. Determination of water of hydration in crystalline barium chloride.
2. Estimation of Ba^{2+} as $BaSO_4$.

Module IV: Inorganic Qualitative Analysis

(a) Reactions of Cations: Study of the reactions of the following cations with a view of their identification and confirmation. Pb^{2+}, Bi^{3+}, Cu^{2+}, Cd^{2+}, Fe^{2+}, Fe^{3+}, Al^{3+}, Ni^{2+}, Co^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+} and NH_4^+. (b) Systematic qualitative analysis of a solution containing any two cations from the above list.

Module V: Determination of Physical Constants

1. Determination of boiling point.
2. Determination of melting point.

Module VI: Organic Preparations

1. *p*-Bromoacetanilide from acetanilide.
2. *p*-Nitroacetanilide from acetanilide.
3. Benzoic acid from benzaldehyde.
4. Benzoic acid from benzamide.

References

1. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Edn., Pearson Education, Noida, 2013.

2. D. A. Skoog, D. M. West, F. J. Holler, S. R. Crouch, *Fundamentals of Analytical Chemistry*, 8th Edn., Brooks/Cole, Thomson Learning, USA, 2004.

3. V. K. Ahluwalia, Sunita Dhingra, Adarsh Gulati, *College Practical Chemistry*, Universities Press (India) Pvt. Ltd., Hyderabad, 2008 (Reprint).

4. G. Svehla, *Vogel's Qualitative Inorganic Analysis*, 7th Edn., Prentice Hall, New Delhi, 1996.

5. V. V. Ramanujam, *Inorganic Semi Micro Qualitative Analysis*, 3rd Edn., The National Publishing Company, Chennai, 1974.

6. W. G. Palmer, *Experimental Inorganic Chemistry*, Cambridge University Press, 1970.

EVALUATION SCHEME

FOR

COMPLEMENTARY COURSES

COMPLEMENTARY COURSE THEORY: EVALUATION SCHEME

The evaluation scheme for each course contains two parts: *viz.*, internal evaluation and external evaluation.

1. INTERNAL EVALUATION

20% of the total marks in each course are for internal evaluation. The colleges shall send only the marks obtained for internal examination to the university. The internal assessment shall be based on a predetermined transparent system involving written tests, class room participation based on attendance, assignment and seminar/viva in respect of theory courses. For practical course it is based on lab involvement and record.

Table 1: Components of Evaluation

Sl. No.	*Components*	*Marks*
1	Class room participation based on attendance (20%)	3
2	Test papers I (40%)	6
3	Assignment (20%)	3
4	Seminar/viva (20%)	3
Total Marks		15

Table 2: Percentage of attendance based on class room participation and eligible marks

% of attendance	*Marks*
85% and above	3
75 - <85%	2
50 - <75%	1

Table 3: Pattern of Test Papers

Duration	*Pattern*	*Total number of questions*	*Number of questions to be answered*	*Marks for each question*	*Ceiling of Marks*
1 Hour	Short answer	6	Up to 6	2	10
	Paragraph	4	Up to 4	5	15
	Essay	2	1	10	10
*Total Marks**					35

*85% and above = 6, 65 to below 85% = 5, 55 to below 65% = 4, 45 to below 55% = 3, 35 to below 45% = 2, below 35% = 1

2. EXTERNAL EVALUATION

External evaluation carries 80% marks. University examinations for two hours duration will be conducted at the end of each semester.

Table 1: Pattern of Question Papers

Duration	*Pattern*	*Total number of questions*	*Number of questions to be answered*	*Marks for each question*	*Ceiling of Marks*
2 Hours	Short answer	12	Up to 12	2	20
	Paragraph	7	Up to 7	5	30
	Essay	2	1	10	10
Total Marks					60

COMPLEMENTARY COURSE PRACTICAL: EVALUATION SCHEME

The evaluation scheme contains two parts: *viz.*, internal evaluation and external evaluation.

1. INTERNAL EVALUATION

20% of the total marks are for internal evaluation. The colleges shall send only the marks obtained for internal examination to the university.

Table 1: Components of Evaluation

Sl. No.	*Components*	*Marks*
1	Record	12
2	Lab involvement (viva – 4 and punctuality – 4)	8
Total Marks		20

Table 2: Number of Experiments and Marks for Practical Records

Number of Experiments (Marks in brackets)	
Volumetric Analysis	*Mixture Analysis*
11-12 (6)	9-10 (6)
10 (5)	8 (5)
9 (4)	7 (4)

2. EXTERNAL EVALUATION

External evaluation carries 80% marks. Practical examination will be conducted at the end of IVth semester.

Table 1: Pattern of Question Paper

Duration	*Pattern*	*Marks*	*Total*
3 Hours	Question on qualitative and quantitative analysis	8	80
	Procedure on volumetric analysis	6	
	Volumetric analysis	28	
	Mixture analysis	28	
	Record	10	

Guidelines

1. *Valuation of Volumetric Procedure*: Eight points – 6 marks. 1. Correct intermediate; 2. Preparation of standard solution; 3. Standardisation of intermediate; 4. Indicator and end point of standardization; 5. Making up of given solution; 6. Titration of made up solution; 7. Indicator; 8. End point/any other relevant points.

2. *Marks for Result:* The reported values (RV) of the students are compared with theoretical value (TV) and skilled value (SV) and calculate error percentage. Up to 1.5% error: 24 marks; between 1.51 – 2%: 20 marks; between 2.1– 2.5%: 16 marks; between 2.51– 3%: 12 marks; greater than 3%: 8 marks.

3. *Marks for Calculation:* Eight points – 4 marks. 1. Equivalent mass of the primary standard substance; 2. Calculation of normality of primary standard; 3. Table for standardization of intermediate with standard substance and indicator at the top; 4. Calculation of normality of the intermediate; 5. Table for estimation including standard substance and indicator; 6. Calculation of normality of the given solution; 7. Equivalent mass of the compound/ion in the given solution; 8. Calculation of weight in the whole of the given solution.

4. *Marks for Mixture Analysis:* Group identification: 1 mark each. Cation identification tests: 3 mark each. Chemistry of identification tests: 3 mark each. Cation confirmation tests: 3 marks each. Chemistry of confirmation tests: 3 mark each. Systematic procedure: 2 marks.

Table 2: Evaluation of Records

Number of Experiments (Marks in brackets)	
Volumetric Analysis (Max. Marks:5)	Mixture Analysis (Max. Marks: 5)
11-12 (5)	9-10 (5)
10 (4)	8 (4)
9 (3)	7 (3)

FIRST SEMESTER BSc. DEGREE EXAMINATION

CBCSSUG - CHEMISTRY

CHE1C01-Complementary course: I

GENERAL CHEMISTRY

Time: 2 Hrs **Max Marks: 60**

Section A (Short answers)

(Answer questions up to 20 marks. Each question carries 2 marks)

1. Methyl orange is not a suitable indicator in the titration of a weak acid against a strong base. Why?
2. Calculate the number of molecules in 2.8 L of CO_2 gas at STP.
3. Write any two advantages of microanalysis.
4. Write Schrodinger wave equation and explain the terms.
5. H_2O is a liquid while H_2S is a gas. Why?
6. How is N/P ratio related to the stability of nucleus?
7. Write any two uses of radioisotopes in medical diagnosis.
8. State Soddy's group displacement law
9. Distinguish isobars and isotones with suitable examples.
10. Explain how mass defect and binding energy are related.
11. Briefly explain the term photosynthesis.
12. Name two iron containing enzymes and their functions. **[Ceiling of marks: 20]**

Section B (Paragraph)

(Answer questions up to 30 marks. Each question carries 5 marks)

13. Explain the principle and advantages of double burette method of titration.
14. Discuss the principle of complexometric titration taking suitable example.
15. Using VSEPR theory explain the geometries of SF_4 and NH_3 .
16. Define lattice energy. Explain the Born-Haber cycle for NaCl.
17. Give an account of biochemical function of Zinc in living beings.
18. Explain the structure and mechanism of action of Na-K pump.
19. What is radiocarbon dating technique? Explain. **[Ceiling of marks: 30]**

Section C (Essay)

(Answer any one. Each question carries 10 marks)

20. Describe how solubility product principle and common ion effect are applied in qualitative inorganic analysis.
21. (a) What are quantum numbers? How are they significant? (b) Sketch the MO diagram of O_2 molecule and compare the stability of O_2 with O_2^{2+} and O_2^{2-} **[1 X 10= 10]**

SECOND SEMESTER B. Sc. DEGREE EXAMINATION

CBCSSUG - CHEMISTRY

CHE2C02 - Complementary course: II

Physical Chemistry

Time: 2 Hrs **Max Marks: 60**

Section A (Short answers)

(Answer questions up to 20 marks. Each question carries 2 marks)

1. How is internal energy change in a process is related to heat and work.
2. Above what temperature does the reaction: $2NO_{(g)} + O_2$ (g) $\rightarrow 2NO_2(g)$ become spontaneous, if $\Delta H = -101.5$ kJ and and $\Delta S = -145JK^{-1}$.
3. State third law of thermodynamics.
4. Mention the entropy criteria for spontaneity and equilibrium.
5. What is meant by anisotropic property? Give one example.
6. If the intercepts of a plane are a/2, b/3 and c/2. What are its Miller indices?
7. Write the significance of van der Waals constants.
8. What are the factors affecting vapour pressure of a liquid.
9. What is meant by reverse osmosis? Give one of its application.
10. What is electrochemical series? Give any two of its utility.
11. What are fuel cells? Schematically depict H_2-O_2 fuel cell.
12. Define Henry's law. Mention one of its applications. **[Ceiling of marks: 20]**

Section B (Paragraph)

(Answer questions up to 30 marks. Each question carries 5 marks)

13. Show that decrease in Gibbs free energy in a process is equal to the useful work done by the system.
14. Give the Maxwell's equation for the distribution of molecular velocities. Explain the influence of temperature on distribution.
15. Discuss the symmetry elements in crystals.
16. Define surface tension of a liquid and explain why water wets glass while mercury does not.
17. Derive van't Hoff osmotic osmotic pressure equation.
18. Explain the principle of coductometric titrations. Discuss the titration curve of a strong acid against weak base.
19. What are buffer solutions? Discuss their applications. Explain the buffer action of NH_4Cl/NH_4OH buffer. **[Ceiling of marks: 30]**

Section C (Essay)

(Answer any one. Each question carries 10 marks)

20. (a) Write a note on different types of defects in crystals. (b) Derive Bragg equation.
21. Define Kohlrausch's law. Discuss the different applications of it. **[1 X 10 = 10]**

THIRD SEMESTER BSc. DEGREE EXAMINATION
CBCSSUG - CHEMISTRY
CHE3C03-Complementary course: III
ORGANIC CHEMISTRY

Time: 2 Hrs **Maximum Marks:60**

Section A (Short answers)
(Answer questions up to 20 marks. Each question carries 2 marks)

1. Illustrate the hybridisation of carbon in carbocations
2. Differentiate Electrophiles and nucleopholes.
3. Draw the most stable conformation of ethane.
4. What are meso compounds.
5. Which is the electrophile in sulphonation reaction? How is it generated?
6. Show that naphthalene is aromatic based on Huckel's rule.
7. Explain iodoform test.
8. Draw the structure of phenolphthalein
9. What is zwitter ion?
10. What is rectified spirit?
11. Explain isoprene rule.
12. What is meant by vulcanisation? **[Ceiling of marks: 20]**

Section B (Paragraph)
(Answer questions up to 30 marks. Each question carries 5 marks)

13. Explain electromeric effect with suitable examples.
14. Compare the stability of boat and chair conformations of cyclohexane.
15. Explain the molecular orbital description of the structure of benzene.
16. Discuss Luca's test for distinguishing different types of alcohols.
17. Compare the rate of nucleophilic addition reaction of aliphatic aldehyde and aliphatic ketones.
18. Discuss the basicity of ammonia, methylamine, and aniline.
19. Explain the structure and the physiological effects nicotine. **[Ceiling of marks: 30]**

Section C (Essay)
(Answer any one. Each question carries 10 marks)

20. (a) Explain the mechanism of Friedel-Craft's alkylation reaction. (b) Discuss the synthetic applications of Diazonium salts.
21. Explain the double helical structure of DNA. **[1 X 10 = 10]**

FOURTH SEMESTER BSc. DEGREE EXAMINATION
CBCSSUG - CHEMISTRY
CHE4C04 - Complementary course: IV
PHYSICAL AND APPLIED CHEMISTRY

Time: 2 Hrs **Maximum Marks:60**

Section A (Short answers)
(Answer questions up to 20 marks. Each question carries 2 marks)

1. Why lyophilic sols are more stable than lyophobic sols.
2. Explain the applications of nanomaterials.
3. Give any two limitations of GLC technique.
4. What is Bathochromic shift?
5. Draw a labelled schematic diagram of NMR spectrum of acetone.
6. Differentiate between thermoplastics and thermosetting plastics.
7. How is Nylon 66 prepared?
8. Why COD greater than BOD?
9. Explain the consequences of eutrophication.
10. Give any two examples of natural food preservatives and artificial sweeteners.
11. Write notr on green solvents.
12. Compare LPG and CNG. **[Ceiling of marks: 20]**

Section B (Paragraph)
(Answer questions up to 30 marks. Each question carries 5 marks)

13. Explain the different purification techniques of colloids.
14. Give the applications of nanomaterial in medicine and catalysis.
15. Sketch and explain different vibrational modes of CO_2.
16. Briefly explain the classification of polymers on the basis of intermolecular forces.
17. What is greenhouse effect? Explain its consequence and control measures.
18. Explain the principles behind TLC.
19. Explain briefly different theories of dye. **[Ceiling of marks: 30]**

Section C (Essay)
(Answer any one. Each question carries 10 marks)

20. What are biodegradable polymers? Explain the applications of different biodegradable polymers.
21. Write a note about manufacture of cement and glass. **[1 X 10 = 10]**

FOURTH SEMESTER BSc. DEGREE EXAMINATION
CBCSSUG - CHEMISTRY
CHE4C05(P) - Complimentary Course V
CHEMISTRY PRACTICAL

Time: 3 Hours **Maximum marks: 80**

Section A
Answer the following questions in 6 minutes.

1. Calculate the mass of Mohr's salt required to prepare 100 ml of its 0.05 N solution?
2. Calculate the normality of oxalic acid solution when 0.63 g of it is dissolved in water in a 100 ml standard flask?
3. Name the indicator used for the titration of Na_2CO_3 against HCl.
4. Write the balanced chemical equation for any permanganometric titration.
5. The yellow precipitate formed on adding potassium chromate solution to Ba^{2+} salt solution is chemically ---------
6. What is/are the group reagent/s for 5^{th} group in inorganic qualitative analysis?
7. The chemical compound formed in the ash test for Aluminium is
8. The pink colour in permanganic acid test is ……. (1x8 = 8 Marks)

Section B
Answer the following question in 10 minutes

7. Give a brief outline of the method for the volumetric estimation of oxalic acid in the whole of the given solution, being provided with AR Mohr's salt crystals. (6 Marks)

Section C

8. Estimate volumetrically the mass of $FeSO_4.7H_2O$ present in the whole of the given solution, being provided with pure Mohr's salt and approximately 0.1N $K_2Cr_2O_7$ solution. (28 Marks)
9. Analyse qualitatively and systematically the given solution with a view to identify and confirm the two cations present in it. Submit a detailed report including chemistry of the identification and confirmation tests & systematic procedure. (28 Marks)

Section D

Record (10 marks)