Г. JOSEPH'S COLLEGE
NOMOUS), IRINJALAKUDA

B.Sc. DEGREE PROGRAMME
IN
CHEMISTRY

SCHEME AND SYLLABI

2018 ADMISSION ONWARDS

CORE COURSES, COMPLEMENTARY COURSES & OPEN COURSES

UNDERGRADUATE PROGRAMME – AN OVERVIEW

Programme means the entire course of study and examinations for the award of a degree. **Duration** of an undergraduate programme is six semesters distributed in a period of 3 years. An **academic week** is a unit of five working days in which distribution of work is organized from Monday to Friday with five contact periods of one hour duration on each day. A sequence of 18 such weeks (90 working days) constitutes a **semester**.

Course means a segment of subject matter to be covered in a semester. The undergraduate programme includes four types of courses, *viz.*, common courses, core courses, complementary courses and open course. **Common courses** include English and additional language courses. Every undergraduate student shall undergo 10 common courses [6 English courses and 4 additional language courses] for completing the programme. **Core courses** comprise compulsory course in a subject related to a particular degree programme offered by the parent department. There are 18 core courses including a project work. **Complementary courses** cover two disciplines that are related to the core subject and are distributed in the first four semesters. There shall be one **open course** in the 5^{th} semester. Students can opt one open course of their choice offered by any department in the institution other than their parent department.

Each course shall have a unique alphanumeric **code number**, which includes abbreviation of the subject in three letters, the semester number (1 to 6) in which the course is offered, the code of the course (A: Common course, B: Core course, C: Complementary course and D: Open course) and the serial number of the course (01, 02, *etc.*). For example, CHE5B06 represents a core course of serial number 06 offered in 5^{th} semester in B.Sc. Chemistry Programme.

Each course shall have certain credits. **Credit** is a unit of academic input measured in terms of weekly contact hours/course contents assigned to a course. For passing the degree programme, the students are required to achieve a minimum of **120 credits** as detailed below.

PROGRAMME OUTCOME

- Critically evaluate ideas and arguments by gathering relevant information, assessing its credibility, and synthesizing evidence to formulate a position .

- Identify problems and independently propose solutions using creative approaches, acquired through interdisciplinary experiences, and a depth and breadth of knowledge/expertise.
- Develop a plan for professional growth and development
- Generate and interpret scientific data using quantitative, qualitative and analytical methodologies and techniques
- Apply contemporary research methods, skills and techniques to conduct independent inquiry in a chosen scientific discipline.

Common courses: 38 credits (22 for English courses + 16 for additional languages).

Core courses: 56 credits (including 2 credits for project work).

Complementary courses: 24 credits (12 credits each).

Open course: 2 credits.

UNDERGRADUATE PROGRAMME IN CHEMISTRY

PREFACE

With the pace that the world keeps and the speed with which technology advances, an understanding of science is inevitable in our day-to-day life. To make the study of science interesting and enjoyable, the creation of a scientific temper in society is a must which could be achieved through proper education and guidance. An effective science education can be imparted at the undergraduate level only by revamping the curriculum according to the needs and developments of the modern society from time to time. To achieve this goal, the curriculum should be restructured by giving emphasis on various aspects such as the creativity of students, knowledge of current developments in the discipline, awareness of environmental impacts due to the development of science and technology, and the skills essential for handling equipments and instruments in laboratories and industries.

Chemistry, being an experimental science, demands testing theories through practical laboratory experiences for a thorough understanding of the subject. Nowadays, chemistry laboratories in academic institutions use large amounts of chemicals. The ever rising cost of chemicals adversely affects many of the practical exercises. The fumes, gases and wastes produced during chemical reactions pollute the environment and affect public health. The awareness and implementation of eco-friendly experiments thus becomes a global necessity. It is in this context, that the need for greener approaches becomes more relevant. It is essential to ensure that laboratory chemicals are used at a minimal level without affecting the skill and understanding aimed through laboratory sessions. The change brought about in the present scheme makes use of micro scale techniques and double burette titrations. This has been done without any conceptual deviation from the principles of experiments. This method not only reduces the expenditure on chemicals but also creates an environmental awareness among the students and pollution free atmosphere in the campus. This scheme saves time and energy of students while performing the experiments.

The syllabus has been prepared in a participatory manner, after discussions with a number of faculty members in the subject and uploading the draft syllabus in the university website and collecting the feedback. As far as possible, the suggested modifications from the teaching community have been incorporated into the syllabus. During the preparation of the

syllabus, the existing syllabus, the syllabi of XIth & XIIth standards, UGC model curriculum and the syllabi of other universities have also been referred to. Care has been taken to ensure that the syllabus is compatible with the syllabi of other universities at the same level. Sufficient emphasis is given in the syllabus for training in laboratory skills and instrumentation.

The units of the syllabus are well defined. The number of contact hours required for each unit is also given. A list of reference books is provided at the end of each course.

AIMS

This curriculum has been prepared with the objective of giving sound knowledge and understanding of chemistry to undergraduate students. The goal of the syllabus is to make the study of chemistry stimulating, relevant and interesting. It has been prepared with a view to equip students with the potential to contribute to academic and industrial environments. This curriculum will expose students to various fields in chemistry and develop interest in related disciplines. Chemistry, being a border science to biology, physics and engineering, has a key role to play in the understanding of these disciplines. The updated syllabus is based on an interdisciplinary approach to understand the application of the subject in daily life.

PROGRAMME SPESIFIC OUTCOME

- To understand basic facts and concepts in chemistry.
- To develop the ability for applying the principles of chemistry.
- To appreciate the achievements in chemistry and to know the role of chemistry in nature and in society.
- To make the students eco-friendly by creating a sense of environmental awareness in them.
- To make the students aware of the applications of chemistry in day-to-day life.

COURSE STRUCTURE

Credit Distribution

Semester	*Common course*		*Core course*	*Complementary course*		*Open course*	*Total*
	English	*Additional Language*		*Mathematics*	*Physics*		
I	4+3	4	2	3	2	-	18
II	4+3	4	2	3	2	-	18
III	4	4	3	3	2	-	16
IV	4	4	3+4	3	2+4	-	24
V	-	-	3+3+3	-	-	2	11
VI	-	-	3+3+3+3+3+4+4+4+4+2	-	-	-	33
Total	**22**	**16**	**56**	**12**	**12**	**2**	**120**

*Practical **Project

Mark Distribution and Indirect Grading System

Mark system is followed instead of direct grading for each question. After external and internal evaluations marks are entered in the answer scripts. All other calculations, including grading, will be done by the university using the software. Indirect Grading System in 7 point scale is followed. Each course is evaluated by assigning marks with a letter grade (A^+, A, B, C, D, E or F) to that course by the method of indirect grading.

Mark Distribution

Sl. No.	*Course*	*Marks*
1	English	600
2	Additional Language	400
3	Core course: Chemistry	1750
4	Complementary course: Mathematics	400
5	Complementary course: Physics	400
6	Open Course	50
	Total Marks	**3600**

Seven point Indirect Grading System

% of Marks	*Grade*	*Interpretation*	*Grade Point Average*	*Range of Grade points*	*Class*
90 and above	A^+	Outstanding	6	5.5 - 6	First Class with distinction
80 to below 90	A	Excellent	5	4.5 – 5.49	
70 to below 80	B	Very good	4	3.5 – 4.49	First Class
60 to below 70	C	Good	3	2.5 – 3.49	
50 to below 60	D	Satisfactory	2	1.5 – 2.49	Second Class
40 to below 50	E	Pass/Adequate	1	0.5 – 1.49	Pass
Below 40	F	Failure	0	0 – 0.49	Fail

CREDIT AND MARK DISTRIBUTION IN EACH SEMESTERS

Total Credits: 120; Total Marks: 3600

Semester	*Course*	*Credit*	*Marks*
I	Common course: English	4	100
	Common course: English	3	100
	Common course: Additional Language	4	100
	Core Course I: Theoretical and Inorganic Chemistry-I	2	100
	Complementary course: Mathematics	3	100
	Complementary course: Physics	2	80
	Total	**18**	**580**
II	Common course: English	4	100
	Common course: English	3	100
	Common course: Additional Language	4	100
	Core Course II: Theoretical and Inorganic Chemistry-II	2	100
	Complementary course: Mathematics	3	100
	Complementary course: Physics	2	80
	Total	**18**	**580**
III	Common course: English	4	100
	Common course: Additional Language	4	100
	Core Course III: Physical Chemistry-I	3	100
	Complementary course: Mathematics	3	100
	Complementary course: Physics	2	80
	Total	**16**	**480**
IV	Common course: English	4	100
	Common course: Additional Language	4	100
	Core Course IV: Organic Chemistry-I	3	100
	Core Course V: Inorganic Chemistry Practical-I	4	100
	Complementary course: Mathematics	3	100
	Complementary course: Physics	2	80
	Complementary course: Physics Practical	4	80
	Total	**24**	**660**
V	Core Course VI: Inorganic Chemistry-III	3	100
	Core Course VII: Organic Chemistry-II	3	100
	Core Course VIII: Physical Chemistry-II	3	100
	Open course	2	50
	Total	**11**	**350**
VI	Core Course IX: Inorganic Chemistry-IV	3	100
	Core Course X: Organic Chemistry-III	3	100
	Core Course XI: Physical Chemistry-III	3	100
	Core Course XII: Advanced and Applied Chemistry	3	100
	Core Course XIII: Elective	3	100
	Core Course XIV: Physical Chemistry Practical	4	100
	Core Course XV: Organic Chemistry Practical	4	100
	Core Course XVI: Inorganic Chemistry Practical-II	4	100
	Core Course XVII: Inorganic Chemistry Practical-III	4	100
	Core Course XVIII: Project Work	2	50
	Total	**33**	**950**

SYLLABUS

FOR

CORE COURSES

Core Course Structure
Total Credits: 56 (Internal: 20%; External: 80%)

Semester	*Code No*	*Course Title*	*Hrs/ Week*	*Total Hrs*	*Credit*	*Marks*
I	CHE1B01	Core Course I: Theoretical and Inorganic Chemistry-I	2	36	2	100
	-	Core Course V : Inorganic Chemistry Practical-I	2	36	-*	-
II	CHE2B02	Core Course II: Theoretical and Inorganic Chemistry-II	2	36	2	100
	-	Core Course V : Inorganic Chemistry Practical-I	2	36	-*	-
III	CHE3B03	Core Course III: Physical Chemistry-I	3	54	3	100
	-	Core Course V : Inorganic Chemistry Practical-I	2	36	-*	-
IV	CHE4B04	Core Course IV: Organic Chemistry-I	3	54	3	100
	CHE4B05(P)	Core Course V : Inorganic Chemistry Practical-I	2	36	4	100
V	CHE5B06	Core Course VI: Inorganic Chemistry-III	3	54	3	100
	CHE5B07	Core Course VII: Organic Chemistry-II	4	72	3	100
	CHE5B08	Core Course VIII: Physical Chemistry-II	4	72	3	100
	-	Core Course XIV: Physical Chemistry Practical	5	90	-**	-
	-	Core Course XV: Organic Chemistry Practical	5	90	-**	-
	-	Core Course XVIII: Project Work	2	36	-**	-
VI	CHE6B09	Core Course IX: Inorganic Chemistry-IV	3	54	3	100
	CHE6B10	Core Course X: Organic Chemistry-III	3	54	3	100
	CHE6B11	Core Course XI: Physical Chemistry-III	3	54	3	100
	CHE6B12	Core Course XII: Advanced and Applied Chemistry	3	54	3	100
	CHE6B13(E1)	Core Course XIII: Elective*** — 1. Industrial Chemistry	3	54	3	100
	CHE6B13(E2)	Core Course XIII: Elective*** — 2. Polymer Chemistry				
	CHE6B13(E3)	Core Course XIII: Elective*** — 3. Medicinal and Environmental Chemistry				
	CHE6B14(P)	Core Course XIV: Physical Chemistry Practical	-	-	4**	100
	CHE6B15(P)	Core Course XV: Organic Chemistry Practical	-	-	4**	100
	CHE6B16(P)	Core Course XVI: Inorganic Chemistry Practical-II #	5	90	4	100
	CHE6B17(P)	Core Course XVII: Inorganic Chemistry Practical-III	5	90	4	100
	CHE6B18(Pr)	Core Course XVIII: Project Work	-	-	2**	50
				Total	**56**	**1750**

* Exam will be held at the end of 4th semester

** Exam will be held at the end of 6th semester

*** An institution can choose any one among the three courses.

Includes industrial visit also. Marks: 85 (Inorganic Chemistry Practical–II) + 15 (Industrial visit).

SEMESTER I

Course Code: CHE1B01
Core Course I: THEORETICAL AND INORGANIC CHEMISTRY - I
Total Hours: 36; Credits: 2; Hours/Week: 2

Module I: Chemistry as a Discipline of Science (6 hrs)

What is Science? - Scientific statements - Scientific methods – Observation - Posing a question - Formulation of hypothesis – Experiment – Theory – Law - Revision of scientific theories and laws - Role of concepts and models in science - Scientific revolution.

Evolution of chemistry - Ancient speculations on the nature of matter - Early form of chemistry – Alchemy - Origin of modern chemistry - Branches of chemistry -Interdisciplinary areas involving physics and biology.

Objectives of Chemical Research - Research design. Components of a research project: Introduction, review of literature, scope, materials and methods, results and discussion, conclusions and bibliography.

Module II: Some Basic Chemical Concepts (3 hrs)

Symbol of elements – Atomic number and mass number - Atomic mass – Isotopes, isobars and isotones - Molecular mass - Mole concept – Molar volume - Oxidation and reduction – Oxidation number and valency – Variable valency - Equivalent mass.

Methods of expressing concentration: Weight percentage, molality, molarity, normality, mole fraction, ppm and millimoles.

Module III: Analytical Chemistry - I (9 hrs)

Laboratory Hygiene and Safety: Storage and handling of chemicals. Simple first aids: Electric shocks, fire, cut by glass and inhalation of poisonous gases - Accidents due to acids and alkalies - Burns due to phenol and bromine. Disposal of sodium and broken mercury thermometer - Use of calcium chloride and silica gel in desiccators. Awareness of Material Safety Data Sheet (MSDS) – R & S Phrases (elementary idea only) – Safe laboratory practices – Lab safety signs.

Volumetric Analysis: Introduction - Primary and secondary standards – Standard solutions - Theory of titrations involving acids and bases, $KMnO_4$, $K_2Cr_2O_7$, I_2 and liberated I_2 - Complexometric titrations. Indicators: Theory of acid-base, redox, adsorption and complexometric indicators. Double burette method of titration: Principle and advantages.

Significant figures – Comparison of results.

Module IV: Atomic Structure (9 hrs)

Introduction based on historical development – John Dalton's atomic theory – Thomson's atom model and its limitations – Rutherford's atom model and its limitations - Failure of classical physics – Black body radiation - Planck's quantum hypothesis - Photoelectric effect - Generalization of quantum theory - Atomic spectra of hydrogen and hydrogen like atoms - Ritz-combination principle– Bohr theory of atom – Calculation of Bohr radius, velocity and energy of an electron - Explanation of atomic spectra – Rydberg equation - Limitations of Bohr theory - Sommerfeld modification - Louis de Broglie's matter waves – Wave-particle duality - Electron diffraction - Heisenberg's uncertainty principle.

Module V: Nuclear Chemistry (9 hrs)

Natural radioactivity – Modes of decay – Group displacement law – Theories of disintegration – Rate of decay – Decay constant – Half life period – Gieger-Nuttall rule – Radioactive equilibrium – Disintegration series – Transmutation reactions using protons, deutrons, α-particles and neutrons – Artificial radioactivity – Positron emission and K electron capture – Synthetic elements.

Nuclear stability – N/P ratio – Packing fraction – Mass defect – Binding energy – Nuclear forces – Exchange theory and nuclear fluid theory – Nuclear fission - Atom bomb – Nuclear fusion – Hydrogen bomb - Nuclear reactors - Nuclear reactors in India.

Isotopes: Detection – Aston's mass spectrograph – Separation of isotopes by gaseous diffusion method and thermal diffusion method – Application of radioactive isotopes – ^{14}C dating – Rock dating – Isotopes as tracers – Study of reaction mechanism (ester hydrolysis) – Radio diagnosis and radiotherapy.

Text Books

1. Jeffrey A. Lee, *The Scientific Endeavor: A Primer on Scientific Principles and Practice*, Pearson Education, 1999.
2. C.N.R. Rao, *Understanding Chemistry*, Universities Press India Ltd., Hyderabad, 1999.
3. Robert H. Hill and David Finster, *Laboratory Safety for Chemistry Students*, 1st Edition, Wiley, Hoboken, NJ, 2010.
4. M.C. Day and J. Selbin, *Theoretical Inorganic Chemistry*, East West Press, New Delhi, 2002.
5. B.R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, 31st Edition, Milestone Publishers and Distributors, New Delhi, 2013.
6. Satya Prakash, *Advanced Inorganic Chemistry, Volume 1*, 5th Edition, S. Chand and Sons, New Delhi, 2012.
7. J. Mendham, R.C. Denney, J. D. Barnes and M. Thomas, *Vogel's Text Book of Quantitative Chemical Analysis*, 6th Edition, Pearson Education, Noida, 2013.
8. H.J. Arnikar, *Essentials of Nuclear Chemistry*, 4th Edition, New Age International (P) Ltd., New Delhi, 1995 (Reprint 2005).

References

1. T.F Gieryn, *Cultural Boundaries of Science*, University of Chicago Press, Chicago, 1999.

2. H. Collins and T. Pinch, *The Golem: What Everyone Should Know about Science*, Cambridge University Press, Cambridge, 1993.

3. C.R. Kothari, *Research Methodology: Methods and Techniques*, 2nd Revised Edition, New Age International Publishers, New Delhi, 2004.

4. *Guidance in a Nutshell - Compilation of Safety Data Sheets*, European Chemicals Agency, Finland, Version 1.0, December 2013.

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

6. B.K, Sen, *Quantum Chemistry – Including Spectroscopy*, 3rd Edition, Kalyani publishers, New Delhi, 2010.

7. D.A. McQuarrie, *Quantum Chemistry*, 2nd Edition, University Science Books, California, 2008.

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

9. J.B. Rajam and L.D. Broglie, *Atomic Physics*, 7th Edition, S. Chand and Co. Pvt. Ltd., New Delhi, 1999.

10. S. Glasstone, *Source Book on Atomic Energy*, 3rd Edition, East-West Press Pvt. Ltd., New Delhi, 1967.

SEMESTER II

Course Code: CHE2B02
Core Course II: THEORETICAL AND INORGANIC CHEMISTRY - II
Total Hours: 36; Credits: 2; Hours/Week: 2

Module I: Quantum Chemistry (12 hrs)

Operator algebra – Linear and Hermitian operators - Laplacian and Hamiltonian operators - Eigen functions and Eigen values of an operator - Postulates of quantum mechanics - Well behaved functions.

Time independent Schrödinger wave equation - Application to particle in a one dimensional box – Normalization of wave function - Particle in a three-dimensional box – Separation of variables - Degeneracy.

Application of Schrödinger wave equation to hydrogen atom – Conversion of Cartesian coordinates to polar coordinates - The wave equation in spherical polar coordinates (derivation not required) - Separation of wave equation - Radial and angular functions (derivation not required) – Orbitals and concept of Quantum numbers (n, l, m).

Radial functions - Radial distribution functions and their plots – Shapes of orbitals (s, p and d). Schrödinger equation for multi-electron atoms: Need for approximation methods.

Electron spin – Spin quantum number - Pauli's Exclusion principle - Hund's rule of maximum multiplicity - Aufbau principle – Electronic configuration of atoms.

Module II: Periodic Properties (6 hrs)

Modern periodic law – Long form periodic table. Periodicity in properties: Atomic and ionic radii - Ionization enthalpy - Electron affinity (electron gain enthalpy) – Electronegativity. Electronegativity scales: Pauling and Mullikan scales. Effective nuclear charge – Slater rule and its applications – Polarising power. Diagonal relationship and anomalous behavior of first element in a group (basic idea only).

Module III: Chemical Bonding – I (9 hrs)

Introduction – Type of bonds – Octet rule and its limitations.

Ionic Bond: Factors favouring the formation of ionic bonds - Lattice energy of ionic compounds - Born-Lande equation (derivation not expected) – Solvation enthalpy and solubility of ionic compounds – Born-Haber cycle and its applications – Properties of ionic compounds - Polarisation of ions – Fajan's rule and its applications.

Covalent Bond: Lewis theory. VSEPR theory: Postulates - Applications - Shapes of BeF_2, BCl_3, $SnCl_2$, CCl_4, NH_3, H_2O, PF_5, SF_4, ClF_3, XeF_2, SF_6, IF_5, XeF_4, IF_7 and XeF_6. Valence Bond Theory. Coordinate bond. Hybridization: Definition and characteristics - sp ($BeCl_2$, C_2H_2), sp^2 (BF_3, C_2H_4), sp^3 (CH_4, NH_3, H_2O, NH_4^+, H_3O^+ and SO_4^{2-}), sp^3d (PCl_5), sp^3d^2 (SF_6) and sp^3d^3 (IF_7) hybridizations. Limitations of

VBT. Properties of covalent compounds. Polarity of covalent bond – Percentage of ionic character – Dipole moment and molecular structure.

Module IV: Chemical Bonding – II (9 hrs)

Covalent Bond: Molecular Orbital Theory – LCAO - Bonding and anti bonding molecular orbitals – Bond order and its significance. MO diagrams of homonuclear and heteronuclear diatomic molecules: H_2, He_2, Li_2, Be_2, B_2, C_2, N_2, O_2, F_2, CO and NO – Comparison of bond length, magnetic behaviour and bond energy of O_2, O_2^+, O_2^{2+}, O_2^- and O_2^{2-}.

Resonance structures of borate, carbonate and nitrate ions – Comparison of bond energy.

Comparison of VB and MO theories.

Metallic Bond: Free electron theory, valence bond theory and band theory (qualitative treatment only) - Explanation of metallic properties based on these theories.

Intermolecular Forces: Introduction. Hydrogen bond: Intra and inter molecular hydrogen bonds - Effect on physical properties. Induction forces and dispersion forces: Van der Waals forces, ion-dipole, dipole-dipole, ion-induced dipole, dipole-induced dipole and induced dipole-induced dipole interactions.

Text Books

1. A.K. Chandra, *Introductory Quantum Chemistry*, 4th Edition, Tata McGraw Hill Publishing Company, Noida, 1994.
2. R.K. Prasad, *Quantum Chemistry*, 4th Edition, New Age International(P) Ltd., New Delhi, 2012.
3. B.K, Sen, *Quantum Chemistry – Including Spectroscopy*, 3rd Edition, Kalyani publishers, New Delhi, 2010.
4. B.R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, 31st Edition, Milestone Publishers and Distributors, New Delhi, 2013.
5. Satya Prakash, *Advanced Inorganic Chemistry, Volume 1*, 5th Edition, S. Chand and Sons, New Delhi, 2012.
6. Manas Chanda, *Atomic Structure and Chemical Bonding*, 4th Edition, Tata McGraw Hill Publishing Company, Noida, 2007.
7. R. Gopalan, *Inorganic Chemistry for Undergraduates*, Universities Press India Ltd., Hyderabad, 2009.

References

1. D.A. McQuarrie, *Quantum Chemistry*, 2nd Edition, University Science Books, California, 2008.
2. M.C. Day and J. Selbin, *Theoretical Inorganic Chemistry*, East West Press, New Delhi, 2002.
3. P.W. Atkins and R.S. Friedman, *Molecular Quantum Mechanics*, 3rd Edition, Oxford University Press, New York, 1997.
4. I.N. Levine, *Quantum Chemistry*, 6th Edition, Pearson Education Inc., New Delhi, 2009.
5. Jack Simons, *An Introduction to Theoretical Chemistry*, 2nd Edition, Cambridge University

Press, Cambridge, 2005.

6. J.D. Lee, *Concise Inorganic Chemistry*, 5th Edition, John Wiley and Sons, New York, 2008.

SEMESTER III

Course Code: CHE3B03
Core Course III: PHYSICAL CHEMISTRY– I
Total Hours: 54; Credits: 3; Hours/Week: 3

Module I: Gaseous State (12 hrs)

Introduction - Postulates of kinetic theory of gases - Derivation of kinetic gas equation - Maxwell's distribution of molecular velocities - Root mean square, average and most probable velocities - Collision number - Mean free path - Collision diameter - Deviation from ideal behavior - Compressibility factor – Van der Waals equation of state (derivation required) - Virial equation - Expression of Van der Waals equation in virial form and calculation of Boyle temperature - PV isotherms of real gases - Continuity of states - Isotherm of Van der Waals equation - Critical phenomena - Critical constants and their determination - Relationship between critical constants and Van der Waals constants.

Module II: Thermodynamics – I (18 hrs)

Definition of thermodynamic terms - System – Surroundings - Types of systems - Intensive and extensive properties - State and path functions - Zeroth law of thermodynamics - First law of thermodynamics – Concept of heat, work, internal energy and enthalpy - Heat capacities at constant volume and at constant pressure & their relationship - Expansion of an ideal gas - Work done in isothermal expansion and reversible isothermal expansion - Calculation of W, q, ΔE and ΔH for expansion of an ideal gas under isothermal and adiabatic conditions - Joule-Thomson effect - Liquefaction of gases - Derivation of the expression for Joule Thomson coefficient – Inversion temperature.

Second law of thermodynamics - Need for the law - Different statements of the law - Carnot's cycle and its efficiency - Carnot theorem - Concept of entropy - Entropy as a state function - Entropy as a function of V & T and P & T - Entropy as a criteria of spontaneity and equilibrium.

Work and free energy functions - Criteria for reversible and irreversible processes - Gibbs-Helmholtz equation - Partial molar free energy - Concept of chemical potential - Gibbs-Duhem equation - Clapeyron equation - Clapeyron-Clausius equation and its application.

Module III: Thermodynamics – II (9 hrs)

Thermochemistry - Standard enthalpies of solution, combustion, neutralization, dissociation, formation and reaction – Hess's law – Variation of enthalpy of reaction with temperature – The Kirchhoff equation – Bond energies.

Third law of thermodynamics - Nernst heat theorem - Statement of third law.

Fundamental concepts of Statistical Thermodynamics - Permutations and combinations – Probability - Relation between entropy and probability - Stirling's approximation - Residual entropy and absolute entropy.

Module IV: Liquid State (6 hrs)

Introduction - Uniqueness of water. Vapour pressure: Explanation and its determination. Surface tension: Explanation and its determination. Parachor: Explanation and its determination - Application to structure elucidation of compounds. Viscosity: Determination of molecular mass from viscosity measurements. Refraction: Refractive index – Molar refraction and optical exaltation – Application to structure elucidation.

Module V: Chemical Equilibria (9 hrs)

Introduction - Law of mass action - Law of chemical equilibrium - Equilibrium constant in terms of concentration, partial pressure and mole fractions - Relationship between Kc, Kp and Kx - Thermodynamic derivation of law of chemical equilibrium - Temperature dependence of equilibrium constant - Van't Hoff's equation - Homogeneous and heterogenous equilibria - Le Chatelier's principle and its applications to chemical and physical equilibria.

Text Books

1. B.R. Puri, L.R. Sharma and M.S. Pathania, *Principles of Physical Chemistry*, 46th Edition, Vishal Publishing Company, New Delhi, 2013.
2. P.L. Soni, O.P. Dharmarha and U.N. Dash, *Textbook of Physical Chemistry*, 23rd Edition, Sultan Chand & Sons, New Delhi, 2011.
3. J. Rajaram and J.C. Kuriacose, *Chemical Thermodynamics*, Pearson Education, New Delhi, 2013.
4. F. Daniels and R.A. Alberty, *Physical Chemistry*, 5th Edition, John Wiley and Sons, Canada, 1980.
5. Gurdeep Raj, *Advanced Physical Chemistry*, 35th Edition, Goel Publishing House, Meerut, 2009.

References

1. Gordon M. Barrow, *Physical Chemistry*, 5th Edition, Tata McGraw Hill Education, New Delhi, 2006.
2. K.L. Kapoor, *Physical Chemistry*, Volumes II and III, Macmillan Publishers, Noida, 2004.
3. S. Glasstone and D.H. Lewis, *Elements of Physical Chemistry*, 2nd Edition, Macmillan & Company, UK, 1962.
4. W.J. Moore, *Physical Chemistry*, 5th Edition, Orient Longman, London, 1999.
5. R.P. Rastogi and R.R. Misra, *An Introduction to Chemical Thermodynamics*, 6th Edition, Vikas Publishing House Pvt. Ltd., Noida, 2002.
6. T.L. Hill, *Introduction to Statistical Thermodynamics*, Addison-Wesley, New York, 1987.
7. P.W. Atkins, *Physical Chemistry*, 8th Edition, Oxford University Press, New Delhi, 2006.
8. G.W. Castellan, *Physical Chemistry*, 3rd Edition, Addison-Wesley Educational Publishers Inc., U.S., 2004.
9. G.K. Vemula Palli, *Physical Chemistry*, Prentice Hall of India, New Delhi, 1997.

10. K.K. Sharma and L.K. Sharma, *A Textbook of Physical Chemistry*, 5th Edition, Vikas Publishing House, New Delhi, 2012.

SEMESTER IV

Course Code: CHE4B04
Core Course IV: ORGANIC CHEMISTRY– I
Total Hours: 54; Credits: 3; Hours/Week: 3

Module I: Introduction to Organic Chemistry (3 hrs)

Historical development – Uniqueness of carbon – Classification of organic compounds - Homologous series - Functional groups (mention only) - Hybridization in organic compounds (mention only). Isomerism: Classification in to structural isomerism and stereo isomerism. Structural isomerism: Chain isomerism, position isomerism, functional isomerism, metamerism and ring-chain isomerism – Keto-enol tautomerism.

Module II: Stereochemistry (15 hrs)

Representation of Organic Molecules: Fischer, Flying wedge, Sawhorse and Newman projection formulae.

Stereoisomerism: Classification into conformational isomerism and configurational isomerism.

Conformational Isomerism: Conformations - Dihedral angle - Torsional strain - Conformational analysis of ethane and *n*-butane including energy diagrams – Conformations of glycol. Baeyer's strain theory –

Merits and demerits. Conformations of cyclohexane - Axial and equatorial bonds - Ring flipping – Conformations of mono substituted cyclohexane.

Optical Isomerism: Definition – Specific rotation – Chirality and elements of symmetry – DL configuration - Enantiomers - Optical isomerism in glyceraldehyde, lactic acid and tartaric acid - Diastereomers – Meso compounds – Cahn-Ingold-Prelog rules - RS notations for acyclic optical isomers with one and two asymmetric carbon atoms - Erythro and threo representations (elementary idea only) - Racemic mixture - Resolution methods - Enantiomeric excess. Optical isomerism in compounds lacking asymmetric carbon atoms: Biphenyls and allenes. Asymmetric synthesis.

Geometrical Isomerism: cis-trans, syn-anti and EZ notations with examples - Methods of distinguishing geometrical isomers using melting point, dipole moment, solubility, cyclisation and heat of hydrogenation.

Module III: Reaction Mechanism: Basic Concepts (12 hrs)

Definition of reaction mechanism - Curved arrow formalism. Nature of bond fission: Homolysis and heterolysis. Types of reagents: Electrophiles and nucleophiles.

Resonance: Condition, rules and techniques of drawing resonance forms - Resonance energy - Calculation of resonance energy of benzene from heat of hydrogenation.

Electron Displacement Effects: Inductive effect: Definition – Characteristics - +I and -I groups. Applications: Comparison of acidity of (i) formic acid and acetic acid (ii) chlorobutanoic acids. Mesomeric effect: Definition – Characteristics - +M and -M groups. Applications: Comparison of basicity of aniline, *p*-nitroaniline and *p*-anisidine. Hyperconjugation: Definition – Characteristics.

Examples: Propene, ethyl carbocation and ethyl free radical. Applications: Comparison of stabilities of (i) 1-butene and 2-butene (ii) toluene, ethyl benzene and *tert*-butyl benzene. Electromeric effect: Definition – Characteristics - +E effect (addition of H^+ to ethene) and -E effect (addition of CN^- to acetaldehyde). Comparison of inductive effect, mesomeric effect and hyperconjugation: Comparison of electron density in benzene, toluene, phenol, chlorobenzene and nitrobenzene. Steric effect: Definition, reason and examples.

Reaction Intermediates: Carbocations, carbanions, free radicals and carbenes (definition, hybridization, structure, classification, formation, stability and important reactions) - Rearrangement of carbocations – Nitrenes (mention only).

Types and Subtypes of Organic Reactions: Substitution, addition, elimination and rearrangement (definition and simple examples only).

Module IV: Aliphatic Hydrocarbons (15 hrs)

Alkanes: Nomenclature – Isomerism – Preparation from alkenes, alkynes and alkyl halides (reduction and Wurtz reaction). Chemical properties: Halogenation (free radical substitution mechanism), aromatisation and isomerisation.

Cycloalkanes: Nomenclature - Preparation by Freund reaction.

Alkenes: Nomenclature – Isomerism. Preparation: Dehydrohalogenation of alkyl halides (Saytzeff's rule, mechanism not expected), dehalogenation of dihalides (stereochemistry expected) and dehydration of alcohols (mechanism expected). Chemical properties: Electrophilic addition - Addition of hydrogen (explanation of stability and heat of hydrogenation based on hyperconjugation and resonance), addition of halogens (mechanism and stereochemistry expected), addition of hydrogen halides (Markownikov and Anti-Markownikov addition with mechanism) and addition of water (mechanism expected) - *Cis* and *trans* hydroxylation, permanganate cleavage and ozonolysis.

Alkadienes: Classification into cumulated, conjugated and isolated dienes – Thiele's theory of partial valency - 1,4-addition of 1,3-butadiene – Diels-Alder reaction.

Alkynes: Nomenclature of alkynes and alkenynes – Isomerism – Berthelot's reaction - Preparation from dihalides and acetylides. Chemical properties: Electrophilic addition – Addition of hydrogen using Lindlar's catalyst and Na/liquid ammonia - Addition of halogens and hydrogen halides – Oxymercuration - Ozonolysis - Reaction with chromic acid and $KMnO_4$ - Acidity of 1-alkynes.

Comparison of electrophilic addition rate of alkenes and alkynes. Chemistry of the test for unsaturation: Bromine water, bromine in CCl_4 and Baeyer's reagent.

Module V: Aromatic Hydrocarbons (6 hrs)

Nomenclature and isomerism in substituted benzene, naphthalene and anthracene - Structure and stability of benzene (Kekule, Resonance and Molecular Orbital concepts). Electrophilic substitution reactions in benzene with mechanisms: Halogenation, nitration, sulphonation, Friedel-Craft's alkylation and acylation - Orientation of aromatic substitution – Ring activating and deactivating groups with examples - *ortho*, *para* and *meta* directing groups - Side chain oxidation.

Haworth synthesis of naphthalene – Nitration and sulphonation of naphthalene. Polycyclic arenes as

carcinogens (simple examples only).

Module VI: Aromaticity (3 hrs)

Huckel's (4n+2) rule and its simple applications to benzenoid (benzene, naphthalene and anthracene) and non-benzenoid (furan, pyrrole, pyridine, indole, quinoline, cyclopropenyl cation, tropylium cation, cyclopentadienyl anion and annulenes) systems – Comparison of basicity of (i) pyrrole and pyridine (ii) indole and quinoline - Anti-aromatic compounds.

Text Books

1. L.G. Wade Jr., *Organic Chemistry*, 6th Edition, Pearson Education, New Delhi, 2013.
2. A. Bahl and B.S. Bahl, *Advanced Organic Chemistry*, 1st Multicolour Edition, S. Chand & Company, New Delhi, 2010.
3. K.S. Tewari, N.K. Vishnoi and S.N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edition, Vikas Publishing House (Pvt.) Ltd., New Delhi, 2004.
4. C.N. Pillai, *Organic Chemistry for Undergraduates*, 1st Edition, University Press, Hyderabad, 2008.
5. S.C. Sharma and M.K. Jain, *Modern Organic Chemistry*, Vishal Publishing Company, New Delhi, 2014.
6. P.S. Kalsi, *Organic Reactions, Stereochemistry and Mechanism*, 4th Edition, New Age International Publishers, New Delhi, 2006.

References

1. J. Clayden, N. Greeves and S. Warren, *Organic Chemistry*, 2nd Edition, Oxford University Press, New York, 2012.
2. D. Nasipuri, *Stereochemistry of Organic Compounds: Principles and Applications*, 3rd Edition, New Age International Publishers, New Delhi, 2011.
3. E.L. Eliel, *Stereochemistry of Carbon Compounds*, Tata McGraw Hill Publishing Company Ltd, New Delhi, 1992.
4. V.K. Ahluvaliya, *Organic Reaction Mechanisms*, 3rd Edition, Narosa Publishing House, New Delhi, 2007.
5. M.S. Singh, *Advanced Organic Chemistry: Reactions and Mechanisms*, Pearson Education, New Delhi, 2014.
6. Peter Sykes, *A Guide Book to Mechanism in Organic Chemistry*, 6th Edition, Pearson Education, New Delhi, 2013.
7. P.Y. Bruice, *Essential Organic Chemistry*, 1st Edition, Pearson Education, New Delhi, 2013.
8. John McMurry, *Fundamentals of Organic Chemistry*, 5th Edition, Brooks/Cole, Pacific Grove, California, 2002.
9. I.L. Finar, *Organic Chemistry Vol. I*, 5th Edition, Pearson Education, New Delhi, 2013.
10. G.M. Louden, *Organic Chemistry*, 4th Edition, Oxford University Press, New York, 2008.

11. Jerry March, *Advanced Organic Chemistry*, 5th Edition, John Wiley and Sons, New York, 2004.
12. R.T. Morrison, R.N. Boyd, *Organic Chemistry*, 7th Edition, Pearson Education, New Delhi, 2013.

SEMESTER IV

Course Code: CHE4B05(P)

Core Course V: INORGANIC CHEMISTRY PRACTICAL - I

Total Hours: 144; Credits: 4; Hours/Week: 2 (I, II, III & IV Semesters)

General Instructions

1. *Use safety coat, goggles, shoes and gloves in the laboratory.*
2. *For weighing, either electronic balance or chemical balance may be used.*
3. *For titrations double burette titration method must be used. Conventional titration method shall be employed only in those cases where double burette titration method is not possible.*
4. *A minimum number of 21 experiments should be done, covering III to VII modules, to appear for the examination.*
5. *Practical examination will be conducted at the end of 4^{th} semester.*

Module I: Introduction to Volumetric Analysis

1. Weighing using chemical balance and electronic balance.
2. Preparation of standard solutions.

Module II: Technique of Quantitative Dilution

Any five experiments of the following types.

1. Preparation of 100 mL 0.2 M H_2SO_4 from commercial acid.
2. Preparation of 250 mL 0.025 M thiosulphate from 0.1 M thiosulphate.

Module III: Neutralization Titrations

1. Strong acid – strong base titration.
2. Strong acid – weak base titration.
3. Weak acid – strong base titration.
4. Estimation of NH_3 by indirect method.
5. Titration of HCl + CH_3COOH mixture *Vs* NaOH using two different indicators to determine the composition.
6. Estimation of borax: Standard sodium carbonate.

Module IV: Redox Titrations

a) Permanganometry

1. Estimation of oxalic acid.
2. Estimation of Fe^{2+}/$FeSO_4.7H_2O$/Mohr's salt.
3. Estimation of hydrogen peroxide.
4. Estimation of calcium.

b) Dichrometry

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

2. Estimation of Fe^{2+}/$FeSO_4.7H_2O$/Mohr's salt using external indicator.
3. Estimation of ferric iron (after reduction with stannous chloride) using internal indicator.

c) Iodimetry and Iodometry

1. Estimation of iodine.
2. Estimation of copper.
3. Estimation of chromium.

Module V: Precipitation Titration (using adsorption indicator)

1. Estimation of chloride in neutral medium.

Module VI: Complexometric Titrations

1. Estimation of zinc.
2. Estimation of magnesium.
3. Estimation of calcium.
4. Determination of hardness of water.

Module VII: Some Estimations of Practical Importance

1. Determination of acetic acid content in vinegar by titration with NaOH.
2. Determination of alkali content in antacid tablets by titration with HCl.
3. Determination of copper content in brass by iodometric titration.
4. Determination of available chlorine in bleaching powder.
5. Determination of COD of water samples.
6. Estimation of citric acid in lemon or orange.
7. Determination of manganese content in pyrolusite.

References

1. J. Mendham, R.C. Denney, J. D. Barnes and M. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Edition, Pearson Education, Noida, 2013.
2. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, *Fundamentals of Analytical Chemistry*, 8th Edition, Brooks/Cole, Thomson Learning, Inc., USA, 2004.
3. G.D. Christian, *Analytical Chemistry*, 7th Edition, John Wiley and Sons, New York, 2013.
4. A.L. Underwood, *Quantitative Analysis*, 6th Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 1999.
5. D.N. Bajpai, O.P. Pandey and S. Giri, *Practical Chemistry; For I, II & III B. Sc.* Students, S. Chand & Company Ltd, New Delhi, 2012.

SEMESTER V

Course Code: CHE5B06
Core Course VI: INORGANIC CHEMISTRY - III
Total Hours: 54; Credits: 3; Hours/Week: 3

Module I: Analytical Chemistry - II (6 hrs)

Qualitative Analysis: Applications of solubility product and common ion effect in the precipitation of cations – Interfering acid radicals and their elimination (oxalate, fluoride, borate, phosphate, chromate, arsenite and arsenate) - Introduction of micro scale experiments in inorganic and organic qualitative analysis & their advantages.

Gravimetric analysis - Co-precipitation and post precipitation - Accuracy and precision – Classification and minimization of errors - Sampling and its types (elementary idea only).

Module II: Representative Elements - I (9 hrs)

Hydrogen: Position in the periodic table – Isotopes of hydrogen (separation method not needed) – Difference between *ortho* and *para* hydrogen.

Alkali and Alkaline Earth Metals: Comparative study based on electronic configuration, oxidation state, size, density, melting point, boiling point, electrode potential, ionization energy, metallic character, flame colour and hydration enthalpy - Reactivity with oxygen and water – Thermal stability and solubility of sulphates and carbonates – Basicity of hydroxides - Anomalous properties of lithium and beryllium - Diagonal relationship between lithium and magnesium & beryllium and aluminium - Preparation and uses of sodium carbonate and plaster of Paris - Structure of $BeCl_2$.

Boron Family: Electronic configuration, size, melting point, boiling point, density, standard electrode potential, ionization energy, electronegativity and oxidation state - Inert pair effect - Reactivity with water, hydrogen and halogen – Comparison of Lewis acidity of boron halides - Anomalous behavior of boron - Diagonal relationship between boron and silicon - Preparation, properties, structure and uses of diborane, boric acid, borazine and boron nitride – Structure of $AlCl_3$.

Carbon Family: Electronic configuration, catenation, size, melting point, boiling point, density, standard electrode potential, ionization energy, electronegativity and oxidation state - Inert pair effect - Reactivity with water, hydrogen and halogen - Allotropy – Structure and hybridization of diamond and graphite – Fullerenes (mention only) – Amorphous carbon. Anomalous properties of carbon.

Module III: Representative Elements - II (12 hrs)

Nitrogen Family: Electronic configuration, size, ionization energy, electronegativity, oxidation state, atomicity and allotropy - Hydrides (comparison of boiling point, reducing property, basic strength and bond angle) – Structure of oxides N and P - Oxy acids of N and P (structure and acidic strength only) – Anomalous properties of nitrogen - Preparation, properties and uses of ammonia and nitric acid.

Oxygen Family: Electronic configuration, size, ionization energy, electronegativity, oxidation state and atomicity - Hydrides (comparison of boiling point and bond angle) – Structure of SO_2 and SO_3 - Oxy and

peroxy acids of sulphur (structure and acidic strength only) – Anomalous properties of oxygen - Preparation, properties, structure and uses of ozone, hydrogen peroxide and sulphuric acid – Role of selenium in xerography.

Halogens: Electronic configuration, size, electron affinity, standard reduction potential, bond energy, electronegativity and oxidation state - Hydrides (acidic strength, reducing property and boiling point) – Oxy acids of chlorine (structure and acidic strength only) – Structure of ClO_2 – Electropositive character of iodine - Anomalous properties of fluorine - Preparation and uses of hydrochloric acid - General preparation and properties of interhalogen compounds (study of individual members not required) – Structure and hybridization of ClF_3, ICl_3 and IF_5 - Comparison of properties of halogens and pseudohalogens (cyanogen as example) – Structure of polyhalide ions.

Noble Gases: Discovery – Occurrence – Separation by charcoal adsorption method - Structure of oxides, fluorides and oxy fluorides of xenon - Reaction of xenon fluorides with water – Uses of noble gases.

Module IV: Inorganic Polymers & Non-aqueous Solvents (9 hrs)

Inorganic Polymers: Structure and applications of silicones and silicates. Phosphazenes: Preparation, properties and structure of di and tri phosphonitrilic chlorides. SN compounds: Preparation, properties and structure of S_2N_2, S_4N_4 and $(SN)_x$.

Non-aqueous Solvents: Classification - General properties - Self ionization and leveling effect – Reactions in liquid ammonia and liquid SO_2.

Module V: Environmental Pollution (12 hrs)

Air pollution: Major air pollutants - Oxides of carbon, nitrogen and sulphur - Particulates – London smog and photochemical smog. Effects of air pollution: Acid rain, green house effect and depletion of ozone. Control of air pollution - Alternate refrigerants. Bhopal Tragedy (a brief study).

Water pollution: Water pollution due to sewage and domestic wastes – Industrial effluents – Agricultural discharge – Eutrophication. Quality of drinking water - Indian standard and WHO standard. Water quality parameters: DO, BOD and COD – Determination of BOD and COD. Toxic metals in water (Pb, Cd and Hg) - Minamata disaster (a brief study). Control of water pollution - Need for the protection of water bodies.

Thermal pollution, noise pollution and radioactive pollution (Sources, effects and consequences) - Hiroshima, Nagasaki and Chernobyl accidents (a brief study).

Local environmental movements: Silent Valley, Plachimada, Narmada.

Pollution Control Board: Duties and responsibilities.

Module VI: Solid Waste Management (6 hrs)

House hold, municipal and industrial solid waste - Non-degradable, degradable and biodegradable waste – Hazardous waste - Pollution due to plastics. Solid waste management: Recycling, digestion, dumping, incineration, land treatment and composting. Impacts of medical waste and E-waste & their disposal.

Energy production from waste.

Text Books

1. A.I. Vogel, *A Textbook of Quantitative Inorganic Analysis*, 3rd Edition, Longmans, Green, London, 1962.
2. B.R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, 31st Edition, Milestone Publishers and Distributors, New Delhi, 2013.
3. J.D. Lee, *Concise Inorganic Chemistry*, 5th Edition, Oxford University Press, New Delhi 2008.
4. P.L. Soni and Mohan Katyal, *Textbook of Inorganic Chemistry*, 20th Edition, S. Chand and Sons, New Delhi, 2013.
5. R. Gopalan, *Inorganic Chemistry for Undergraduates*, Universities Press, Hyderabad, 2009.
6. S.S. Dara, *A Textbook of Environmental Chemistry and Pollution Control*, 8th Edition, S. Chand and Sons, New Delhi, 2008 (Reprint).
7. B.K. Sharma and H. Kaur, *Environmental Chemistry*, Goel Publishing House, Meerut, 1996.

References

1. J. Mendham. R.C. Denney, J.D. Barnes and M. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Edition, Pearson Education, Noida, 2013.
2. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, *Fundamentals of Analytical Chemistry*, 8th Edition, Brooks/Cole, Thomson Learning, Inc., USA, 2004.
3. J.E. Huheey, E.A. Keitler and R.L. Keitler, *Inorganic Chemistry – Principles of Structure and Reactivity*, 4th Edition, Pearson Education, New Delhi, 2013.
4. B. Doughlas, D.H. McDaniel and J.J. Alexander, *Concepts and Models in Inorganic Chemistry*, 3rd Edition, John Wiley and Sons, New York, 1994.
5. D.F. Shriver and P. Atkins, *Inorganic Chemistry*, 5th Edition, Oxford University Press, New York, 2010.
6. Gary L. Miessler, Paul J. Fischer and Donald A. Tarr, *Inorganic Chemistry*, 5th Edition, Prentice Hall, New Jersey, 2013.
7. Wahid U. Malik, G.D. Tuli and R.D. Madan, *Selected Topics in Inorganic Chemistry*, S. Chand and Co., New Delhi, 2010 (Reprint).
8. Gurudeep Raj, *Advanced Inorganic Chemistry Vol-I*, 33rd Edition, Krishna Prakashan Media (P) Ltd., Meerut, 2014.
9. Gurudeep Raj, *Advanced Inorganic Chemistry Vol-II*, 31st Edition, Krishna Prakashan Media (P) Ltd., Meerut, 2008.
10. A.G. Sharpe and H.J. Emeleus, *Modern Aspects of Inorganic Chemistry*, 4th Edition, UBs Publisher's Distributors Ltd., New Delhi, 2000.
11. A.K. De., *Environmental Chemistry*, 6th Edition, New Age International (P) Ltd., New Delhi, 2006.
12. A.K. Ahluwalia, *Environmental Chemistry*, Ane Books India, New Delhi, 2008.

SEMESTER V

Course Code: CHE5B07
Core Course VII: ORGANIC CHEMISTRY - II
Total Hours: 72; Credits: 3; Hours/Week: 4

Module I: Halogen Compounds (9 hrs)

Nomenclature – Classification - Isomerism. Preparation of alkyl halides: From alcohols, Swarts reaction, Finkelsain reaction and allylic bromination of alkenes. Preparation of aryl halides: From benzene and diazonium salts. Nucleophilic substitution reactions: S_N1 & S_N2 mechanisms - Characteristics and energy profile diagrams - Comparison of rate of alkyl, aryl, allyl and vinyl halides. Elimination reactions: E1 & E2 mechanisms and their characteristics - Saytzeff's rule. Substitution *Vs* elimination. Nucleophilic aromatic substitution reaction with mechanism: Elimination–addition and addition–elimination mechanisms - Benzyne intermediate. Distinction between nuclear and side chain halogenated hydrocarbons. Uses of $CHCl_3$, CHI_3, $CF_3CHClBr$ and CF_2Cl_2 – Uses and health effects of CCl_4.

Module II: Organometallic Compounds (3 hrs)

Preparation and synthetic applications of Grignard reagent, organozinc compounds and organolithium compounds.

Module III: Hydroxy Compounds (12 hrs)

Alcohols: Nomenclature – Classification - Isomerism. Preparation: From alkenes (hydration, hydroboration oxidation and oxymercuration-demercuration reactions) and carbonyl compounds (reduction and with Grignard reagent). Preparation of ethanol from molasses – Preparation of rectified spirit and absolute alcohol - Power alcohol, proof spirit and denatured spirit (mention only). Chemical properties: Reactions involving cleavage of O-H bonds (acidity and esterification), oxidation (with PCC, Collin's reagent, Jone's reagent and $KMnO_4$) and catalytic dehydrogenation - Pinacol–pinacolone rearrangement (mechanism expected) - Chemistry of methanol poisoning – Harmful effects of ethanol in the human body. Test for alcohols: Luca's test and Victor Meyer's test.

Phenols: Nomenclature - Classification. Preparation: From cumene and sulphonic acid. Chemical properties: Acidity (substituent effects), bromination, nitration, sulphonation, Riemer-Tiemann reaction (mechanism expected), Kolbe reaction and Liebermann's nitroso reaction. Distinction between alcohols and phenols. Preparation and applications of phenolphthalein, fluorescein, eosin and alizarin – Reason for the colour change of phenolphthalein with pH. Uses of phenol.

Module IV: Ethers and Epoxides (6 hrs)

Ethers: Nomenclature – Isomerism - Preparation by Williamson's synthesis. Reactions of ethers: Acidic cleavage and Claisen rearrangement (mechanism expected) - Zeisel's method of estimation of methoxy groups. Crown ethers: Nomenclature and importance in organic synthesis.

Epoxides: Nomenclature – Preparation from alkenes – Acid and base catalyzed ring opening reactions.

Module V: Aldehydes and Ketones (9 hrs)

Nomenclature – Isomerism. Preparation: From alcohols, cyanides, acid chlorides, calcium carboxylates and Etard's reaction. Chemical properties: Nucleophilic addition (addition of water, HCN, bisulphite, alcohol and Grignard reagent - Comparison of nucleophilic addition rate of aliphatic and aromatic aldehydes and ketones), addition-elimination reactions (with hydroxyl amine, hydrazines, semicarbazide, ammonia and amines), reduction (Clemmenson, Wolff-Kishner, metal hydride and MPV reductions) and oxidation (with $KMnO_4$, Tollen's reagent, Fehling's solution, Benedict's reagent, bromine water and Oppenauer oxidation) – Acidity of α-hydrogen - Aldol condensation (mechanism expected) – Claisen-Schmidt, Knoevenagel, benzoin and Perkin's reactions - Haloform reaction – Iodoform test. Cannizarro reaction (mechanism expected) and Beckmann rearrangement (mechanism expected). Preparation and uses of vanillin. Distinction between aldehydes and ketones.

Module VI: Carboxylic Acids and Sulphonic Acids (12 hrs)

Carboxylic Acids: Nomenclature – Isomerism. Preparation: Hydrolysis of nitrile and carboxylation of Grignard reagent. Chemical properties: Acidity (effect of substituent on the acidity of aliphatic and aromatic carboxylic acids) - HVZ reaction - Decarboxylation - Kolbe electrolysis (mechanism expected) - Action of heat on dicarboxylic acids – Blanc's rule. Preparation, reactions and uses of oxalic acid, cinnamic acid and citric acid - Role of lactic acid in exercise - Preparation and reactions of acid derivatives (acid chlorides, esters, amides and acid anhydrides) – Comparison of boiling point and reactivity of acid derivatives - Ascend and descend in carboxylic acid series.

Sulphonic Acids: Preparation and properties of benzene sulphonic acid – Tosylation - Synthesis and application of saccharin.

Comparison of acidity of alcohols, phenols, carboxylic acids and sulphonic acids.

Module VII: Nitrogen Compounds (15 hrs)

Nitro Compounds: Nitro-aci tautomerism - Difference between alkyl nitrites and nitro alkanes - Nef's reaction - Reduction products of nitrobenzene in various media – Harmful effects of nitrobenzene in the human body. Explosives: Definition - TNT, nitroglycerine, RDX and ANFO (structural formula and chemistry behind the explosion).

Amines: Nomenclature – Isomerism. Preparation: From alkyl halides, nitro compounds, nitriles, isonitriles and amides - Hofmann's bromamide reaction, Schmidt reaction and Gabriel phthalmide synthesis. Chemical properties: Basicity (effect of substituents on the basicity of aliphatic and aromatic amines), carbylamine reaction, conversion of amine to alkene (Hofmann's elimination with mechanism and stereochemistry), acylation and reaction with nitrous acid. Electrophilic substitution reactions of aniline: Halogenation, nitration and sulphonation. Preparation and uses sulpha drugs – Structural formula of sulphapyridine, sulphadiazine, sulphathiazole and sulphaguanidine. Separation of amines by Hinsberg's method.

Diazonium Salts: Preparation and synthetic applications of benzene diazonium chloride. Preparation of

methyl orange - Reason for its colour change with pH.

Carbonic Acid Derivatives: Preparation and properties of urea and semicarbazide – Estimation of urea (hypobromite method and urease method) - Basicity of guanidine.

Module VIII: Heterocyclic & Active Methylene Compounds (6 hrs)

Heterocyclic Compounds: Classification – Nomenclature - Preparation and properties of furan, pyridine and indole.

Active Methylene Compounds: Examples – Preparation of ethyl acetoacetate by Claisen condensation (mechanism expected) - Tautomerism - Synthetic applications of ethylacetoacetate.

Text Books

1. L.G. Wade Jr., *Organic Chemistry*, 6th Edition, Pearson Education, New Delhi, 2013.
2. A. Bahl and B.S. Bahl, *Advanced Organic Chemistry*, 1st Multicolour Edition, S. Chand & Company, New Delhi, 2010.
3. K.S. Tewari, N.K. Vishnoi and S.N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edition, Vikas Publishing House (Pvt.) Ltd., New Delhi, 2004.
4. C.N. Pillai, *Organic Chemistry for Undergraduates*, 1st Edition, University Press, Hyderabad, 2008.
5. S.C. Sharma and M.K. Jain, *Modern Organic Chemistry*, Vishal Publishing Company, New Delhi, 2014.

References

1. J. Clayden, N. Greeves and S. Warren, *Organic Chemistry*, 2nd Edition, Oxford University Press, New York, 2012.
2. P.Y. Bruice, *Essential Organic Chemistry*, 1st Edition, Pearson Education, New Delhi, 2013.
3. V.K. Ahluwaliya, *Organic Reaction Mechanisms*, 4th Edition, Narosa Publishing House, New Delhi, 2013 (Reprint).
4. John McMurry, *Fundamentals of Organic Chemistry*, 5th Edition, Brooks/Cole, Pacific Grove, California, 2002.
5. I.L. Finar, *Organic Chemistry Vol. I*, 5th Edition, Pearson Education, New Delhi, 2013.
6. G.M. Louden, *Organic Chemistry*, 4th Edition, Oxford University Press, New York, 2008.
7. Jerry March, *Advanced Organic Chemistry*, 5th Edition, John Wiley and Sons, New York, 2004.
8. R.T. Morrison, R.N. Boyd, *Organic Chemistry*, 7th Edition, Pearson Education, New Delhi, 2013.
9. T.L. Gilchrist, *Heterocyclic Chemistry*, 3rd Edition, Pearson Education, New Delhi, 1997.

SEMESTER V

Course Code: CHE5B08
Core Course VIII: PHYSICAL CHEMISTRY - II
Total Hours: 72; Credits: 3; Hours/Week: 4

Module I: Kinetics & Catalysis (12 hrs)

Kinetics: Chemical kinetics and its scope - Rate of a reaction - Factors influencing the rate of a reaction - Rate law - Order and molecularity - Derivation of rate constants for first, second (with same and different reactants), third (with same reactants only) and zero order reactions with examples (graphical representations needed) - Half life period (derivation for first and n^{th} order reactions) - Methods to determine the order of a reaction - Steady state approximation - Parallel reactions, opposing reactions, consecutive reactions and chain reactions with examples (elementary idea only) - Effect of temperature on reaction rates - Arrhenius equation - Determination and significance of Arrhenius parameters - Theories of reaction rates - Collision theory - Derivation of rate equation for bimolecular reactions using collision theory - Transition state theory - Expression for rate constant based on equilibrium constant and thermodynamic aspects (derivation not required) - Unimolecular reactions - Lindemann mechanism.

Catalysis: Homogeneous and heterogenous catalysis - Theories of homogenous and heterogenous catalysis - Enzyme catalysis - Michaelis-Menten equation (derivation not required).

Module II: Photochemistry (6 hrs)

Introduction - Difference between thermal and photochemical processes - Beer Lambert's law. Laws of photochemistry: Grothus-Draper law and Stark-Einstein's law of photochemical equivalence. Quantum yield and its explanation – Photosynthesis - Photochemical hydrogen-chlorine and hydrogen-bromine reactions. Photophysical processes: Jablonski diagram – Fluorescence – Phosphorescence. Non-radiative processes: Internal conversion and inter system crossing. Photosensitization – Chemiluminescence. Chemistry of vision.

Module III: Adsorption & Colloids (9 hrs)

Adsorption: Introduction - Difference between adsorption and absorption - Chemisorption and physisorption - Factors affecting adsorption. Adsorption isotherms: Freundlich and Langmuir isotherms (derivation required) - Multilayer adsorption - BET equation (derivation not needed) and its applications to surface area measurements. Applications of adsorption.

Colloids: Types and classification - Preparation and purification of colloids - Kinetic, optical and electrical properties of colloids - Protective colloids - Gold number - Hardy-Schulze rule. Emulsions and gels: Properties and applications – Surfactants. Electrical double layer - Zeta potential - Donnan membrane equilibrium - Dorn effect – Applications of colloids.

Module IV: Phase Equilibria (9 hrs)

Introduction - Phase, component and degree of freedom - Gibbs phase rule and its derivation. One component systems: Water and sulphur systems. Two component systems: Simple eutectic system (lead-silver system) - Pattinson's process - Two component systems involving formation of compounds with congruent melting points (zinc-magnesium system and ferric chloride-water system) - Two component systems involving formation of compounds with incongruent melting points (sodium sulphate-water system). Freezing mixtures - Thermal analysis – Cooling curve method - Deliquescence and efflorescence.

Liquid-liquid equilibria - Partially miscible and immiscible liquid systems – CST - Upper CST and lower CST - Steam distillation. Nernst distribution law: Derivation and applications.

Module V: Chromatography (9 hrs)

Introduction – Definition – Classification - Principles and applications of column chromatography, thin layer chromatography, paper chromatography, ion exchange chromatography, gel permeation chromatography, gas chromatography and high performance liquid chromatography - Rf values.

Module VI: Spectroscopy (18 hrs)

Interaction of electromagnetic radiation with matter - Energy levels in molecules - Born-Oppenheimer approximation.

Rotational Spectroscopy: Introduction - Rigid rotor - Expression for energy - Selection rules - Intensities of spectral lines - Determination of bond lengths of diatomic molecules.

Vibrational Spectroscopy: Simple harmonic oscillator – Energy levels - Force constant - Selection rules – Anharmonicity - Fundamental frequencies – Overtones – Fingerprint region - Group frequency concept - Degree of freedom for polyatomic molecules - Modes of vibrations of CO_2 and H_2O.

Raman Spectroscopy: Basic principles – Qualitative treatment of rotational Raman effect - Vibrational Raman spectra - Stokes & anti-stokes lines and their intensity difference - Selection rules - Mutual exclusion principle.

Electronic Spectroscopy: Basic principles - Frank-Condon principle - Electronic transitions - Singlet and triplet states - Dissociation energy of diatomic molecules – Chromophore and auxochrome - Bathochromic and hypsochromic shifts.

Nuclear Magnetic Resonance (NMR) Spectroscopy: Proton NMR and ^{13}C NMR – Principle - Number and position of signals - Chemical shift - Intensity of signals - Different scales – Spin-spin coupling.

Electron Spin Resonance (ESR) Spectroscopy: Principle - Hyperfine structure - ESR of methyl, phenyl and cycloheptatrienyl radicals.

Module VII: Molecular Symmetry and Group Theory (9 hrs)

Elements of symmetry of molecules – Identity, proper axis of rotation, reflection plane, inversion centre and improper axis of rotation – Schonflies notation – Combinations of symmetry operations – Mathematical group – Point group classification of simple molecules – Cnv, Cnh, Dnh. Group

multiplication table for C2v, C3v and C2h

Text Books

1. B.R. Puri, L.R. Sharma and M.S. Pathania, *Principles of Physical Chemistry*, 46th Edition, Vishal Publishing Company, New Delhi, 2013.
2. F. Daniels and R.A. Alberty, *Physical Chemistry*, 5th Edition, John Wiley & Sons, Canada, 1980.
3. Gurdeep Raj, *Advanced Physical Chemistry*, 35th Edition, Goel Publishing House, Meerut, 2009.
4. S. Glasstone and D.H. Lewis, *Elements of Physical Chemistry*, 2nd Edition, MacMillan & Company, UK, 1962.
5. J. Rajaram and J.C. Kuriacose, *Kinetics and Mechanism of Chemical Transformation*, 1st Edition, Macmillan India Ltd., New Delhi, 1993.
6. G.H. Jeffery, J. Bassett, J. Mendham and R.C. Denney, *Vogel's Textbook of Quantitative Chemical Analysis*, 5th Edition, John Wiley & Sons, Inc., New York, 1989.
7. C.N. Banwell and E.M. McCash, *Fundamentals* of *Molecular Spectroscopy*, 4th Edition, McGraw–Hill Publishing Company Limited, New Delhi, 2002.
8. Gurudeep R. Chatwal and Sham K. Anand, *Spectroscopy: Atomic and Molecular*, 5th Edition, Himalaya Publishing House, New Delhi, 2013.
9. K. Veera Reddy, *Symmetry & Spectroscopy of Molecules*, 2nd Edition, New Age International, New Delhi, 2009.

References

1. K. Laidler, *Chemical Kinetics*, 3rd Edition, Pearson Education, New Delhi, 2004.
2. K.K. Sharma and L.K. Sharma, *A Textbook of Physical Chemistry*, 5th Edition, Vikas Publishing House, New Delhi, 2012.
3. K.L. Kapoor, *Physical Chemistry Vol. 3&5*, Macmillan Publishers, Noida, 2004.
4. G.K. Vemula Palli, *Physical Chemistry*, Prentice Hall of India, New Delhi, 1997.
5. P.W. Atkins, *Physical Chemistry*, 8th Edition, Oxford University Press, New Delhi, 2006.
6. G.M. Barrow, *Physical Chemistry*, 5th Edition, McGraw Hill, London, 1992.
7. W.J. Moore, *Physical Chemistry*, 5th Edition, Orient Longman, London, 1999.
8. N. Kundu and S.K. Jain, *Physical Chemistry*, S. Chand & Company, New Delhi, 1999.
9. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, *Fundamentals of Analytical Chemistry*, 8th Edition, Brooks/Cole, Thomson Learning, Inc., USA, 2004.
10. B.K. Sharma, *Instrumental Methods of Chemical Analysis*, 24th Edition, Geol Publishing House, Meerut, 2005.
11. G.M. Barrow, *Introduction to Molecular Spectroscopy*, McGraw Hill, London, 1962.
12. P.R. Singh and S.K. Dixit, *Molecular Spectroscopy: Principles and Chemical Applications*, S. Chand & Company, New Delhi 1980.

13. P.K. Bhattacharya, *Group Theory and its Chemical Applications*, Himalaya Publishing House, New Delhi, 1986.

14. F.A. Cotton, *Chemical Applications of Group Theory*, 3rd Edition, John Wiley & Sons, New York, 1990.

SEMESTER VI

Course Code: CHE6B09
Core Course IX: INORGANIC CHEMISTRY - IV
Total Hours: 54; Credits: 3; Hours/Week: 3

Module I: Metallurgy (12 hrs)

Occurrence of metals based on standard electrode potential – Concentration of ores – Calcination and roasting - Reduction to free metal – Electrometallurgy – Hydrometallurgy. Refining of metals: Electrolytic refining, ion exchange method, zone refining, vapour phase refining and oxidative refining - Ellingham diagrams for metal oxides - Extractive metallurgy of Al, Fe, Ni, Cu and Ti. Alloys: Definition - Composition and uses of german silver, brass, bronze, gunmetal and alnico. Steel: Open hearth process – Classification of steel – Composition and uses of alloy steels - Intramedullary rods (a brief study).

Module II: Transition and Inner Transition Elements (12 hrs)

Transition Metals: General characteristics: Metallic character, oxidation states, size, density, melting points, boiling points, ionization energy, colour, magnetic properties, reducing properties, catalytic properties, non-stoichiometric compounds, complex formation and alloy formation. Difference between first row and other two rows. Preparation, properties, structure and uses of $KMnO_4$ and $K_2Cr_2O_7$.

Lanthanides: Electronic configuration and general characteristics – Occurrence of lanthanides - Importance of beach sands of Kerala – Isolation of lanthanides from monazite sand - Separation by ion exchange method. Lanthanide contraction: Causes and consequences. Industrial importance of lanthanides.

Actinides: Electronic configuration and general characteristics – Comparison with lanthanides.

Module III: Coordination Chemistry (18 hrs)

Introduction - Types of ligands – Anionic, cationic and neutral complexes – IUPAC Nomenclature - Structural and stereo isomerism in coordination compounds.

Bonding theories: Review of Werner's theory and Sidgwick's concept of coordination – EAN rule - Valence bond theory - Geometries of coordination numbers 4 and 6 – Limitations of VBT. Crystal filed theory - Splitting of *d*-orbitals in octahedral, tetrahedral, tetragonal and square planar complexes – Factors affecting crystal field splitting - CFSE of low spin and high spin octahedral complexes - Spectrochemical series - Explanation of geometry, magnetism and colour - Merits and demerits of Crystal field theory. Molecular orbital theory for octahedral complexes (with sigma bonds only).

Stability of complexes: Inert and labile complexes - Factors influencing stability.

Application of complexes in qualitative and quantitative analysis.

Module IV: Organometallic Compounds (6 hrs)

Definition – Classification based on the nature of metal-carbon bond – Zeise's salt - Metal carbonyls – 18 electron rule – Mononuclear and polynuclear carbonyls of Fe, Co and Ni (structure only) – Bonding in metal carbonyls. Ferrocene: Preparation, properties and bonding (VBT only). Zeigler Natta catalyst in the polymerization of alkene and Wilkinson catalyst in the hydrogenation of alkene (mechanism not expected).

Module V: Bioinorganic Chemistry (6 hrs)

Metal ions in biological system – Trace and bulk metal ions – Haemoglobin and myoglobin (elementary idea of structure and oxygen binding mechanism) – Chlorophyll and photosynthesis (mechanism not expected) - Sodium–potassium pump – Biochemistry of Ca, Zn and Co - Toxicity of metal ions (Pb, Hg and As). Anticancer drugs: *Cis*-platin, oxaliplatin and carboplatin – Structure and significance.

Text books

1. B.R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, 31st Edition, Milestone Publishers and Distributors, New Delhi, 2013.
2. P.L. Soni and Mohan Katyal, *Textbook of Inorganic Chemistry*, 20th Edition, S. Chand and Sons, New Delhi, 2013.
3. Satya Prakash, *Advanced Inorganic Chemistry, Volume 2*, S. Chand and Sons, New Delhi, 2005.
4. J.D. Lee, *Concise Inorganic Chemistry*, 5th Edition, Oxford University Press, New Delhi 2008.
5. R. Gopalan, *Inorganic Chemistry for Undergraduates*, Universities Press, Hyderabad, 2009.
6. R. Gopalan and V. Ramalingam, *Concise Coordination Chemistry*, 1st Edition, Vikas Publishing House, New Delhi, 2001.
7. Wahid U. Malik, G.D. Tuli and R.D. Madan, *Selected Topics in Inorganic Chemistry*, S. Chand and Co., New Delhi, 2010 (Reprint).

References

1. F.A. Cotton and G. Wilkinson, *Advanced Inorganic Chemistry*, 6th Edition, Wiley India Pvt. Ltd., New Delhi, 2009 (Reprint).
2. J.E. Huheey, E.A. Keitler and R.L. Keitler, *Inorganic Chemistry – Principles of Structure and Reactivity*, 4th Edition, Pearson Education, New Delhi, 2013.
3. D.F. Shriver and P. Atkins, *Inorganic Chemistry*, 5th Edition, Oxford University Press, New York, 2010.
4. Gary L. Miessler, Paul J. Fischer and Donald A. Tarr, *Inorganic Chemistry*, 5th Edition, Prentice Hall, New Jersey, 2013.
5. Gurudeep Raj, *Advanced Inorganic Chemistry Vol-I*, 33rd Edition, Krishna Prakashan Media (P) Ltd., Meerut, 2014.
6. Gurudeep Raj, *Advanced Inorganic Chemistry Vol-II*, 31st Edition, Krishna Prakashan Media (P) Ltd., Meerut, 2008.
7. F. Basolo and R.C. Johnson, *Coordination Chemistry*, 2nd Edition, Science Reviews,

Wilmington, DE, 1986.

8. P. Powell, *Principles of Organometallic Compounds*, 2nd Edition, Chapman and Hall, London, 1988.

SEMESTER VI

Course Code: CHE6B10
Core Course X: ORGANIC CHEMISTRY - III
Total Hours: 54; Credits: 3; Hours/Week: 3

Module I: Structure Elucidation Using Spectral Data (9 hrs)

Application of spectral techniques in the structural elucidation of organic compounds.

UV-Vis: λ_{max} calculation for dienes and α,β unsaturated carbonyl compounds - UV spectra of butadiene, acetone, methyl vinyl ketone and benzene.

IR: Concept of group frequencies - IR spectra of alcohols, phenols, amines, ethers, aldehydes, ketones, carboxylic acids, esters and amides.

^{1}H NMR: Chemical shift – Spin-spin splitting - PMR spectra of $CHBr_2CH_2Br$, ethyl alcohol, acetaldehyde, acetone, propanoic acid and toluene.

Module II: Carbohydrates (9 hrs)

Classification. Monosaccharides: Cyclic structure of ribose, glucose and fructose – Epimers and anomeres - Mutarotation – Reactions of glucose - Killiani-Fischer synthesis and Ruff degradation – Conversion of aldoses to ketoses and vice versa – Osazone formation. Disaccharides: Cyclic structure of maltose, lactose and sucrose – Inversion of cane sugar. Reducing and non-reducing sugars. Polysaccharides: Structure of cellulose, starch and glycogen (structure elucidation not required). Test for carbohydrates: Chemistry of Tollen's test, Fehling's test, Benedict's test, test with NaOH and Molisch test – Tests for urine sugar and blood sugar. Applications of carbohydrates.

Module III: Proteins (9 hrs)

Classification of amino acids – Structure of amino acids - Zwitter ion formation - Isoelectric point. Synthesis of amino acids: Strecker synthesis and amino malonate synthesis. Peptides and polypeptides.

Structure determination of peptides: Edmann degradation and Sanger's methods. Peptide synthesis: Solid phase synthesis. Classification of proteins - Primary, secondary, tertiary and quaternary structure of proteins. Denaturation of proteins: Definition, reason and examples. Enzymes: Characteristics and examples. Tests for proteins: Chemistry of Xanthoproteic test, Biuret test, Hopkins-Cole test, Millon's test and Ninhydrin test.

Module IV: Lipids, Steroids, Vitamins & Hormones (9 hrs)

Lipids: Classification - Fats and oils – Saponification number – Iodine number – Hydrogenation and drying of oils & their applications. Waxes: Structure, examples and uses. Phospholipids: Structure of Lecithin. Derived lipids. Biological functions of lipids.

Steroids: Classification - Cholesterol and sex hormones (structure and biological functions only) - Elementary idea of HDL and LDL – Cholesterol and heart attack – Anabolic steroids and their abuse

(elementary idea only) – Structure of Methandrostenolone - Doping in sports (a brief study).

Vitamins: Classification – Source and deficiency diseases - Structure of vitamin A, vitamin B_3, vitamin B_6 and vitamin C.

Hormones: Peptide hormones, amine hormones and steroid hormones (name, organ of secretion and biological functions, structures not required).

Note: Structural elucidation not expected in any case.

Module V: Nucleic acids, Alkaloids and Terpenes (12 hrs)

Nucleic acids: Structures of pentose sugar (open and cyclic structures of ribose and deoxy ribose), nitrogenous bases, nucleosides and nucleotides – Double helical structure of DNA – DNA replication and protein synthesis – Difference between DNA & RNA – DNA finger printing and its applications.

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

Terpenes: Classification – Isoprene rule – Essential oils - Isolation of essential oils by steam distillation and Enfleurage process – Uses of lemongrass oil, eucalyptus oil and sandalwood oil – Isolation of terpenes from essential oils (elementary idea) - Source, structure and uses of citral, geraniol, limonene and menthol. Structure of natural rubber – Vulcanization and its advantages.

Note: Structural elucidation not expected in any case.

Module VI: Pericyclic Reactions (6 hrs)

Introduction – Molecular orbitals of conjugated π systems (C_2, C_3, C_4, C_5 and C_6 systems). Types of pericyclic reactions. Electrocyclic reactions: Butadiene-cyclobutene and hexatriene-cyclohexadiene interconversions. Cycloaddition reactions: Dimerisation of ethylene and Diel's-Alder reaction. Sigmatropic reactions: [1,3], [1,5] and [3,3] rearrangements. FMO explanations for the above reactions. Pericyclic reactions in human body – Vitamin D from cholesterol (elementary idea).

Text Books

1. I.L. Finar, *Organic Chemistry Vol. II*, 5th Edition, Pearson Education, New Delhi, 2013.
2. R.M. Silverstein and F.X. Webster, *Spectrometric Identification of Organic Compounds*, 6th Edition, John Wiley and Sons, New York, 2004.
3. Y.R. Sharma, *Elementary Organic Spectroscopy*, 4th Edition, S. Chand & Company Ltd., New Delhi, 1012 (Reprint).
4. P.Y. Bruice, *Essential Organic Chemistry*, 1st Edition, Pearson Education, New Delhi, 2013.
5. A. Bahl and B.S. Bahl, *Advanced Organic Chemistry*, 1st Multicolour Edition, S. Chand & Company, New Delhi, 2010.
6. K.S. Tewari, N.K. Vishnoi and S.N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edition,

Vikas Publishing House (Pvt.) Ltd., New Delhi, 2004.

7. C.N. Pillai, *Organic Chemistry for Undergraduates*, 1st Edition, University Press, Hyderabad, 2008.

8. S.C. Sharma and M.K. Jain, *Modern Organic Chemistry*, Vishal Publishing Company, New Delhi, 2014.

9. Jagdamba Singh and Jaya Singh, *Photochemistry and Pericyclic Reactions*, 3rd Edition, New Age Science Ltd., New Delhi, 2009.

References

1. L.G. Wade Jr., *Organic Chemistry*, 6th Edition, Pearson Education, New Delhi, 2013.
2. P.S. Kalsi, *Applications of Spectroscopic Techniques in Organic Chemistry***,** 6th Edition, New Age International (P) Ltd., New Delhi, 2004.
3. William Kemp, *Organic Spectroscopy*, 2nd Edition, Macmillan, New York, 1987.
4. J. Clayden, N. Greeves and S. Warren, *Organic Chemistry*, 2nd Edition, Oxford University Press, New York, 2012.
5. John McMurry, *Fundamentals of Organic Chemistry*, 5th Edition, Brooks/Cole, Pacific Grove, California, 2002.
6. O.P. Agarwal, *Chemistry of Organic Natural Products Vol. I*, 40th Edition, Krishna Prakashan Media Pvt. Ltd., Meerut, 2010.
7. O.P. Agarwal, *Chemistry of Organic Natural Products Vol. II*, 38th Edition, Krishna Prakashan Media Pvt. Ltd., Meerut, 2010.

SEMESTER VI

Course Code: CHE6B11
Core Course XI: PHYSICAL CHEMISTRY - III
Total Hours: 54; Credits: 3; Hours/Week: 3

Module I: Electrochemistry – I (12 hrs)

Faraday's laws and applications – Conductance - Specific conductance, molar conductance and equivalent conductance - Measurement of equivalent conductance - Variation of conductance with dilution - Migration of ions and Kohlrausch's law - Arrhenius theory of electrolyte dissociation and its limitations - Weak and strong electrolytes - Ostwald's dilution law, its uses and limitations - Debye-Huckel-Onsager's equation for strong electrolytes (elementary treatment only) - Debye-Falkenhagen and Wein effects - Transport number and its determination by Hittorf's and moving boundary methods.

Applications of conductivity measurements: Determination of degree of dissociation, ionic product of water and solubility product of sparingly soluble salts - Conductometric titrations.

Module II: Electrochemistry – II (15 hrs)

Galvanic cells - Reversible cells - Reversible electrodes - Types of reversible electrodes - Reference electrodes - Standard hydrogen electrode, calomel electrode and quinhydrone electrode - Standard electrode potential - Electrochemical series - Nernst equation for electrode potential and EMF of a cell - Relationship between free energy and electrical energy - Gibbs Helmholtz equation to galvanic cells. Concentration cells: Concentration cells with and without transference - Liquid junction potential. Application of EMF measurements: Solubility of sparingly soluble salts - Determination of pH - pH measurement using glass electrode - Potentiometric titrations - Hydrogen-oxygen fuel cell - Electrochemical theory of corrosion of metals.

Module III: Ionic Equilibria (6 hrs)

Theories of acids and bases: Arrhenius, Lowry-Bronsted and Lewis theories – Levelling and differentiating solvents – pKa, pKb and pH - Applications of common ion effect and solubility product – Hydrolysis of salts of all types – Degree of hydrolysis - Hydrolysis constant and its relation with k_w. Buffer solutions – Mechanism of buffer action - Buffer index – Henderson equation – Applications of buffers.

Module IV: Solutions (6 hrs)

Kinds of solutions - Solubility of gases in liquids – Henry's law and its applications - Raoult's law - Ideal and non ideal solutions - Dilute solutions - Colligative properties - Qualitative treatment of colligative properties - Relative lowering of vapour pressure - Elevation of boiling point - Depression in freezing point - Osmotic pressure - Reverse osmosis and its applications - Application of colligative properties in finding molecular weights (thermodynamic derivation not needed) - Abnormal molecular mass – Van't Hoff factor.

Module V: Solid State – I (12 hrs)

Nature of solid state – Amorphous and crystalline solids - Law of constancy of interfacial angles - Law of rational indices - Space lattice and unit cell - Miller indices - Seven crystal systems and fourteen Bravais lattices - X-ray diffraction - Bragg's law (derivation required) - Simple account of rotating crystal method and powder pattern method - Analysis of powder patterns of NaCl, CsCl and KCl - Simple, face centered and body centered cubic systems - Identification of cubic crystals from inter-planar ratio - Close packing of spheres - Structure of simple ionic compounds of the type AB (NaCl and CsCl) and AB_2 (CaF_2).

Module VI: Solid State – II (3 hrs)

Defects in crystals. Stoichiometric defects: Schottky and Frenkel defects. Non-stoichiometric defects: Metal excess, deficiency and impurity defects. Semi conductors: Intrinsic and extrinsic conduction (elementary idea). Liquid crystals: Classification and applications (elementary idea).

Text Books

1. B.R. Puri, L.R. Sharma and M.S. Pathania, *Principles of Physical Chemistry*, 46th Edition, Vishal Publishing Company, New Delhi, 2013.
2. P.L. Soni, O.P. Dharmarha and U.N. Dash, *Textbook of Physical Chemistry*, 23rd Edition, Sultan Chand & Sons, New Delhi, 2011.
3. S. Glasstone, *An Introduction to Electrochemistry*, East-West Press Pvt. Ltd., New Delhi, 2007 (Reprint).
4. Gurdeep Raj, *Advanced Physical Chemistry*, 35th Edition, Goel Publishing House, Meerut, 2009.
5. S. Glasstone and D.H. Lewis, *Elements of Physical Chemistry*, 2nd Edition, Macmillan & Company, New York, 1962.
6. C.N.R. Rao and J. Gopalakrishnan, *New Directions in Solid State Chemistry*, 2nd Edition, Cambridge University Press, Cambridge, 1997.

References

1. J. Bockris, O'M and A.K.N. Reddy, *Modern Electrochemistry*, Kluwer Academic/Plenum Publishers, New York, 2000.
2. K.K. Sharma and L.K. Sharma, *A Textbook of Physical Chemistry*, 5th Edition, Vikas Publishing House, New Delhi, 2012.
3. K.L. Kapoor, *Physical Chemistry*, Macmillan Publishers, Noida, 2004.
4. G.K. Vemula Palli, *Physical Chemistry*, Prentice Hall of India, New Delhi, 1997.
5. P.W. Atkins, *Physical Chemistry*, 8th Edition, Oxford University Press, New Delhi, 2006.
6. G.M. Barrow, *Physical Chemistry*, 5th Edition, McGraw Hill, London, 1992.
7. W.J. Moore, *Physical Chemistry*, 5th Edition, Orient Longman, London, 1999.
8. S.H. Maron and C.F. Pruton, *Principles of Physical Chemistry*, Macmillan Company, New York, 1968.
9. F. Daniels and R.A. Alberty, *Physical Chemistry*, 5th Edition, John Wiley and Sons, Canada, 1980.

B. Sc. CHEMISTRY - SEMESTER V1

Course Code: CHE6B12

Core Course XII: ADVANCED AND APPLIED CHEMISTRY

Total Hours: 54; Credits: 3; Hours/Week: 3

Module I: Nanochemistry (6 hrs)

Historical introduction to nanochemistry - Nanosize domain - Classification of nanomaterials (0D, 1D and 2D) - Size dependence of material properties - Surface area to volume ratio and its significance - Variation in electronic and optical properties. Introduction to metal nanoparticles (gold, silver and platinum nanoparticles), semiconductor nanoparticles or quantum dots (CdS and CdSe nanoparticles) and metal oxide nanoparticles (zinc oxide, iron oxide, silica and titania nanoparticles). Carbon nanostructures: Fullerenes, carbon nanotubes and graphene (elementary idea only). Applications of nanomaterials in electronics, optics, catalysis, medicine and in environment related issues (detailed discussion not required).

Module II: New Vistas in Chemistry (12 hrs)

Green Chemistry: Introduction - Environmental concern on chemical industry and need of green chemistry – Origin of green chemistry – Twelve principles of green chemistry with explanations - Atom economy and microwave assisted reactions - Green solvents - Green synthesis of ibuprofen. Microwave and ultrasound assisted green synthesis: Aldol condensation, Diels-Alder reaction and Williamson's synthesis.

Supramolecular Chemistry: Introduction – Concepts of primary and secondary structures with examples (structures of protein and DNA) - Molecular recognition - Host-guest interactions - Types of noncovalent interactions.

Combinatorial Chemistry: Introduction – Combinatorial synthesis (elementary idea only). Applications of combinatorial synthesis in drug discovery (brief study).

General Introduction to Computers: Operating systems and programming languages (basic idea only).

Conceptual Background of Molecular Modeling: Molecular mechanic (force field) and molecular orbital (*ab initio* and semi-empirical) methods for molecular geometry optimization and computation of basic molecular properties (elementary idea only).

Module III: Renewable energy Sources (3 hrs)

Renewable energy source: Energy source, availability, various forms of energy, renewable and conventional energy systems, comparison, Renewable energy sources- solar energy, nature of solar radiation, components – principle of solar cell

Module IV: Synthetic Polymers (6 hrs)

Classification - Tacticity – Monomers, structural formula and applications of addition polymers (polyethene, polystyrene, PVC, teflon, PAN, PMMA, polyacetylene, Buna S, Buna N and neoprene) and condensation polymers (nylon 66, nylon 6, bakelite, melmac, terylene, kevlar, lexan and nomex) - Advantages of Ziegler Natta polymerization (mechanism not expected) - Plastic identification codes. Biodegradable polymers: PGA, PLA and PHBV.

Module V: Applied Inorganic Chemistry (9 hrs)

Cement (manufacture, composition and setting) - Glass (manufacture, annealing, types of glasses and uses) - Refractory materials (borides and carbides) - Inorganic fertilizers - Essential nutrients for plants - Nitrogenous, phosphatic and potash fertilizers - Rocket propellants (classification with examples) - Composition and health effect of toothpaste and talcum powder. Chemical industries in Kerala: Location, raw materials, chemistry involved in the preparation and uses of the following.

Fertilizers and Chemicals Travancore Ltd.: Ammonium sulphate.

Travancore Cochin Chemicals Ltd.: Caustic soda and chlorine.

Malabar Cements Ltd.: Cement.

Steel Complex Ltd.: Various grades of steel billets.

Travancore Titanium Products Ltd.: Titanium dioxide pigment from ilmenite.

Module VI: Applied Organic Chemistry – I (9 hrs)

Petroleum: Carbon range and uses of various fractions of petroleum distillation – Petrol Knocking - Octane number – Anti-knocking compounds – Diesel oil - Cetane number – Flash point – Composition and uses of LPG and CNG.

Pharmaceuticals: Medicinal chemistry - Drugs (chemical, generic and trade names with examples). Terminology: Prodrug, pharmacy, pharmacology, pharmacophore, pharmacognosy, pharmacodynamics and pharmacokinetics (elementary idea only). Antipyretics, analgesics, antacids, antihistamines, antibiotics, antiseptics, disinfectants, anesthetics, narcotics, tranquilizers, antidepressants and psychedelic drugs (definition and examples, structures not expected) - Preparation of paracetamol and aspirin.

Cleansing Agents: Soaps and detergents: Preparation, classification, advantages and disadvantages – TFM - Cleaning action – Composition of shaving creams. Shampoos: Ingredients and functions. Different kinds of shampoos: Anti-dandruff, anti-lice, herbal and baby shampoos. Health effects of shampoos.

Pesticides: Insecticides, herbicides, rodenticides and fungicides (definition and examples) Structure of Endosulfan, DDT and BHC - Harmful effects of pesticides. Endosulfan disaster in Kerala (brief study).

Module VII: Applied Organic Chemistry – II (9 hrs)

Dyes: Definition - Requirements of a dye - Theories of colour and chemical constitution Classification based on structure and mode of application to the fabric - Preparation and uses of Rosaniline and Indigo.

Cosmetics: Chemicals used in and health effects of hair dye, perfumes, antiperspirants, cleansing creams (cold creams, vanishing creams and bleach creams), sun screen preparations, UV absorbers, skin bleaching agents, depilatories, nail polishes, lipsticks and eye liners – Turmeric and Neem preparations - Vitamin oil. Harmful effects of cosmetics.

Food Chemistry: Common food adulterants in various food materials and their identification: Milk, vegetable oils, tea, coffee powder, rice and chilly powder. Methods of preservation: Drying, pasteurization, refrigeration, vacuum packing, use of salt and pickling. Food additives: Food preservatives, artificial sweeteners and antioxidants (definition and examples, structures not required) - Structure of BHT, BHA and Ajinomoto – Common permitted and non-permitted food colours (structures not required) – Artificial ripening of fruits and its health effects. Modern food: Definition and health effects of fast foods, instant foods, dehydrated foods, junk foods and condiments - Composition and health effects of chocolates and soft drinks. Harmful effects of modern food habits. Natural food:Composition and advantages of milk - Importance of regional and seasonal fruits – Composition, importance and medical uses of coconut water and Neera - Advantages of traditional Kerala foods.

Text Books

1. M.A. Shah and Tokeer Ahmad, *Principles of Nanoscience and Nanotechnology*, Narosa Publishing House, New Delhi, 2010.

2. V.K. Ahluwaliya, *Green Chemistry*, Narosa Publishing House, New Delhi, 2011.

3. P.S. Kalsi and J.P. Kalsi, *Bioorganic, Bioinorganic and Supramolecular Chemistry*, 1st Edition, New Age International Publishers (P) Ltd., New Delhi, 2007.

4. W. Bannwarth and B. Hinzen, *Combinatorial Chemistry - From Theory to Application*, 2nd

Edition, Wiley-VCH, 2006.
5. E. Joseph Billo, *Excel for Chemists - A Comprehensive Guide,* 3rd Edition, John Wiley & Sons,Inc., Hoboken, New Jersey, 2011.
6. Andrew R. Leach, *Molecular Modelling: Principles and Applications*, 2nd Edition Prentice Hall, 2001.
7. V.R. Gowarikar, *Polymer Chemistry*, New Age International (P) Ltd., New Delhi, 2010.
8. B.R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry,* 31st Edition, Milestone Publishers and Distributors, New Delhi, 2013.
9. K.S. Tewari, N.K. Vishnoi and S.N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edition,
Vikas Publishing House (Pvt.) Ltd., New Delhi, 2004.
10. Gurdeep R. Chatwal, *Synthetic Drugs*, Himalaya Publishing House, Bombay, 1995.
11. M.S.R. Winter, *A Consumer's Dictionary of Cosmetic Ingredients*, 7th Edition, Three Rivers Press, New York, 2009.
12. H.S. Rathore and L.M.L. Nollet, *Pesticides: Evaluation of Environmental Pollution*, CRC Press, USA, 2012.
13. B. Srilakshmi, *Food Science*, 5th Edition, New Age Publishers, New Delhi, 2010.

References

1. T. Pradeep**,** *A Textbook of Nanoscience and Nanotechnology,* McGrawhill, New Delhi, 2012.
2. V.S. Muralidharan and A. Subramania, *Nano Science and Technology,* CRC Press, London, 2008.
3. Andrew P. Dicks, *Green Organic Chemistry in Lecture and Laboratory*, CRC Press, University of Toronto, Ontario, Canada, 2011.
4. M. Kirchhoff and M. Ryan, *Greener Approaches to Undergraduate Chemistry Experiments*, American Chemical Society, Washington, DC, 2002.
5. Helena Dodziuk, *Introduction to Supramolecular Chemistry,* Springer, New York, 2002.
6. A.W. Czarnik and S.H. DeWitt, *A Practical Guide to Combinatorial Chemistry*, 1st Edition, American Chemical Society, 1997.
7. John Walkenbach, *Excel 2013 Formulas*, 1st Edition, Wiley, New York, 2013.
8. S. Wilson, *Chemistry by Computer: An Overview of the Applications of Computers in Chemistry*,Plenum Publishing, New York, 1986.
9. Fred W. Billmeyer, Jr., *Textbook of Polymer Science*, 3rd Edition, John Wiley & Sons, Singapore, 1994.

10. P.L. Soni and Mohan Katyal, *Textbook of Inorganic Chemistry*, 20th Edition, S. Chand and Sons,New Delhi, 2013.

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

12. G. Thomas, *Fundamentals of Medicinal Chemistry*, John Wiley & Sons Ltd., 2006.

13. B. Siva Sankar, *Food Processing and Preservation*, Prentice–Hall of India Pvt. Ltd., New Delhi,2002

14. Bansal N K, Kleeman M and Mells M, *Renewable Energy Sources and Conversion Technology*, Tata McGraw-Hill. (1990)

15. Kothari D.P., *"Renewable energy resources and emerging technologies",* Prentice Hall of India Pvt. Ltd., 2008.

16. . Rai G.D, *"Non-Conventional energy Sources"*, Khanna Publishers, 2000.

SEMESTER VI

Course Code: CHE6B13(E2)
Core Course XIII: Elective - POLYMER CHEMISTRY
Total Hours: 54; Credits: 3; Hours/Week: 3

Module I: Introduction (6 hrs)

Polymers and macromolecules – Monomers – Homo and hetero polymers – Copolymers - Classification based on origin (natural, semi synthetic and synthetic), synthesis (addition and condensation), structure (linear, branched chain and cross linked) and intermolecular forces (elastomeres, fibres, thermoplastics and thermosetting polymers) – Tacticity.

Module II: Types of Polymerisation (9 hrs)

Chain and step growth polymerizations – Free radical, ionic and coordination polymerizations with mechanism – Zeigler-Natta polymerization (mechanism expected) and its advantages - Ring-opening & group transfer polymerisations.

Module III: Properties and Reactions of Polymers (9 hrs)

Glass Transition Temperature (Tg): Definition- Factors affecting Tg - Importance of Tg.

Molecular Weight of Polymers: Number average, weight average and viscosity average molecular weights – Poly Dispersity Index and its significance - Molecular weights and degree of polymerisation.

Viscoelasticity of polymers (basic concept only) - Vulcanisation and cyclisation reactions.

Polymer Degradation: Basic idea of thermal, photo and oxidative degradations of polymers.

Module IV: Polymerisation Techniques and Processing (12 hrs)

Polymerisation Techniques: Bulk, solution, suspension, emulsion, melt condensation and interfacial polycondensation polymerisations.

Polymer Processing: Calendering, rotational moulding, compression, injection moulding, blow moulding and thermoforming.

Module V: Commercial Polymers (12 hrs)

Preparation, structure, properties and uses of polyethylene (LDPE and HDPE), polypropylene, polystyrene, PVC, PVP, saran, dynel, teflon, PAN, PMMA, super glue, synthetic rubbers (BR, SBR, nitrile rubber, neoprene, butyl rubber and silicone rubber), terylene, glyptal, lexan, kevlar, nomex, polyurethanes, melmac, phenol-formaldehyde resin and urea-formaldehyde resin – Plastic identification codes – Pollution due to plastics - Recycling of plastics.

Module VI: Advances in Polymers (6 hrs)

Polymers in medical field - High temperature and fire-resistant polymers - Conducting polymers - Carbon fibers (basic idea only).

References

1. F.W. Billmeyer Jr., *Textbook of Polymer Science*, John Wiley and Sons, New Delhi, 2007.
2. V.R. Gowarikar, *Polymer Chemistry*, New Age International Pvt. Ltd., New Delhi, 2010.
3. B.K. Sharma, *Polymer Chemistry*, Goel Publishing House, Meerut, 1989.
4. M.G. Arora, M. Singh and M.S. Yadav, *Polymer Chemistry*, 2nd Revised Edition, Anmol Publications Private Ltd., New Delhi, 1989.
5. K.J. Saunders, *Organic Polymer Chemistry*, 2nd Edition, Chapman and Hall, London, 1988.
6. Malcolm P. Stevens, *Polymer Chemistry: An Introduction*, 3rd Edition, Oxford University Press, USA, 1998.
7. Gowri Sankar Misra, *Introductory Polymer Chemistry*, New Age International, New Delhi, 1993.

Course Code: CHE6B14(P)
Core Course XIV: PHYSICAL CHEMISTRY PRACTICAL
Total Hours: 90; Credits: 4; Hours/Week: 5 (Semester V)

General Instructions

1. *For weighing, either electronic balance or chemical balance may be used.*
2. *Use safety coat, goggles, shoes and gloves in the laboratory.*
3. *A minimum number of 13 experiments must be done, covering the nine modules, to appear for the examination.*
4. *The practical must be completed in the 5^{th} semester. Practical examination will be conducted at the end of 6^{th} semester.*

Module I: Viscosity

1. Determination of viscosity of various liquids using Ostwald's viscometer.
2. Study of glycerine-water system and determination of percentage of glycerine using viscometer (plot composition against time of flow x density of the solution).

Module II: Colligative properties (Cooling curve method)

1. Determination of cryoscopic constant (K_f) of solid solvent using a solute of known molecular mass.
2. Determination of molecular mass of the solute using a solvent of known cryoscopic constant (K_f).

Solid solvents: Naphthalene, biphenyl, camphor. Solutes: Naphthalene, biphenyl, 1,4 dichlorobenzene, diphenylamine, acetanilide, benzophenone.

Module III: Transition Temperature

1. Determination of molal transition point depression constant (K_t) of salt hydrate using solute of known molecular mass.
2. Determination of molecular mass of the solute using a solvent of known molal transition point depression constant (K_t).

   Salt hydrates: $Na_2S_2O_3.5H_2O$, $CH_3COONa.3H_2O$. Solutes: Urea, Glucose

Module IV: Phase Equilibria

1. Construction of phase diagram & determination of eutectic composition and eutectic temperature: *Naphthalene-biphenyl system, Naphthelene-diphenyl amine system, Biphenyl–diphenylamine system.*

2. Influence of KCl impurity on miscibility temperature of phenol–water system and determination of concentration of given KCl solution.

Module V: Refractometry

1. Determination of composition of glycerine-water mixture by refractive index method.
2. Determination of refractive indices of KCl solutions of different concentration and concentration of unknown KCl solution.

Module VI: Conductance

1. Conductometric titration of strong acid x strong base.
2. Conductometric titration of mixture of acids (strong and weak) x strong base.

Module VII: Potentiometry

1. Potentiometric titration of strong acid x strong base.
2. Potentiometric titration of weak acid x strong base.

Module VIII: pH metry

1. Preparation of alkaline buffer solutions.
2. pH metric titration of weak acid with strong base and calculation of dissociation constant.

Module IX: Kinetics *(Demonstration experiments)*

1. Determination of specific reaction rate of the hydrolysis of methyl acetate catalysed by hydrogen ion at room temperature.
2. Determination of overall order of saponification of ethyl acetate.

References

1. A. Findlay, *Findlay's Practical Physical Chemistry*, 9th Edition, John Wiley and Sons, New York, 1972.
2. J.B. Yadav, *Advanced Practical Physical Chemistry*, Goel Publications, Meerut, 2008.
3. D.P. Shoemaker and C.W. Garland, *Experiments in Physical Chemistry*, McGraw-Hill Book Company, New York, 1962.
4. W.G. Palmer, *Experimental Physical Chemistry*, Cambridge University Press, Cambridge, 2009.
5. R.C. Das and B. Behra, *Experiments in Physical Chemistry*, Tata McGraw Hill, New Delhi, 1983.
6. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, *Fundamentals of Analytical Chemistry*, 8th Edition, Brooks/Cole, Thomson Learning, Inc., USA, 2004.

SEMESTER VI

Course Code: CHE6B15(P)
Core Course XV: ORGANIC CHEMISTRY PRACTICAL
Total Hours: 90; Credits: 4; Hours/Week: 5 (Semester V)

General Instructions

1. *Micro scale analysis must be adopted for organic qualitative analysis.*
2. *Use safety coat, goggles, shoes and gloves in the laboratory.*
3. *Reactions must be carried out in tiles, wherever possible.*
4. *A minimum number of 7 organic analysis and 7 organic preparations shall be done to appear for the examination.*
5. *The practical must be completed in the 5^{th} semester. Practical examination will be conducted at the end of 6^{th} semester.*

Module I: Reagent Preparation

Preparation of Borshe's reagent, Schiff's reagent, Tollen's Reagent, Fehling's solution, phenolphthalein, methyl orange, N-Phenylanthranilic acid and neutral $FeCl_3$.

Module II: Determination of Physical Constants

1. Determination of boiling point.
2. Determination of melting point (capillary method and using melting point apparatus).

Module III: Recrystallisation Techniques

Recrystallise any four organic compounds using ethyl acetate, ethanol and water. Note the crystalline shape.

Module IV: Solvent Extraction (Use ether and record the yield recovery).

1. Aniline from water.
2. Methyl benzoate from water.

Module V: Reactions of Organic Compounds

Study of the reactions of functional groups from the following list (also prepare the derivatives).

1. Phenols (phenol, α-naphthol, β-naphthol).
2. Nitro compounds (nitrobenzene, *o*-nitrotoluene).
3. Amines (aniline, N,N-dimethyl aniline).
4. Halogen compounds (chlorobenzene, benzyl chloride, *p*-dichlorobenzene).
5. Aldehydes and ketones (benzaldehyde, acetophenone).
6. Carboxylic acid (benzoic acid, cinnamic acid, phthalic acid, salicylic acid).

7. Carbohydrates (glucose, sucrose).
9. Amides (benzamide, urea).
10. Esters (ethyl benzoate, methyl salicylate).
11. Hydrocarbons (naphthalene, anthracene).

Module VI: Organic Preparations

1. Halogenation: *p*-bromoacetanilide from acetanilide, Tribromoaniline from aniline.
2. Nitration: *p*-nitroacetanilide from acetanilide
3. Oxidation: Benzoic acid from benzaldehyde, Benzoic acid from toluene.
4. Hydrolysis: Benzoic acid from ethyl benzoate, Benzoic acid from benzamide.
5. Diazo-coupling: Methyl orange from aniline, Phenylazo–β-naphthol from aniline.
6. Haloform reaction: Iodoform from acetone or ethyl methyl ketone.
7. Acylation: Acetylation of salicylic acid or aniline, Benzoylation of aniline or phenol.

Note: *Determine the yield. Calculate the theoretical yield and percentage conversion. Recrystallise the prepared compounds from appropriate solvents.*

Module VII: Chromatography

Paper chromatographic separation of mixture of two amino acids.

References

1. B.S. Furniss, A.J. Hannaford, P.W.G. Smith and A.R. Tatchell, *Vogel's Textbook of Practical Organic Chemistry,* 5th Edition, Pearson Education, Noida, 2014.
2. F.G. Mann and B.C. Saunders, *Practical Organic Chemistry*, 4th Edition, Pearson Education, Noida, 2011.
3. Arthur I. Vogel, *Elementary Practical Organic Chemistry- Small Scale Preparations*, 2nd Edition, Pearson Education, Noida, 2013.
4. V.K. Ahluwalia and S. Dhingra, *Comprehensive Practical Organic Chemistry*, Universities Press, Hyderabad, 2004 (Reprint).

SEMESTER VI

Course Code: CHE6B16(P)
Core Course XVI: INORGANIC CHEMISTRY PRACTCAL-II
Total Hours: 90; Credits: 4; Hours/Week: 5

General Instructions

1. *For weighing, either electronic balance or chemical balance may be used.*
2. *Use safety coat, goggles, shoes and gloves in the laboratory.*
3. *A minimum number of 10 experiments must be done, covering the three modules, to appear for the examination.*
4. *The report of industrial visit must be submitted, along with the practical record, to appear for the examination.*

Module I: Gravimetric Analysis – I (using silica crucible)

1. Determination of water of hydration in crystalline barium chloride.
2. Determination of water of hydration in crystalline magnesium sulphate.
3. Estimation of Ba^{2+} as $BaSO_4$
4. Estimation of SO_4^{2-} as $BaSO_4$
5. Estimation Fe^{3+} as Fe_2O_3
6. Estimation Ca^{2+} as $CaCO_3$
7. Estimation Al^{3+} as Al_2O_3

Module II: Gravimetric Analysis – II (using sintered crucible)

1. Estimation Ni^{2+} as nickel dimethyl glyoximate.
2. Estimation Cu^{2+} as cuprous thiocyanate
3. Estimation Mg^{2+} as magnesium oxinate

Module III: Colorimetry

1. Verification of Beer-Lambert law for $KMnO_4$ and $K_2Cr_2O_7$ & determination of concentration of the given solution.
2. Estimation of iron.
3. Estimation of chromium.
4. Estimation of nickel.

References

1. J. Mendham. R.C. Denney, J.D. Barnes and M. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Edition, Pearson Education, Noida, 2013.
2. D.N Bajpai, O.P. Pandey and S. Giri, *Practical Chemistry for I, II & III B. Sc. Students*, S. Chand & Company Ltd., New Delhi, 2012 (Reprint).
3. V.K. Ahluwalia, Sunita Dhingra and Adarsh Gulati, *College Practical Chemistry*, Universities Press

(India) Pvt. Ltd., Hyderabad, 2008 (Reprint).

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

SEMESTER VI

Course Code: CHE6B17(P)
Core Course XVII: INORGANIC CHEMISTRY PRACTCAL-III
Total Hours: 90; Credits: 4; Hours/Week: 5

General Instructions

1. *Micro scale analysis must be adopted for inorganic qualitative analysis.*
2. *Mixtures containing more than one interfering anions must be avoided.*
3. *If interfering anions are not present, cations may be given from the same group.*
4. *Use safety coat, goggles, shoes and gloves in the laboratory.*
5. *A minimum of 6 inorganic mixtures and 8 inorganic preparations must be done to appear for the examination.*

Module I: Inorganic Qualitative Analysis

1. Study of the reactions of following ions.

   Anions: Carbonate, sulphate, fluoride, chloride, bromide, iodide, acetate, borate, oxalate, phosphate and nitrate.

   Cations: Lead, bismuth, copper, cadmium, iron, aluminium, cobalt, nickel, manganese, zinc, barium, calcium, strontium, magnesium and ammonium.
2. Systematic analysis of mixtures containing two cations and two anions from the above list.
3. *Elimination of interfering anions:* Fluoride, borate, oxalate and phosphate.

Module II: Inorganic Preparations

1. Ferric alum
2. Potash alum
3. Mohr's salt
4. Nickel(II) dimethylglyoximate
5. Potassium trisoxalatoferrate(III)
6. Potassium trioxalatochromate(III)
7. Tris(thiourea)copper(I) sulphate
8. Tetraamminecopper(II) sulphate
9. Microcosmic salt
10. Sodium nitroprusside

References

1. G. Svehla, *Vogel's Qualitative Inorganic Analysis*, 7th Edition, Prentice Hall, New Delhi, 1996.
2. V.V. Ramanujam, *Inorganic Semi Micro Qualitative Analysis*, 3rd Edition, The National Publishing Company, Chennai, 1974.
3. W.G. Palmer, *Experimental Inorganic Chemistry*, Cambridge University Press, 1970.

SEMESTER VI

Course Code: CHE6B18(Pr)
Core Course XVIII: PROJECT WORK
Total Hours: 36; Credits: 2; Hours/Week: 2 (Semester V)

Guidelines

1. Students shall undertake the project work related to chemistry only.
2. The UG level project work is a group activity, maximum number of students being limited to five. However, each student shall prepare and submit the project report separately.
3. Head of the department must provide the service of a teacher for supervising the project work of each group. A teacher can guide more than one group, if necessary.
4. The students must complete the project in the 5^{th} semester. However, the evaluation of the project report will be carried out at the end of 6^{th} semester.
5. Project work can be experimental, theoretical or both.
6. No two groups in the same institution are permitted to do project work on the same problem. Also the project must not be a repetition of the work done by students of previous batches.
7. Each group must submit a copy of the project report to keep in the department.
8. The project report must be hard bound, spiral bound or paper back.
9. The project report shall be divided as, Chapter I: Introduction, Chapter II: Review of literature, Chapter III: Scope of the research problem, Chapter IV: Materials and methods, Chapter V: Results and discussion, Chapter VI: Conclusion and suggestions, if any, and Chapter VII: Bibliography.
10. Each student must present the project report before the external examiner during project evaluation.

EVALUATION SCHEME

FOR

CORE COURSES

CORE 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.

Table 1: Components of Evaluation

Sl. No.	*Components*	*Marks*
1	Attendance	5
2	Test papers: I & II	5 + 5
3	Assignment	2
4	Seminar/ Viva*	3
	Total Marks	20

**Viva:* CHE1B01, CHE2B02, CHE3B03, CHE4B04, CHE5B06, CHE6B10, CHE6B11, CHE6B12 and elective course; *Seminar:* CHE5B07, CHE5B08 and CHE6B09.

Table 2: Percentage of Attendance and Eligible Marks

% of attendance	*Marks*
Above 90%	5
85-89%	4
80-84%	3
76-79%	2
75%	1

Table 3: Pattern of Test Papers

Duration	*Pattern*	*Total number of questions*	*Number of questions to be answered*	*Marks for each question*	*Marks*
1.5 Hours	One word	4	4	1	4
	Short answer	5	4	2	8
	Paragraph	5	3	6	18
	Essay	2	1	10	10
				*Total Marks**	40

*90% and above = 5, 80 to below 90% = 4.5, 70 to below 80% = 4, 60 to below 70% = 3.5, 50 to below 60% = 3, 40 to below 50% = 2, 35 to below 40% = 1, below 35% = 0

2. EXTERNAL EVALUATION

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

Table 1: Pattern of Question Paper

Duration	*Pattern*	*Total number of questions*	*Number of questions to be answered*	*Marks for each question*	*Marks*
3 Hours	One word	10	10	1	10
	Short answer	12	10	2	20
	Paragraph	8	5	6	30
	Essay	4	2	10	20
				Total Marks	80

CORE COURSE PRACTICAL: 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.

Table 1: Components of Evaluation

Sl. No.	*Components*	*Marks*
1	Attendance in the lab	5
2	Punctuality, performance and discipline	4
3	Model tests: I & II	2 + 2
4	Practical Record: Required number of experiments and neatness	4
5	Viva-Voce	3
	Total Marks	20

Table 2: Percentage of Attendance and Eligible Marks

% of attendance	*Marks*
Above 90%	5
85-89%	4
80-84%	3
76-79%	2
75%	1

Table 3: Number of Experiments and Marks for Practical Records

Number of Experiments (Marks in brackets)						
Inorganic Chemistry Practical-I	*Physical Chemistry Practical*	*Organic Chemistry Practical*		*Inorganic Chemistry Practical -II*	*Inorganic Chemistry Practical -III*	
		Analysis	*Preparation*		*Mixture*	*Preparation*
25-28 (4)	17-18 (4)	10 (3)	7-10 (1)	13-14 (4)	8 (3)	8-10 (1)
24 (3)	16 (3)	9 (2.5)		12 (3)	7 (2)	
23 (2)	15 (2.5)	8 (2)		11 (2)	6 (1)	
22 (1.5)	14 (2)	7 (1)		10 (1)		
21 (1)	13 (1)					

EXTERNAL EVALUATION

External evaluation carries 80% marks. Practical examinations along with viva-voce will be conducted at the end of 4th and 6th semesters.

PATTERN OF QUESTION PAPERS

Table 1: Inorganic Chemistry Practical - I

Duration	*Pattern*	*Marks*	*Total Marks*
3 Hours	Question on volumetric analysis	8	80
	Procedure	8	
	Result	40	
	Calculation	8	
	Record	8	
	Viva-Voce	8	

Guidelines

1. *Valuation of Volumetric Procedure*: Eight points – 8 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 and end point of estimation; 8. Any other relevant points.

2. *Marks for Result:* For calculating the error percentage both theoretical value and skilled value are considered. The reported values (RV) of the students are compared with theoretical value (TV) and

skilled value (SV) to calculate the error percentage. Up to 1.5% error: 40 marks; between 1.51 – 2%: 30 marks; between 2.1 – 2.5%: 20 marks; between 2.51– 3%: 10 marks; greater than 3%: 4 marks.

3. *Marks for Calculation:* Eight points – 8 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 link solution; 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.

Table 2: Physical Chemistry Practical

Duration	*Pattern*	*Marks*	*Total Marks*
3 Hours	Procedure	8	80
	Result	40	
	Graph	8	
	Duplicate/ other particulars	4	
	Calculation	4	
	Record	8	
	Viva-Voce	8	

Guidelines

1. *Valuation of Procedure:* Eight points – 8 marks.
2. *Marks for Result:* The mark distribution may vary for different experiments.

Table 3: Organic Chemistry Practical

Duration	*Pattern*	*Marks*	*Total Marks*
3 Hours	Question on organic analysis & preparation	8	80
	Procedure for organic preparation	8	
	Organic Preparation	12	
	Organic Analysis	36	
	Record	8	
	Viva-Voce	8	

Guidelines

1. *Procedure for Organic Preparation:* Eight points – 8 marks. 1) Type of reaction; 2) Balanced equation of the reaction; 3) Requirements; 4) Solvent used; 5) Reaction condition; 6) Precipitating agent; 7) Recrystallisation; 8) Solvent for recrystallisation.

2. *Organic Preparation:* The students shall exhibit the crude and recrystallized samples of the prepared organic compound for inspection. Yield: 3 marks; colour: 3 marks; dryness: 3 marks; crystalline shape: 3 marks.

3. *Organic Analysis:* Aliphatic/aromatic: 2 marks, saturated/unsaturated: 2 marks, detection of elements: 3 marks, identification test of functional group: 5 marks, chemistry of identification test: 3 marks, confirmation test of functional group: 5 marks, chemistry of confirmation test: 3 marks, suggestion of derivative: 1 mark, method of preparation of the derivative: 2 marks, preparation of

derivative suggested by the examiner: 3 marks, chemistry of the derivative preparation: 3 marks, systematic procedure: 4 marks.

Table 4: Inorganic Chemistry Practical - II

Duration	*Pattern*	*Marks*	*Total Marks*
3 Hours	**Gravimetry and Colorimetry**		65
	Procedure of colorimetry	4	
	Procedure of gravimetry	8	
	Result	35	
	Calculation	2	
	Record	8	
	Viva-Voce	8	
	Industrial Visit		
	Report	8	15
	Viva-Voce	7	

Guidelines

1. *Points for Evaluation of Colorimetry Procedure*: Four points – 4 marks. 1) Preparation of standard solutions; 2) Addition of appropriate reagents to develop colour; 3) Determination of absorbance using a colorimeter; 4) Plot the graph and find out the concentration of the unknown.

2. *Points for Evaluation of Gravimetry Procedure*: Eight points – 8 marks. 1) Making up of the given solution 2) Transferring a definite volume of the made up solution in to a beaker 3) Addition of appropriate reagents 4) Dilution and heating to boiling 5) Precipitation by appropriate reagent and heating to make the precipitate granular 6) Allowing to settle and filtering through quantitative filter paper or previously weighed sintered crucible till the washings are free from ions 7) Incineration in a previously weighed silica crucible or drying the sintered crucible in an air oven 8) Repeating heating, cooling and weighing to constant weight 9) From the weight of precipitate the weight of metal in the given solution can be calculated.

3. *Marks for Gravimetry Result:* The reported value of the student is compared with theoretical value and one skilled value (closer to theoretical value) and error percentage is calculated. Up to 1.5% error: 35 marks; between 1.51 – 2%: 25 marks; between 2.1– 2.5%: 15 marks; greater than 2.51%: 4 marks.

4. *Industrial Visit:* Good presentation of any one Chemical Factory / Research centre visit is considered for a maximum of 8 marks. Students are expected to make individual report. So variety must be appreciated. Viva-voce shall be conducted based on the industrial visit.

Table 5: Inorganic Chemistry Practical - III

Duration	*Pattern*	*Marks*	*Total Marks*
3 Hours	Question on qualitative analysis	4	80
	Procedure for inorganic preparation	4	
	Identification tests for ions	16	
	Confirmation tests for ions	16	
	Identification of cation group	2	
	Chemistry of identification tests	8	
	Chemistry of confirmation tests	8	
	Systematic procedure & elimination	4	
	Chemistry of elimination	2	
	Record	8	
	Viva-Voce	8	

Guidelines

1. *Identification Tests:* 4 Marks each for two anions two cations.
2. *Identification of Cation Group:* 1 Mark each.
3. *Confirmation Tests:* 4 Marks each for two anions and two cations.
4. *Chemistry of Identification Tests:* 2 Marks each for two anions and two cations.
5. *Chemistry of Confirmation Tests:* 2 Marks each for two anions and two cations.

Table 6: Evaluation of Records

Number of Experiments (Marks in brackets)						
Inorganic Chemistry Practical - I	*Physical Chemistry Practical*	*Organic Chemistry Practical*		*Inorganic Chemistry Practical -II*	*Inorganic Chemistry Practical -III*	
		Analysis	*Preparation*		*Mixture*	*Preparation*
25-28 (8)	17,18 (8)	10 (4)	10 (4)	13-14 (8)	8 (6)	10 (2)
24 (7)	16 (7)	9 (3)	9 (3)	12(7)	7 (5)	9 (1.5)
23 (6)	15 (6)	8 (2)	8 (2)	11 (6)	6 (4)	8 (1)
22 (5)	14 (5)	7 (1)	7 (1)	10 (5)		
21 (4)	13 (4)					

CORE COURSE PROJECT: EVALUATION SCHEME

Project evaluation will be conducted at the end of sixth semester.

Table 1: Internal Evaluation

Sl. No	*Criteria*	*Marks*
1	Punctuality	2
2	Skill in doing project work	2
3	Project presentation	3
4	Viva-Voce	3
	Total Marks	10

Table 2: External Evaluation

Sl. No	*Criteria*	*Marks*
1	Content and relevance of the project	10
2	Project report	10
3	Project presentation	10
4	Viva-voce	10
	Total Marks	40

MODEL QUESTION PAPERS

FOR

CORE COURSES

Name:.....
Reg. No.:.....

FIRST SEMESTER B. Sc. DEGREE EXAMINATION

CHE1B01; Core Course I: THEORETICAL AND INORGANIC CHEMISTRY - I

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

Section A (One word)

Answer all questions. Each question carries 1 mark

1. An untested rational explanation of a phenomena generated on the basis of its observation and also previous knowledge is called a ----------
2. A medieval chemical philosophy having the transmutation of base metals into gold as one of its asserted aims was called ----------
3. The first synthesized organic compound is ----------
4. Atoms having different atomic number but the same mass number are called ----------
5. 10 g $CaCO_3$ on heating leaves behind a residue weighing 5.6 g. Carbon dioxide released into the atmospehre at STP will be ----------
6. 4 g of NaOH are dissolved in 90 mL of water. The mole fraction of NaOH in water is --
7. Name an indicator used in complexometric titration.
8. The ionization enthalpy of He^+ is 19.6×10^{-18} J/atm. The energy of the first stationary state of Li^{2+} is ----------
9. The minimum amount of the target material required to sustain a fission chain reaction at a constant rate is called ----------
10. The radiant energy of sun is due to ----------

Section B (Short answer)

Answer any ten questions. Each question carries 2 marks

11. List the different branches of chemistry.
12. What are the components of a research project report?
13. How does scientific hypothesis differ from a scientific theory?
14. Differentiate between molarity and molality.
15. Equivalent mass of $KMnO_4$ in acid medium is 31.6. Justify your answer.
16. Calculate the mass of (a) 2.5 g atom of calcium (b) 1.5 g mol of CO_2.
17. Find out the volume of the following at STP (a) 7 g of nitrogen (b) 6.02×10^{22} molecules of ammonia.
18. Write the nuclear equation for (a) the emission of an α-particle from Th-232 (b) the emission of a β-particle from Ra-228.
19. The half life period of a radionuclide is 4.8 minutes. Calculate its decay constant.
20. How does the nuclear fluid theory explain nuclear forces?
21. HCl is not used to acidify $KMnO_4$ solution in volumetric estimation of Fe^{2+} or $C_2O_4^{2-}$. Why?
22. Calculate the wave length associated with a bullet of mass 1×10^{-3} Kg travelling with a velocity of 3×10^4 m/s.

Section C (Paragraph)

Answer any five questions. Each question carries 6 marks

23. Differentiate between the terms scientific proof and scientific evidence.
24. What are the objectives of a chemical research?
25. What are redox indicators? Discuss taking a suitable example.
26. Discuss the principles of iodimetric and iodometric titrations.
27. Write short notes on (a) MSDS (b) R & S Phrases
28. What is meant by dual character of an electron? Derive an expression for the wavelength of de Broglie matter waves.
29. (a) Describe radiocarbon dating (b) The amount of ^{14}C present in an old piece of wood is found to be one-sixth of that present in a fresh piece of wood. Calculate the age of the wood. Half life of ^{14}C is 5668 years.
30. Explain with examples how radioisotopes are useful in (a) medical diagnosis (b) radiotherapy.

Section D (Essay)

Answer any two questions. Each question carries 10 marks

31. Discuss (a) safe laboratory practices (b) treatment for burns due to phenol and bromine (c) disposal of sodium and broken mercury thermometer.
32. What are the postulates of Bohr theory? Derive the Bohr energy and frequency equations.
33. Write notes on (a) Planck's quantum hypothesis (b) Electron diffraction (c) Heisenberg's uncertainty principle.
34. Discuss the principles and salient features of nuclear reactors.

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SECOND SEMESTER B. Sc. DEGREE EXAMINATION

CHE2B02; Core Course II: THEORETICAL AND INORGANIC CHEMISTRY - II

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

Section A (One word)

Answer all questions. Each question carries 1 mark

1. The kinetic energy part of Hamiltonian operator is ----------
2. 4p orbitals have ---------- radial nodes.
3. The region where there is zero probability of locating the electron between two non-zero probability region is called ----------
4. Sketch the shape of d_{z^2} orbital.
5. The most electronegative element in the periodic table is ---------
6. Lithium shows diagonal relationship with ----------
7. The number of pi bonds in acetylene molecule is ----------
8. Among CH_3Cl, CH_2Cl_2 and $CHCl_3$, the dipole moment is maximum for --------
9. A mixture of *o*-nitrophenol and *p*-nitrophenol can be separated by ----------
10. Among B_2, C_2 and N_2 the paramagnetic species is/are ----------

Section B (Short answer)

Answer any ten questions. Each question carries 2 marks

11. What is meant by a well behaved wave function?
12. Write the time independent Schrodinger wave equation and explain the terms.
13. State and explain Aufbau principle.
14. What is the expression for energy of a particle in a one dimensional box? Explain the terms.
15. Ca^{2+} ion is smaller than Ca atom. Why?
16. Electron affinities of noble gases are zero. Why?
17. What are the applications of Born-Haber cycle?
18. Predict the hybridization and shapes of XeF_6, NH_4^+, H_3O^+ and SO_4^{2-}.
19. Write the Born-Lande equation and explain the terms.
20. Discuss any four properties of ionic compounds.
21. What is meant by bond order? What is its significance?
22. Draw the resonance structures of borate, carbonate and nitrate ions. Compare the bond energy.

Section C (Paragraph)

Answer any five questions. Each question carries 6 marks

23. What are the postulates of quantum mechanics?
24. Draw the radial probability distribution curves of *2s*, *2p* and *3s* orbitals. Explain.

25. What are Linear and Hermitian operators? Explain.
26. Explain why the ionization energy of transition elements is reasonably constant.
27. Define lattice energy? How is it related to solubility of a compound in water?
28. Discuss the hybridization and structure of (a) ethylene (b) SF_6.
29. Write a note on intermolecular forces.
30. Write the electronic configuration of O_2, O_2^+, O_2^{2+}, O_2^- and O_2^{2-}. Compare their bond length and bond energy.

Section D (Essay)

Answer any two questions. Each question carries 10 marks

31. What are quantum numbers? Discuss the significance of each quantum number. What are the possible values of l, if $n = 4$.
32. Discuss (a) Electronegativity scales (b) Slater rule and its applications.
33. Discuss in detail Fajan's rule and its applications.
34. Discuss the valence bond theory and band theory of metallic bonding and explain metallic properties based on these theories.

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THIRD SEMESTER B. Sc. DEGREE EXAMINATION

CHE3B03; Core Course III: PHYSICAL CHEMISTRY – I

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

Section A (One word)

Answer all questions. Each question carries 1 mark

1. For an ideal behaviour, the compressibility factor Z is ----------
2. The temperature below which a gas does not obey ideal gas law is called ----------
3. The maximum efficiency of a steam engine working between 100^{o}C and 25^{o}C is -------
4. Entropy of CO at absolute zero is ----------
5. Among volume, temperature, entropy and enthalpy, intensive property is/are ---------
6. The relation between T and P in an adiabatic process is ----------
7. Born-Haber cycle is an application of --------- law.
8. The unit of viscosity in SI system is ----------
9. Surface tension is related to Parachor by the equation ----------
10. The equilibrium constant K_P for the dissociation of PCl_5 is 1.6 at 200^{o}C. The pressure at which PCl_5 will be 50% dissociated at 200^{o}C is ------ atm.

Section B (Short answer)

Answer any ten questions. Each question carries 2 marks

11. Calculate the temperature at which O_2 molecule will have the same RMS velocity as CO_2 molecule.
12. Calculate the value of work done when 2g of H_2 expands from a volume of 1 litre to a volume of 10 litres at 27^{0}C.
13. Write Clapeyron-Clausius equation (integrated form) for liquid-vapour equilibrium and explain the terms.
14. Write Gibbs-Duhem equation and explain the terms.
15. Explain the physical significance of entropy.
16. Define third law of thermodynamics.
17. Calculate the entropy of vapourisation of a liquid which boils at 120^{o}C. Given enthalpy of vapourisation is 3600 $Jmol^{-1}$.
18. What is optical exaltation?
19. Give the equation for molar refraction of a liquid and explain the terms.
20. Why chemical equilibrium is termed dynamic?
21. State Le Chatelier's principle.
22. What is homogenious equilibrium? Give example.

Section C (Paragraph)

Answer any five questions. Each question carries 6 marks

23. Derive the relationship between heat capacity at constant volume and constant pressure for an ideal gas.

24. Derive the expressions for critical constants in terms of Vander-Waals constants.
25. Derive the relation between temperature and pressure for an adiabatic process.

26. Calculate the change in freezing point for ice when the pressure is increased by 1 atm. Molar volume of water and ice are 18.0 and 19.6 cm^3 and the enthalpy of fusion for ice is 6008 $Jmol^{-1}$. (IJ = 9.87 x 10^{-3} dm^3.atm.)
27. Discuss the variation of free energy with temperature and pressure.
28. Derive an expression for the relation between entropy and probability?
29. What is Parachor? How is it used for structure elucidation?
30. Derive the relationship between K_p and K_c.

Section D (Essay)

Answer any two question. Each question carries 10 marks

31. What is Joule-Thomson effect? Describe Linde's method and Claude's method for the liquifaction of gases.
32. Derive Gibb's Helmholtz equation. What is its significance?
33. What is Kirchoff`s equation? The enthalpy of reaction for the formation of ammonia from N_2 and H_2 at 25^oC was found to be -91.94 kJ mol^{-1}. What will be the enthalpy of reaction at 50^oC? The molar heat capacities at constant pressure and at 27^oC for nitrogen, hydrogen, ammonia are 28.45, 28.32 and 37.07 joules mol^{-1} respectively.
34. (a) Derive Van't Hoff equation for temperature dependence of equilibrium constant. (b) The equilibrium constant for a reaction is 1×10^5. Calculate the standard free energy change for the reaction in kilojoules at 25^oC.

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FOURTH SEMESTER B. Sc. DEGREE EXAMINATION
(UG-CBCSS) Chemistry
CHE4B04; Core Course IV: ORGANIC CHEMISTRY – I

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

Section A (One word)

Answer all questions. Each question carries 1 mark

1. Propanal and propanone are ---------- isomers
2. The energy difference between staggered and eclipsed conformation of ethane is ----KJ/mol.
3. Most stable conformation of *n*-butane is ---------
4. Homolysis of carbon-carbon bond generates ----------
5. The temporary migration of pi electrons to one of the bonded atom in presence of an attacking reagent is called ----------
6. When isopropyl bromide is warmed with metallic sodium in dry ether, the compound formed is ----
7. When 2-bromo-2-methylbutane is warmed with alcoholic KOH, the major product formed is ----------
8. The electrophile in aromatic sulphonation reaction is ---------
9. What is the product obtained when benzene is first nitrated and then chlorinated?
10. Write the structural formula of 9-methyl anthracene.

Section B (Short answer)

Answer any ten questions. Each question carries 2 marks

11. Define homologous series. What are its characteristics?
12. Write a note on keto-enol tautomerism taking a suitable example.
13. Write any four unique properties of carbon.
14. Draw any two stable conformations of methyl cyclohexane.
15. Explain the isomerism exhibited by maleic acid and fumaric acid.
16. Compare the basicity of aniline, *p*-nitroaniline and *p*-anisidine. Justify your answer.
17. What is meant by a free radical substitution reaction? Give an example.
18. Write the mechanism of dehydration of neopentyl alcohol catalysed by mineral acids.
19. Starting from carbon and hydrogen, how is 2-pentyne synthesized?
20. What is meant by *cis* hydroxylation? What are the reagents used for this reaction?
21. An organic compound with molecular formula C_4H_8 on ozonolysis yield acetone as one of the product. Write the structural formula of C_4H_8 and explain the reaction.
22. Discuss the Haworth synthesis of naphthalene.

Section C (Paragraph)

Answer any five questions. Each question carries 6 marks

23. Write a note on the optical activity of biphenyls.
24. Discuss any two methods for the resolution of a racemic mixture.
25. What are the postulates of Baeyer's strain theory?
26. Compare the electron densities in benzene, toluene, phenol, chlorobenzene and nitrobenzene. Justify your answer.
27. Differentiate between singlet carbene and triplet carbene.
28. Why are 1-alkynes acidic? Write any three reactions for their acidity.
29. How does 2-butyne reacts with (a) H_2/Lindlar's catalyst (b) H_2/Na/liquid ammonia (c) Baeyer's reagent (d) O_3/Zn/H_2O.
30. What is Huckel's rule? How is it used to explain the aromaticity of tropylium cation and cyclopentadienyl anion.

Section D (Essay)

Answer any two questions. Each question carries 10 marks

31. (a) Discuss with suitable example the E,Z system of nomenclature of geometrical isomers.
    (b) Discuss the optical isomerism in tartaric acid.
32. Discuss the structure, hybridization and stability of carbocations.
33. Using suitable examples discuss in detail the mechanisms of Markownikov and Anti-Markownikov addition in alkenes.
34. Discuss the mechanism of (a) nitration and sulphonation of naphthalene (b) bromination of benzene.

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FOURTH SEMESTER B. Sc. DEGREE EXAMINATION

CHE4B05(P); Core Course V: INORGANIC CHEMISTRY PRACTICAL – I
Time: 3 Hours **Maximum marks: 80**

Section A

Answer the following questions in 10 minutes.

1. Calculate the mass of crystalline oxalic acid required to prepare 250 mL of its 0.5 N solution?
2. Calculate the normality of Mohr's salt solution when 1.96 g of it is dissolved in water in a 100 mL standard flask?
3. When 100 mL 1N $ZnSO_4$ solution is diluted to 500 mL the normality of the resulting solution will be ----------
4. Name the indicator used for the titration of Na_2CO_3 against H_2SO_4.
5. Write the structure of N-Phenyl anthranilic acid.
6. The titration of Fe^{2+} solution against $KMnO_4$ is a ---------- titration.
7. What is the role of $SnCl_2$ in the estimation of Fe^{3+} during dichrometry?
8. Write the balanced chemical equation for the titration of I_2 solution against $Na_2S_2O_3$.

(1x8 = 8 Marks)

Section B

Answer the following question in 10 minutes

9. Give a brief outline of the method for the volumetric estimation of Mg^{2+} in the whole of the given solution of $MgSO_4$, being provided with AR $ZnSO_4$ crystals.

(8 Marks)

Part C

10. Estimate the weight of Fe^{3+} in the whole of the given solution of ferric alum, being provided with AR Mohr's salt. *(48 Marks)*

Part D

Viva-Voce *(8 marks)*
Record *(8 marks)*

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FIFTH SEMESTER B. Sc. DEGREE EXAMINATION

CHE5B06; Core Course VI: INORGANIC CHEMISTRY - III

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

Section A (One word)

Answer all questions. Each question carries 1 mark

1. The expression for the solubility product of magnesium phosphate is --------
2. The group III cations are precipitated as their ----------
3. Write the order of density of alkali metals.
4. The thermal stability of alkaline earth metal carbonates follow the order ----------
5. The hybridization in diamond is ----------
6. Among the hydrides of nitrogen, the highest bond angle is shown by ----------
7. The hybridization of iodine in IF_5 is ---------
8. Write the auto-ionization of liquid SO_2.
9. The compound responsible for Bhopal tragedy is ----------
10. Environmentalists perceive a grave threat to the pristine Silent Valley ecosystem in the ----- Project proposed to be built on the Kunthippuzha river.

Section B (Short answer)

Answer any ten questions. Each question carries 2 marks

11. How is borate in a mixture eliminated?
12. How does fluoride interfere in cation analysis?
13. What is meant by co-precipitation? How is the error due to co-precipitation minimized?
14. What is inorganic graphite? Why is it called so? Mention its uses.
15. Give any four diagonal relationships between lithium and magnesium.
16. Arrange HClO, $HClO_2$, $HClO_3$ and $HClO_4$ in the increasing order of acidic strength. Give reasons for your answer.
17. Give any four similarities between pseudohalides and halides.
18. What are phosphazenes? Give the structure of $P_3N_3Cl_6$.
19. Discuss the properties and structure of S_4N_4.
20. Explain the formation of acid rain. What are its harmful effects?
21. What are the harmful effects of SO_2?
22. Differentiate between BOD and COD.

Section C (Paragraph)

Answer any five questions. Each question carries 6 marks

23. Describe how the solubility product principle and common ion effect are applied in inorganic qualitative analysis.

24. Give any one method for the preparation of borazine. How does it differ from benzene in chemical reactions?
25. Discuss the following properties, taking boron family as example (a) ionization energy (b) inert pair effect (c) melting point.
26. Comment on the electropositive character of iodine.
27. Explain the charcoal adsorption method for the separation of noble gases.
28. Discuss the structure and applications of silicones.
29. Discuss the formation, effects and control of photochemical smog.
30. Write a note on impacts of medical waste and its disposal.

Section D (Essay)

Answer any two questions. Each question carries 10 marks

31. Discuss the preparation, properties and uses of sulphuric acid.
32. Discuss the reactions taking place in liquid ammonia solvent.
33. (a) CO_2 is an inert and harmless gas, yet it is considered to be a serious pollutant. Discuss.
    (b) What are the sources of thermal pollution? How does it affect the aquatic environment?
34. Discuss various methods of solid waste management.

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FIFTH SEMESTER B. Sc. DEGREE EXAMINATION

CHE5B07; Core Course VII: ORGANIC CHEMISTRY - II

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

Section A (One word)

Answer all questions. Each question carries 1 mark

1. The IUPAC name of allyl chloride is --------
2. 100% pure alcohol is called ----------
3. Ethyl phenyl ether when boiled with HBr form ---------
4. The isomerism exhibited by 1-methoxypropane and 2-methoxypropane is called ------
5. Oxidation of secondary alcohol to ketone with aluminium ter-butoxide is known as --
6. The chemical test used to distinguish acetophenone and benzophenone is ----------
7. Acetic acid is treated with Br_2/P followed by aqueous KOH. The product formed is ----
8. Rosenmund's reduction of propionyl chloride gives ---------
9. Aniline on benzoylation gives ----------
10. N,N-Dimethyl aniline on reaction with nitrous acid yield ----------

Section B (Short answer)

Answer any ten questions. Each question carries 2 marks

11. How is alkyl fluoride prepared?
12. How are nuclear and side chain halogenated hydrocarbons distinguished? Justify your answer.
13. How is rectified spirit converted to absolute alcohol?
14. How is phenolphthalein prepared?
15. Explain Zeisel's method of estimation of methoxy groups.
16. Starting from benzonitrile how is acetophenone synthesized?
17. What is Etard's reaction?
18. Starting from benzaldehyde how is cinnamaldehyde prepared?
19. Compare the nucleophilic addition rate of formaldehyde, acetaldehyde and acetone. Justify your answer.
20. Give the method of preparation of eosin.
21. Outline the synthesis of saccharin.
22. Discuss the mechanism of Kolbe's electrolysis.

Section C (Paragraph)

Answer any five questions. Each question carries 6 marks

23. Discuss the addition–elimination mechanism in aromatic nucleophilic substitution.
24. What is Pinacol–pinacolone rearrangement? Discuss the mechanism of the reaction.
25. Describe the structure and importance of crown ethers in organic synthesis.
26. Explain (a) Reformatsky reaction (b) Corey-House synthesis.
27. Starting from ethyl magnesium chloride how are the following compounds synthesized? (a) 2-methyl-2-butanol (b) propanoic acid (c) propanal (d) 3-pentanol.

28. Discuss the mechanism of (a) Cannizarro reaction (b) Aldol condensation
29. Discuss the reduction products of nitrobenzene under different media.
30. Discuss the structure of pyridine and comment on its electrophilic and nucleophilic reactions.

Section D (Essay)

Answer any two questions. Each question carries 10 marks

31. Explain S_N1 and S_N2 mechanisms with special reference to stereochemistry and solvent effects.
32. (a) Compare the acidity of alcohols and phenols. (b) Discuss the effect of substituents on the acidity of phenol.
33. Give a detailed account of the effect of substituents on the acidity of aliphatic and aromatic carboxylic acids.
34. (a) Discuss the synthetic uses of benzene diazonium chloride?
    (b) How urea is estimated by hypobromite method?

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FIFTH SEMESTER B. Sc. DEGREE EXAMINATION
CHE5B08; Core Course VIII: PHYSICAL CHEMISTRY - II

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

Section A (One word)

Answer all questions. Each question carries 1 mark

1. The rate of a chemical reaction doubles for every 10^{o}C rise in temperature. If the rate is increased by 60^{o}C, the rate of reaction increased by about ---------- times.
2. Quantum yield of Hydrogen-Chlorine reaction is ----------
3. Phosphorescence is due to transition from ----------
4. Conversion of a precipitate to colloidal state is called ---------
5. Name one optical property of colloid.
6. ---------- is an example for a system with incongruent melting point.
7. For the decomposition of $CaCO_3$, the number of components is equal to ---------
8. The principle of column chromatography is ----------
9. The basic requirement for a molecule to be micro wave active is the presence of ------
10. The zero point energy of a molecule undergoing simple harmonic oscillation is --------

Section B (Short answer)

Answer any ten questions. Each question carries 2 marks

11. Order of a reaction need not be whole number always. Account.
12. Give one example each for (i) a parallel reaction; (ii) a consecutive reaction.
13. What is chemiluminescence? Give one example.
14. Explain Bredig's method for the preparation of gold sol.
15. What is meant by Dorn Effect?
16. Name the different symmetry elements implied by C_6 axis.
17. Discuss the principle of gel permeation chromatography.
18. What type of molecules gives rotational Raman spectra?
19. What is Frank – Condon principle?
20. Write any two advantages of Raman spectra over IR spectra.
21. Discuss the ESR spectra of methyl radical.
22. What is proper axis of rotation?

Section C (Paragraph)

Answer any five questions. Each question carries 6 marks

23. Discuss briefly the activated complex theory of reaction rates.
24. Certain reactions have very high quantum yield whereas others have very low quantum yield. Explain.
25. Draw phase diagram of sulphur system. Explain it.
26. Draw and explain the phase diagram of Zn-Mg system.
27. Explain the term chemical shift?

28. Explain how rotational spectroscopy can be used to find the bond length.
29. Draw the group multiplication table of C_{2v} point group.
30. What is meant by inverse of an operation? Explain with suitable examples.

Section D (Essay)

Answer any two questions. Each question carries 10 marks

31. (a) Derive an expression for the rate constant of a bimolecular gaseous reaction using collision theory (b) The activation energy of a first order reaction is 250 $KJmol^{-1}$. The half life of the reaction is 6.5×10^6 second at 450^oC. What will be the half life at 550^oC?
32. (a) Give methods for purification of colloids (b) Derive Langmuir isotherm.
33. Discuss the principle and applications of high performance liquid chromatography.
34. a) Derive an expression for energy of a rigid rotator b) The pure rotational spectrum of gaseous HCl consists of a series of equally spaced lines separated by 20.80 cm^{-1}. Calculate the bond length of HCl. (The atomic mass of Hydrogen = 1.008 and that of Chlorine = 35.5 g/mol).

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SIXTH SEMESTER B. Sc. DEGREE EXAMINATION

CHE6B09; Core Course IX: INORGANIC CHEMISTRY - IV

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

Section A (One word)

Answer all questions. Each question carries 1 mark

1. The sulphide ores are generally concentrated by ----------
2. Ilmenite is an ore of ----------
3. Among the d-block elements, the density is maximum for --------
4. The electronic configuration of Gadolinium is ---------
5. The structural formula of Zn-EDTA complex is ----------
6. The spin only magnetic moment of $K_2[MnCl_4]$ is ---------
7. Draw the structure of cisplatin.
8. Wilkinson's catalyst is ----------
9. Vitamin B_{12} is a complex of --------
10. Give an example for a trace metal in biological system.

Section B (Short answer)

Answer any ten questions. Each question carries 2 marks

11. What is meant by Ellingham diagram? Represent the Ellingham diagram of a metal oxide.
12. Explain Van Arkel process with an example.
13. Transition metals are less reactive than alkali and alkaline earth metals. Justify your answer.
14. Give the IUPAC names of (a) $[Cu(NH_3)_4]SO_4$ (b) $K_3[Cu(SCN)_4]$ (c) $Fe(CO)_5$ (d) $Na_4[Fe(CN)_6]$
15. Octahedral field splitting energy is always greater than tetrahedral field splitting energy. Give reasons.
16. Draw the structures and specify the hybridization of the metal ion of $[Ni(CN)_4]^{2-}$ and $[CoCl_4]^{2-}$.
17. What is spectrochemical series? Why is it called so?
18. Explain why Cu^{2+} does not form regular octahedral complexes where as Ni^{2+} does.
19. Explain why $K_2[PtCl_6]$ does not give white precipitate of AgCl with $AgNO_3$.
20. $[V(CO)_6$ is readily reduced to $[V(CO)]_6^-$. Why?
21. Comment on the structure of $[Co_2(CO)_8]$.
22. Explain the toxicity produced by iron.

Section C (Paragraph)

Answer any five questions. Each question carries 6 marks

23. Describe Mond's process for the extraction of nickel.
24. Explain aluminothermic process giving suitable examples.
25. Give an account of the separation of lanthanide elements using ion-exchange resin.
26. Compare the complex forming abilities of lanthanides and actinides.
27. Discuss the splitting of *d* orbitals in square planar complexes.
28. What are the postulates of VBT of complexes? What are its demerits?

29. What is lanthanide contraction? Explain its causes and consequences.

30. Describe the structure of ferrocene.

Section D (Essay)

Answer any two questions. Each question carries 10 marks

31. Discuss the process of extraction of pig iron. How is it converted to wrought iron?
32. Write an account of the MOT of octahedral complexes containing only sigma bonds?
33. Describe the optical isomerism exhibited by coordination compounds, giving suitable examples.
34. (a) Explain the relative affinity of oxygen in haemoglobin and myoglobin. (b) Discuss the mechanism of sodium-potassium pump.

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SIXTH SEMESTER B. Sc. DEGREE EXAMINATION

CHE6B10; Core Course X: ORGANIC CHEMISTRY - III

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

Section A (One word)

Answer all questions. Each question carries 1 mark

1. How many absorption peaks are present in the NMR spectrum of neopentane?
2. The simplest aldose is ----------
3. The number of moles of phenyl hydrazine consumed when one mol of glucose is converted to osazone is -------
4. In a DNA molecule (A+T) / (G+C) ratio is 0.9. If the number of moles of cytosine in the molecule of DNA is 300000, the number of moles of thymine in the molecule is -------
5. When glucose is heated with large excess of HI, the product obtained is ----------
6. An example of an amino acid containing sulphur is ----------
7. The sunshine vitamin is ----------
8. Draw the structure of a female sex hormone.
9. Cheilosis is caused by the deficiency of vitamin ----------
10. The normal LDL level in human is ----------

Section B (Short answer)

Answer any ten questions. Each question carries 2 marks

11. What is chemical shift?
12. How will you distinguish 1,3 pentadiene and 1,4 pentadiene by UV spectroscopy?
13. Write a short note on mutarotation.
14. Glucose on treatment with Fehling's solution gives a red precipitate. Justify.
15. Draw the cyclic structures of maltose and sucrose.
16. What do you mean by isoelectric point?
17. Draw the structures of histidine, valine, tryptophan and leucine.
18. What is meant by saponification number? Explain its significance.
19. Write a brief note on anabolic steroids and their abuse.
20. Draw the structure of coniine. What are its physiological effects?
21. Draw the structures of menthol, citral, limonene and nicotine.
22. What is Cope rearrangement?

Section C (Paragraph)

Answer any five questions. Each question carries 6 marks

23. How will you distinguish $CH_3COOC_2H_5$ from $CH_3CH_2CH_2COOH$ by IR spectroscopy?
24. How will you convert fructose to glucose?
25. Discuss Killiani-Fischer reaction taking suitable example.
26. Explain the various steps involved in the sequencing of peptides by Edmann method.
27. Describe Watson and Crick model of DNA.

28. Draw the structures of Vitamin A, Vitamin B_3, Vitamin B_6 and Vitamin C. Name their deficiency diseases.
29. Write a short note on DNA finger printing and its applications.
30. What do you understand by the terms suprafacial and antrafacial overlapping?

Section D (Essay)

Answer any two questions. Each question carries 10 marks

31. (a) A compound containing C,H and O has the following spectral features. IR: 1720 cm^{-1}, 2900 cm^{-1}; NMR: δ2.32 (4H,q), δ1.02 (6H,t). Identify the compound and give suitable explanation for the spectral values. (b) A compound with molecular weight 116 gave the following spectral information. UV: 283 nm. IR: 3000-2500 cm^{-1} (*b*), 1715 cm^{-1} (*s*), 1342 cm^{-1}(*w*). NMR: τ7.88 (3H,s), τ7.40 (2H,t), τ 7.75(2H,t), τ -1.1(1H,s). Find the structural formula of the compound.
32. Discuss in detail the biosyntheisis of protein.
33. (a) Discuss the primary, secondary, tertiary and quaternary structure of proteins. (b) What is meant by denaturation of proteins? Give examples.
34. (a) Sketch the MO diagram of 1,3-butadiene and show the HOMO and LUMO in the ground state (b) Using the Frontier orbital diagram show the mode of cyclisation of 1,3-butadiene under thermal and photochemical conditions.

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SIXTH SEMESTER B. Sc. DEGREE EXAMINATION

CHE6B11; Core Course XI: PHYSICAL CHEMISTRY - III

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

Section A (One word)

Answer all questions. Each question carries 1 mark

1. In the electrolysis of dilute H_2SO_4 using platinum electrode ---------- is liberated at the cathode.
2. At 25^oC, the molar conductance at infinite dilution of HCl, CH_3COONa and NaCl are 26.1, 91 and 126.4 Sm^2mol^{-1}. Molar conductance of acetic acid at infinite dilution in Sm^2mol^{-1} is ----------
3. The standard electrode potential values of the elements A, B and C are 0.68, -2.50 and -5.0 V respectively. The order of their reducing power is ----------
4. In the lead-acid battery, during charging, the cathode reaction is ----------
5. The standard reduction potential of the following four metals with its metal ion is given as follows. Na/Na^+ = -2.75 V, Zn/Zn^{2+} = - 0.76 V, Cd/Cd^{2+} = - 0.40V, Sn/Sn^{2+} = -0.15 V. The order of the reducing power is ----------
6. Conjugate base of HCO_3^- is ---------
7. pH of an aqueous solution containing H^+ ion concentration 3 x 10^{-3} M is ---------
8. The value of Van't Hoff factor of potassium ferrocyanide in H_2O, assuming complete dissociation, is ----------
9. The freezing point of 0.1 M aqueous solution of glucose is -------- (cryoscopic contant of water = 1.86).
10. Number of particles per unit cell of fcc is ----------

Section B (Short answer)

Answer any ten questions. Each question carries 2 marks

11. Explain Debye – Falkenhagen Effect.
12. State the Debye-Huckel limiting law.
13. What is liquid function potential? How it can be eliminated?
14. Calculate the pH of 10^{-8}M HCl.
15. What is Ostwald's dilution law?
16. What is salt hydrolysis? What types of salts undergo hydrolysis?
17. Calculate the relative lowering of vapour pressure of 0.1 M aqueous solution of glucose.
18. Define coordination number of a particle in a crystal. What is the CN of Ca in CaF_2?
19. What is radius ratio? How does coordination number vary with the radius ratio?
20. What is a Frenkel defect? Explain.
21. Calculate the number of unit cells present in one gram of an ideal crystal of NaCl.
22. Calculate the Miller indices of a plane which cuts the X,Y and Z axis at 2*a*, 4*b* and 3*c* respectively, where *a*, *b* and *c* are unit intercepts.

Section C (Paragraph)

Answer any five questions. Each question carries 6 marks

23. State and explain Kohlrausch's law. How this law is useful for the calculation of molar ionic conductance at infinite dilution of weak electrolytes?
24. Explain the variation of equivalent conductance with dilution.
25. Write a note on H_2-O_2 fuel cell.
26. Quinhydrone electrode behaves as a reversible hydrogen electrode. Explain in detail.
27. What are the advantages of potentiometric titrations?
28. Derive the Henderson equation.
29. Write a note on non-stoichiometric defects in crystals.
30. Describe the powder method of X-ray diffraction of solids.

Section D (Essay)

Answer any two questions. Each question carries 10 marks

31. Discuss the application of conductivity measurements.
32. (a) What are concentration cells? How are they classified? Give examples. (b) Write the mechanism of rusting of iron. Which are the important methods for preventing corrosion?
33. (a) Define osmotic pressure. Describe a method for its measurement. (b) What are non-ideal solutions? Explain their classification with examples.
34. (a) Derive Bragg's equation (b) When a metal crystallizes in fcc, the edge length of the unit cell is found to be $4A^o$ and crystallized in bcc, the edge length is $3A^o$. Calculate the ratio of the densities of the metal in fcc and bcc forms.

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SIXTH SEMESTER B. Sc. DEGREE EXAMINATION

CHE6B12; Core Course IX: ADVANCED AND APPLIED CHEMISTRY

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

Section A (One word)

Answer all questions. Each question carries 1 mark

1. In carbon nanotubes carbon atoms are ---------- hybridized.
2. Give an example for a quantum dot.
3. The domain of chemistry beyond that of molecules and focuses on the chemical systems made up of a discrete number of assembled molecular subunits is called -----
4. Malabar Cements Ltd. is situated in ---------- district.
5. Pre-ignition of the fuel in the cylinder ahead of the flame is called ----------
6. The monomer of Lucite glass is ----------
7. A biodegradable polymer used for controlled drug release is ----------
8. Blue colour is imparted to glass by mixing with ----------
9. Write the structure of Endosulfan.
10. Name an artificial sweetener which is unstable at cooking temperature.

Section B (Short answer)

Answer any ten questions. Each question carries 2 marks

11. Write a note on graphene.
12. Define molecular self assembly.
13. Discuss the Green synthesis of ibuprofen.
14. What is meant by a programming language? Give examples.
15. Differentiate between renewable and non-renewable energy sourses.
16. Mention any four applications of polyacetylene.
17. Write the monomer unit/s present in Kevlar. Mention its important applications.
18. What is Bakelite? Briefly discuss its important applications.
19. What are the raw materials used for the manufacture of ammonium sulphate in FACT? What is the important use of ammonium sulphate?
20. What are rocket propellants? How are they classified?
21. What are antioxidants? Give examples.
22. Give the structure of Ajinomoto. For what purpose it is used?

Section C (Paragraph)

Answer any five questions. Each question carries 6 marks

23. What is combinatorial chemistry? Discuss briefly the applications of combinatorial synthesis in drug discovery.
24. Discuss molecular mechanic method for molecular geometry optimization.
25. Write a note on synthetic rubbers.
26. Discuss the composition and health effect of toothpaste and talcum powder.
27. Discuss carbon range and uses of various fractions of petroleum distillation.

28. Write short notes on (a) antacids (b) antihistamines (c) antibiotics.
29. Explain the terms (a) pharmacognosy (b) pharmacodynamics (c) pharmacokinetics.
30. Discuss the composition and health effects of soft drinks.

Section D (Essay)

Answer any two questions. Each question carries 10 marks

31. Write an essay on the applications of nanomaterials.
32. Explain the manufacture of cement. What is the chemistry behind the setting of cement?
33. Explain any five principles of Green chemistry.
34. (a) Discuss the theories of colour and chemical constitution (b) Outline the synthesis of Rosaniline and Indigo.

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SIXTH SEMESTER B. Sc. DEGREE EXAMINATION

CHE6B13(E2); Core Course XII: Elective - POLYMER CHEMISTRY

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

Section A (One word)

Answer all questions. Each question carries 1 mark

1. ---------- is a natural polymer.
2. ---------- is a condensation polymer.
3. ---------- is an example of a chain growth polymer.
4. ---------- is a cross linked polymer.
5. Heating natural rubber with sulphur is called ----------
6. The polymer used for making soft drink bottles is --------
7. The monomer of super glue is ----------
8. Mention any one use of melmac.
9. Name the polymer used in bullet proof vests.
10. Name the polymer used for preparing plugs and switches.

Section B (Short answer)

Answer any ten questions. Each question carries 2 marks

11. Discuss tacticity of a polymer.
12. What are semisynthetic polymers? Give examples.
13. What are copolymers? Give examples.
14. What are step growth polymers? Give examples.
15. Define Polydispersity Index. What is its significance?
16. What is injection moulding?
17. What are the uses of polyurethanes?
18. How is polypropene prepared? Mention its uses?
19. What is PVP? What are its uses?
20. What is PHBV? Mention its use.
21. Write a note on fire resistant polymers.
22. What are conducting polymers? Give examples.

Section C (Paragraph)

Answer any five questions. Each question carries 6 marks

23. Discuss the classification of polymers.
24. Discuss group transfer polymerization.
25. Discuss any three polymer degradation processes.
26. Discuss blow moulding and thermoforming.
27. What is meant by calendaring? Discuss the various steps used in it.
28. Write a note on plastic identification codes.

29. Discuss the preparation, properties and uses of saran, dynel and teflon.
30. Discuss the classification and important applications of carbon fibres.

Section D (Essay)

Answer any two questions. Each question carries 10 marks

31. Discuss the mechanism of Zeigler-Natta polymerization. What are its advantages?
32. What is glass transition temperature? What are the factors affecting Tg?
33. Discuss any four polymerisation techniques.
34. Discuss the preparation, properties and uses of synthetic rubbers.

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SIXTH SEMESTER B. Sc. DEGREE EXAMINATION

CHE6B14(P); Core Course XIII: PHYSICAL CHEMISTRY PRACTICAL

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

Section A

A. Write in the first ten minutes the procedure for the question marked in Section B.

(8 Marks)

Section B

B. Conduct the experiment for the question marked below and record the data and results neatly and systematically. *(56 Marks)*

1. Determine the cryoscopic constant (K_f) of the given solid solvent 1A--- . Solute IB---- of molecular mass------- is given. Conduct a duplicate experiment. Draw cooling curves for the solvent and the two trials. Report two K_f values. Weight of pure solvent given is ------ g.
2. Determine the molecular mass (M) of the given solute 2B -- by Rast method. K_f of the solvent 2A— is-------- . Conduct a duplicate experiment. Draw cooling curves for the solvent and the two trials. Report two M values. Weight of pure solvent given is ------- g.
3. Determine the transition temperature constant (K_t) of crystalline 3A---- . Solute 3B-- of molecular mass------ is given. Draw cooling curves for the solvent and the two trials. Report two K_t values. Weight of pure solvent is given is ------- g.
4. Determine the molecular mass (M) of the given solute 4B-- by measuring the depression in transition temperature of the solvent 4A---. Transition temperature constant (K_t) of crystalline 4A --- is------ . Draw cooling curves for the solvent and two trials. Report two M values. Weight of pure solvent given is ------- g.
5. Determine the composition of the given binary mixture of 5A----- & 5B----- viscometrically using at least five mixtures of known composition.
6. Determine the miscibility temperatures of at least five mixtures of standard aqueous solutions of sodium chloride and phenol & determine the concentration of the given sodium chloride solution 6A------- graphically.
7. Determine the composition of the given mixture 7A--- of glycerol and water by refractometric method, using five standard mixtures of the two components.
8. By potentiometric titration, standardize the given HCl solution 8A--- with the given standard KOH solution of normality
9. By conductometric titration, standardize the given HCl solution 9A---- with the given standard KOH solution of normality ---------

Section C

Viva-Voce *(8 marks)*

Record *(8 marks)*

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SIXTH SEMESTER B. Sc. DEGREE EXAMINATION

CHE6B15(P); Core Course XIV: ORGANIC CHEMISTRY PRACTICAL

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

Section A

Answer the following questions in 10 minutes.

1. The formula of Prussian blue is ----------
2. When cinnamic acid is treated with bromine water the compound formed is -------
3. When naphthalene in benzene is treated with picric acid in benzene, the compound formed has the structural formula ----------.
4. When acetophenone is treated with Borsche's reagent, the compound formed is ----.
5. Conversion of aniline into tribromoaniline is a/an ---------- reaction.
6. The electrophile during nitration is ----------
7. The structural formula of the compound formed by the acetylation of salicylic acid is ----.
8. Diazotisation of sulphanilic acid followed by coupling with N,N-dimethyl aniline yield ----.

(1x8 = 8 Marks)

Section B

Answer the following question in 10 minutes

9. Write the principle and procedure for the conversion of benzamide into benzoic acid.

(8 Marks)

Section C

10. Convert the whole of the given acetanilide in to *p*-nitroacetanilide. Exhibit the crude and crystallised samples for inspection. *(12 Marks)*
11. Analyse qualitatively and systematically the given organic compound by micro method with a view to identify the following.

    (a) Detect the elements present in it. (b) Find out whether the compound is aliphatic or aromatic.

    (c) Find out whether the compound is saturated or unsaturated. (d) Detect the elements present in it. (e) Identify and confirm the functional groups. (f) Suggest a suitable derivative. Give its method of preparation. Prepare the derivative suggested by the examiner and exhibit. (g) Write the systematic procedure of analysis including chemistry of identification tests, confirmation tests and derivative preparation.

(36 Marks)

Section D

Viva-Voce *(8 marks)*

Record *(8 marks)*

Name:.....
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SIXTH SEMESTER B. Sc. DEGREE EXAMINATION

CHE6B16(P); Core Course XV: INORGANIC CHEMISTRY PRACTCAL - II Time: 3 Hours Maximum marks: 80

Section A

1. Write a brief outline of the method used for the colorimetric estimation of chromium in the whole of the given solution of $K_2Cr_2O_7$. *(4 Marks)*
2. Write a brief outline of the method used for the gravimetric estimation of nickel in the whole of the given solution of nickel chloride. *(8 Marks)*

Section B

3. Estimate gravimetrically the mass of barium present in the whole of the given solution of barium chloride. *(37 Marks)*

Section C

Viva-Voce based on colorimetry and gravimetry *(8 marks)*
Record *(8 marks)*

Section D

Report of industrial visit *(8 marks)*
Viva-Voce based on industrial visit *(7 marks)*

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SIXTH SEMESTER B. Sc. DEGREE EXAMINATION

CHE6B17(P); Core Course XVI: INORGANIC CHEMISTRY PRACTICAL – III
Time: 3 Hours **Maximum marks: 80**

Section A

1. The reddish brown precipitate in the confirmatory test for Cu^{2+} ion is due to the formation of -----
2. The yellow precipitate formed in the identification test for phosphate, on adding conc. HNO_3 and ammonium molybdate, has the formula ---------
3. The compound responsible for the green edged flame in the ethyl borate test is ------
4. The chemical compound formed in the ash test for zinc is ----------

(4x1 = 4 Marks)

Section B

5. Write a brief outline of the method used for the preparation of ferric alum.(4 Marks)

Section C

6. Analyse qualitatively the given mixture by micro method to identify and confirm the two cations and two anions present in it. Record the data systematically including chemistry of identification tests, confirmation tests and elimination, if any.

(56 Marks)

Section D

Viva-Voce (*8 marks)*

Record

(8 marks)

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	36	2	80
	-	Complementary Course V: Chemistry Practical	2	36	-*	-
II	CHE2C02	Complementary Course II: Physical Chemistry	2	36	2	80
	-	Complementary Course V: Chemistry Practical	2	36	-*	-
III	CHE3C03	Complementary Course III: Organic Chemistry	3	54	2	80
	-	Complementary Course V: Chemistry Practical	2	36	-*	-
IV	CHE4C04	Complementary Course IV: Physical and Applied Chemistry	3	54	2	80
	CHE4C05(P)	Complementary Course V: Chemistry Practical	2	36	4*	80
				Total	**12**	**400**

* Examination will be held at the end of 4th semester

SEMESTER I

Course Code: CHE1C01
Complementary Course I: GENERAL CHEMISTRY
Total Hours: 36; Credits: 2; Hours/Week: 2

Module I: Some Basic Chemical Concepts (9 hrs)

Evolution of Chemistry- Ancient speculations on the nature of matter - Early form of Chemistry – Alchemy - Origin of modern chemistry.

Modern periodic law – Long form periodic table. Periodicity in properties: Atomic radii, ionic radii, ionization enthalpy, electron affinity (electron gain enthalpy) and electronegativity (Pauling scale).

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.

Theory of acids and bases: Arrhenius theory, Bronsted-Lowry theory and Lewis theory.

Module II: Analytical Chemistry (6 hrs)

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).

Module III: Atomic Structure and Chemical Bonding (9 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 - Valence bond 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.

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) and sp^3d^3 (IF_7).

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

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

Module IV: 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 - Nuclear reactors in India.

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

Module V: Bioinorganic Chemistry (6 hrs)

Metal ions in biological systems - Biochemistry of iron – Haemoglobin and myoglobin - Mechanism of O_2 and CO_2 transportation - 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. R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, 31st Edition, Milestone Publishers and Distributors, New Delhi, 2013.
2. C.N.R. Rao, *Understanding Chemistry*, Universities Press India Ltd., Hyderabad, 1999.
3. J. Mendham. R.C. Denney, J.D. Barnes and M. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Edition, Pearson Education, Noida, 2013.
4. G. Svehla, *Vogel's Qualitative Inorganic Analysis*, 7th Edition, Prentice Hall, New Delhi, 1996.
5. R.K. Prasad, *Quantum Chemistry*, 4th Edition, New Age International (P) Ltd., New Delhi, 2012.
6. Manas Chanda, *Atomic Structure and Chemical Bonding*, 4th Edition, Tata McGraw Hill Publishing Company, Noida, 2007.
7. H.J. Arnikar, *Essentials of Nuclear Chemistry*, 4th Edition, New Age International (P) Ltd., New Delhi, 1995 (Reprint 2005).
8. J.D. Lee, *Concise Inorganic Chemistry*, 5th Edition, Oxford University Press, New Delhi, 2008.

SEMESTER II

Course Code: CHE2C02
Complementary Course II: PHYSICAL CHEMISTRY
Total Hours: 36; Credits: 2; Hours/Week: 2

Module I: Thermodynamics (9 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.

Module II: Gaseous and Solid States (9 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.

Liquid crystals: Types, examples and applications.

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.

Module IV: Electrochemistry (12 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 and calomel electrode – Standard electrode potential - Nernst equation - Cation and anion reversible electrodes – H_2-O_2 fuel cell.

Ostwald's dilution law – Hydrolysis of salts - Buffer solutions – Henderson's equation – Applications of buffers.

References

1. B.R. Puri, L.R. Sharma and M.S. Pathania, *Principles of Physical Chemistry*, 46th Edition, Vishal Publishing Company, New Delhi, 2013.

2. J. Rajaram and J.C. Kuriacose, *Chemical Thermodynamics*, Pearson Education, New Delhi, 2013.

3. K.K. Sharma and L.K. Sharma, *A Textbook of Physical Chemistry*, 5th Edition, Vikas Publishing House, New Delhi, 2012.

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

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

SEMESTER III

Course Code: CHE3C03
Complementary Course III: ORGANIC CHEMISTRY
Total Hours: 54; Credits: 2; Hours/Week: 3

Module I: Organic Chemistry – Some Basic Concepts (9 hrs)

Introduction: Origin of organic chemistry – Uniqueness of carbon – Homologous series - Nomenclature of alkyl halides, alcohols, aldehydes, ketones, carboxylic acids and amines. Structural isomerism: Chain isomerism, position isomerism, functional isomerism and metamerism. Hybridisation in organic molecules (a brief study) - Curved arrow formalism - Homolysis and heterolysis of bonds - Electrophiles and nucleophiles.

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).

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

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 - Racemisation and resolution (elementary idea).

Module III: Aromatic Hydrocarbons (6 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 non-benzenoid (pyrrole, pyridine, indol and tropylium cation) aromatic compounds.

Module IV: Chemistry of Functional Groups – I (9 hrs)

Halogen Compounds: Preparation of alkyl halides from alkanes and alkenes - Wurtz reaction and Fittig's reaction - Mechanism of S_N^1 and S_N^2 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.

Ethers: Preparation by Williamson's synthesis – Acidic cleavage - Crown ethers (mention only).

Module V: Chemistry of Functional Groups – II (9 hrs)

Aldehydes & Ketones: Preparation from alcohols – Nucleophilic addition reactions (HCN and bisulphite) - Comparison of nucleophilic addition rate of aliphatic aldehydes and ketones – Preparation and importance of urotropine.

Carboxylic Acids: Preparation from Grignard reagent - HVZ reaction – Decarboxylation - Kolbe electrolysis.

Nitro Compounds: Preparation of TNT – Reason for its explosive nature - Preparation of picric acid from phenol.

Amines: Preparation from nitro compounds - Hofmann's bromamide reaction – Hofmann's carbylamine reaction. Basicity: Comparison of basicity of (i) ammonia, methyl amine and aniline (ii) aniline, N-methyl aniline and N,N-dimethyl aniline (iii) aniline, *p*-nitroaniline and *p*-anisidine.

Diazonium Salts: Preparation and synthetic applications of benzene diazonium chloride – Preparation and uses of methyl orange.

Module VI: Biomolecules (12 hrs)

Carbohydrates: Classification with examples – Cyclic structures of glucose, fructose and sucrose – Mutarotation – Starch, cellulose and glycogen – 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.

Lipids: Classification – Fats, oils and waxes (definition, structure and examples) – Saponification number and iodine number – Hydrogenation of oils and its application.

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.

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. L.G. Wade Jr., *Organic Chemistry*, 6th Edition, Pearson Education, New Delhi, 2013.
2. P.Y. Bruice, *Essential Organic Chemistry*, 1st Edition, Pearson Education, New Delhi, 2013.
3. I.L. Finar, *Organic Chemistry Vol. I&II*, 5th Edition, Pearson Education, New Delhi, 2013.
4. K.S. Tewari, N.K. Vishnoi and S.N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edition, Vikas Publishing House (P) Ltd., New Delhi, 2004.
5. A. Bahl and B.S. Bahl, *Advanced Organic Chemistry*, 1st Multicolour Edition, S. Chand & Company, New Delhi, 2010.
6. C.N. Pillai, *Organic Chemistry for Undergraduates*, 1st Edition, University Press, Hyderabad, 2008.
7. M.S. Singh, *Advanced Organic Chemistry: Reactions and Mechanisms*, Pearson Education, New Delhi, 2014.

SEMESTER IV

Course Code: CHE4C04
Complementary Course IV: PHYSICAL AND APPLIED CHEMISTRY
Total Hours: 54; Credits: 2; Hours/Week: 3

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.

Module II: Kinetics & Catalysis (9 hrs)

Kinetics: Rates of reactions - Factors influencing rate of reactions - Order and molecularity - Zero, first, second and third order reactions - Derivation of integrated rate equations for first order and second order reactions (single reactant only) - Half life period for first order reaction - Units of rate constants - Influence of temperature on reaction rates - Arrhenius equation - Calculation of Arrhenius parameters - Collision theory of reaction rate.

Catalysis: Types of catalysis – Homogeneous and heterogeneous catalysis. Theories of catalysis: Outline of intermediate compound formation theory and adsorption theory.

Module III: Chromatography (6 hrs)

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

Module IV: Spectroscopy (9 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).

Module V: Polymers (6 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.

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.

Solid Waste Management: Sanitary landfill and composting.

Module VII: Chemistry in Daily Life (12 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. Prodrug. Antipyretics, analgesics, antibiotics, antacids, antiseptics, antihistamines and tranquilizers (definition and examples, structures not expected).

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

Cleansing Agents: Soaps - Saponification of lipids – Hard and soft soaps. Detergents (classification and examples) – Cleansing action - Advantages and disadvantages of soaps and detergents. Composition and health effects of tooth paste.

Cosmetics: Hair dye, Talcum powder, perfumes and deodorants (composition and health effects).

Food: Food additives: Food preservatives, artificial sweeteners and antioxidants (definition and examples, structures not required) – Structure of BHT, BHA and Ajinomoto - Commonly used permitted and non-permitted food colours (structures not required) - Fast foods and junk foods & their health effects - Artificial ripening of fruits and its health effects. Importance of milk, coconut water and Neera.

Agriculture: Inorganic fertilizers: Essential nutrients for plants – Nitrogenous, phosphatic and potash fertilizers (examples only). Pesticides: Insecticides, herbicides, rodenticides and fungicides (definition

and examples only) – Structure of Endosulphan, DDT and BHC - Harmful effects of pesticides.

Cement: Manufacture, composition and setting.

Glass: Manufacture – Annealing - Types of glasses and uses.

References

1. B.R. Puri, L.R. Sharma and M.S. Pathania, *Principles of Physical Chemistry*, 46th Edition, Vishal Publishing Company, New Delhi, 2013.
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3. P.S. Kalsi, *Applications of Spectroscopic Techniques in Organic Chemistry***,** 6th Edition New Age International (P) Ltd., New Delhi, 2004.
4. C.N. Banwell and E.M. McCash, *Fundamentals* of *Molecular Spectroscopy*, 4th Edition, McGraw–Hill publishing Company Limited, New Delhi, 2002.
5. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, *Fundamentals of Analytical Chemistry*, 8th Edition, Brooks/Cole, Thomson Learning, Inc., USA, 2004.
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7. A.K. De, *Environmental Chemistry*, 6th Edition, New Age International Pvt. Ltd., New Delhi, 2006.
8. A.K. Ahluwalia, *Environmental Chemistry*, Ane Books India, New Delhi, 2008.
9. V.R. Gowarikar, *Polymer Chemistry*, New Age International Pvt. Ltd., New Delhi, 2010.
10. B.R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, 31st Edition, Milestone Publishers and Distributors, New Delhi, 2009.
11. Gurdeep R. Chatwal, *Synthetic Drugs*, Himalaya Publishing House, Bombay, 1995.
12. Jayashree Ghosh, *A Textbook of Pharmaceutical Chemistry*, 3rd Edition, S. Chand and Company Ltd., New Delhi, 1999.
13. B. Srilakshmi, *Food Science*, 5th Edition, New Age Publishers Pvt. Ltd., New Delhi, 2010.

SEMESTER IV

Course Code: CHE4C05(P)

Complementary Course V: CHEMISTRY PRACTICAL

Total Hours: 144; Credits: 4; Hours/Week: 2 (I, II, III & IV Semesters)

General Instructions

1. *Semi micro analysis or 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 10 volumetric estimations must be done to appear for the examination.*
7. *Practical examination will be conducted at the end of 4^{th} semester.*

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 Ttrations***
   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 and M. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Edition, Pearson Education, Noida, 2013.
2. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, *Fundamentals of Analytical Chemistry*, 8th Edition, Brooks/Cole, Thomson Learning, Inc., USA, 2004.
3. V.K. Ahluwalia, Sunita Dhingra and Adarsh Gulati, *College Practical Chemistry*, Universities Press (India) Pvt. Ltd., Hyderabad, 2008 (Reprint).
4. G. Svehla, *Vogel's Qualitative Inorganic Analysis*, 7th Edition, Prentice Hall, New Delhi, 1996.
5. V.V. Ramanujam, *Inorganic Semi Micro Qualitative Analysis*, 3rd Edition, 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.

Table 1: Components of Evaluation

Sl. No.	*Components*	*Marks*
1	Attendance	4
2	Test papers: I & II	4 + 4
3	Assignment	2
4	Viva-Voce	2
	Total Marks	16

Table 2: Percentage of Attendance and Eligible Marks

% of attendance	*Marks*
Above 90%	4
85-89%	3.2
80-84%	2.4
76-79%	1.6
75%	0.8

Table 3: Pattern of Test Papers

Duration	*Pattern*	*Total number of questions*	*Number of questions to be answered*	*Marks for each question*	*Marks*
1.5 Hours	One word	4	4	1	4
	Short answer	4	4	2	8
	Paragraph	3	2	5	10
	Essay	2	1	10	10
				*Total Marks**	32

*90% and above = 4, 80 to below 90% = 3.5, 70 to below 80% = 3, 60 to below 70% = 2.5, 50 to below 60% = 2, 40 to below 50% = 1.5, 35 to below 40% = 1, below 35% = 0.

2. EXTERNAL EVALUATION

External evaluation carries 80% marks. University examinations 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*	*Marks*
3 Hours	One word	10	10	1	10
	Short answer	10	7	2	14
	Paragraph	6	4	5	20
	Essay	4	2	10	20
				Total Marks	64

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	Attendance in the lab	4
2	Punctuality, performance and discipline	2
3	Model tests: I & II	2 + 2
4	Practical Record: Required number of experiments and neatness	4
5	Viva-Voce	2
	Total Marks	16

Table 2: Percentage of Attendance and Eligible Marks

% of attendance	*Marks*
Above 90%	4
85-89%	3.2
80-84%	2.4
76-79%	1.6
75%	0.8

Table 3: Number of Experiments and Marks for Practical Records

Number of Experiments (Marks in brackets)	
Volumetric Analysis	*Mixture Analysis*
13-14 (2)	10 (2)
11-12 (1.5)	8-9 (1.5)
10 (1)	7 (1)

2. EXTERNAL EVALUATION

External evaluation carries 80% marks. Practical examination along with Viva-voce will be conducted at the end of 4th semester.

Table 1: Pattern of Question Paper

Duration	*Pattern*	*Marks*	*Total Marks*
3 Hours	Question on qualitative and quantitative analysis	6	64
	Procedure on volumetric analysis	4	
	Volumetric analysis	20	
	Mixture analysis	24	
	Record	6	
	Viva voce	4	

Guidelines

1. *Valuation of Volumetric Procedure*: Eight points – 4 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: 16 marks; between 1.51 – 2%: 10 marks; between 2.1– 2.5%: 7 marks; between 2.51– 3%: 4 marks; greater than 3%: 2 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: 2 mark each. Cation confirmation tests: 3 marks each. Chemistry of confirmation tests: 2 mark each. Systematic procedure: 2 marks.

Table 2: Evaluation of Records

Number of Experiments (Marks in brackets)	
Volumetric Analysis Max. Marks: 3	*Mixture Analysis Max. Marks: 3*
12-13 (3)	10 (3)
11 (2.5)	9 (2.5)
10 (2)	8 (2)
9 (1.5)	7 (1.5)

MODEL QUESTION PAPERS

FOR

COMPLEMENTARY COURSES

Name:.....

Reg. No.:.....

FIRST SEMESTER B. Sc. DEGREE EXAMINATION
CHE1C01; Complementary Course I: GENERAL CHEMISTRY
Time: 3 Hours **Maximum marks: 64**

Section A (One word)

Answer all questions. Each question carries 1 mark

1. The volume occupied by 56g of nitrogen gas at STP is ---------- litre.
2. The shape of sulphate ion is ----------
3. The hybridization of iodine in IF_7 is ----------
4. The shape of pi electron cloud in acetylene is ----------
5. For a *3d* orbital, the value of *l* is ----------
6. Name the vitamin, which contain cobalt.
7. The radiant energy of sun is due to ----------
8. Name the indicator used in iodimetric titration.
9. In permanganometric titrations $KMnO_4$ behaves as a/an ----------
10. Draw the structure of N-phenyl anthranilic acid.

Section B (Short answer)

Answer any seven questions. Each question carries 2 marks

11. State modern periodic law.
12. Calculate the mole fraction of solute in 0.5 molal aqueous solution of sucrose.
13. What is lattice energy? What is its significance?
14. Explain the hybridization and shape of ethylene.
15. What are the limitations of Bohr theory?
16. What is mass defect?
17. Differentiate between isotopes and isotones.
18. How is N/P ratio related to nuclear stability?
19. Differentiate between accuracy and precision of a measurement.
20. Phenolphthalein is not suitable for the titration of a strong acid with weak base. Why?

Section C (Paragraph)

Answer any four questions. Each question carries 5 marks

21. What is electron affinity? Comment on the trends in the period and group with proper reasons.
22. What is electronegativity? Discuss the Pauling scale.
23. What are the postulates of VSEPR theory?
24. Discuss the sodium-potassium pump.
25. Describe how solubility product principle and common ion effect are applied in inorganic qualitative analysis?
26. Explain the function of metallochromic indicators in complexometric titrations?

Section D (Essay)

Answer any two questions. Each question carries 10 marks

27. Discuss the various theories of acids and bases.
28. Discuss the mechanism of O_2 transportation by haemoglobin.
29. Explain with examples how radioisotopes are useful in medical diagnosis and radiotherapy.

30. What are the postulates of Molecular Orbital Theory? Construct the energy level diagram for the electrons in O_2 molecule and account for its paramagnetic behavior.

Name:.....
Reg. No.:.....

SECOND SEMESTER B. Sc. DEGREE EXAMINATION

CHE2C02; Complementary Course II: PHYSICAL CHEMISTRY

Time: 3 Hours **Maximum marks: 64**

Section A (One word)

Answer all questions. Each question carries 1 mark

1. Entropy of CO at absolute zero is ----------
2. The work done during a reversible process is ---------
3. What is the number of atoms per unit cell of a crystal with bcc?
4. The surface tension of the liquid becomes ---------- at the critical temperature.
5. To which type of Bravais lattice does NaCl belong?
6. Properties which depend only on the number of particles and not on their nature are called ------
7. The freezing point of 0.1 M aqueous solution of glucose is -------- (cryoscopic contant of water = 1.86).
8. Specific conductance = Observed conductance x ----------
9. The oxidation potential of hydrogen electrode is taken as ----------
10. The additional potential, over and above the standard electrode potential, which is needed to secure the evolution of a gas at the electrode, in an electrolytic cell is called ---------

Section B (Short answer)

Answer any seven questions. Each question carries 2 marks

11. Define third law of thermodynamics.
12. Mathematically formulate the first law of thermodynamics.
13. Calculate the value of work done when 2g of H_2 expands from a volume of 1 litre to a volume of 10 litres at 27^0C.
14. Calculate the entropy of vapourisation of a liquid which boils at 120^oC. Given enthalpy of vapourisation is 3600 $Jmol^{-1}$.
15. Calculate the temperature at which O_2 molecule will have the same RMS velocity as CO_2 molecule.
16. If the intercepts of a crystal plane are *a/2, b*, and *c/2*, what are its Miller indices?
17. What is the effect of pressure on the melting point of ice?
18. Explain the term 'reverse osmosis'.
19. What is a half cell reaction?
20. Define Ostwald's dilution law.

Section C (Paragraph)

Answer any four questions. Each question carries 5 marks

21. Derive the relation between temperature and pressure for an adiabatic process.
22. Define vapour pressure. Explain liquid state as a continuation of the gaseous state into a region of high molecular forces.
23. Discuss the symmetry elements in crystals.
24. What are redox electrodes? Explain the construction and working of a redox electrode.
25. What are buffer solutions? How are they classified? Discuss the applications of Buffers.
26. Discuss the hydrolysis of various types of salts.

Section D (Essay)

Answer any two questions. Each question carries 10 marks

27. Derive Gibbs Helmholtz equation. What is its significance?
28. Give a brief account of the different types of defects of crystals.
29. (a) What are the laws of osmotic pressure? (b) Derive an expression for the molecular mass of a dissolved solute from the laws of osmotic pressure (c) A 5% solution of sucrose is isotonic with a 0.88% solution of a molecular solute at the same temperature. Calculate the molar mass of the solute.
30. Explain the principle of conductometric titrations. Discuss the titration curves of (a) a strong acid with a strong base (b) a strong acid with a weak base.

Name:.....
Reg. No.:.....

THIRD SEMESTER B. Sc. DEGREE EXAMINATION

CHE3C03; Complementary Course III: ORGANIC CHEMISTRY

Time: 3 Hours **Maximum marks: 64**

Section A (One word)

Answer all questions. Each question carries 1 mark

1. The IUPAC name of *tert*-butyl chloride is ----------
2. The temporary migration of pi electrons in presence of an attacking reagent is called ----------
3. Most stable conformation of cyclohexane is ---------
4. The optical isomers which are not mirror images are called ---------
5. Draw the structure of tropylium cation.
6. The electrophile in Friedel-Craft's acylation is ----------
7. For preparing *tert*-butyl ethyl ether by Williamson's synthesis, the reactants needed are ---------
8. When benzamide is warmed with Br_2 and alkali the product formed is ----------
9. Draw the structure of nicotine.
10. Give any one physiological function of coniine.

Section B (Short answer)

Answer any seven questions. Each question carries 2 marks

11. What are carbocations? Compare the stability of alkyl carbocations. Justify your answer.
12. What is metamerism? Give examples.
13. Draw and compare the stabilities of two extreme conformations of ethane.
14. What is meant by geometrical isomerism? Give examples.
15. What is Huckel's rule? Explain it taking a non-benzenoid aromatic compound as example.
16. What is the product obtained when benzene is first nitrated and then chlorinated? Justify.
17. What is mutarotation? Give example.
18. What is meant by vulcanization? What are its advantages?
19. Discuss briefly the isolation of essential oils from plants.
20. State and explain isoprene rule.

Section C (Paragraph)

Answer any four questions. Each question carries 5 marks

21. Discuss the optical isomerism in tartaric acid.
22. Discuss the mechanism of nitration and sulphonation in benzene.
23. Discuss the mechanism of S_N2 reaction in alkyl halides with special reference to stereochemistry.
24. Taking suitable examples compare the basicity of amines.
25. Discuss the primary, secondary and tertiary structure of proteins.
26. Define Saponification number and iodine number. What are their applications?

Section D (Essay)

Answer any two questions. Each question carries 10 marks

27. With suitable examples discuss the different types of electron displacement effects in organic compounds.
28. Write notes on (a) Luca's test (b) Chemistry of methanol poisoning (c) Harmful effects of ethanol in the human body.
29. Discuss the preparation and synthetic applications of benzene diazonium chloride.

30. Discuss in detail the double-helical structure of DNA.

Name:.....
Reg. No.:.....

FOURTH SEMESTER B. Sc. DEGREE EXAMINATION

CHE4C04; Complementary Course IV: PHYSICAL AND APPLIED CHEMISTRY

Time: 3 Hours **Maximum marks: 64**

Section A (One word)

Answer all questions. Each question carries 1 mark

1. ---------- is an example of multi molecular colloid.
2. The coagulating power of Na^{+}, Mg^{2+} and Al^{3+} in the coagulation of arsenic sulphide sol follow the order -------
3. The chromatographic technique where both stationary phase and mobile phase are liquids is called ----------
4. The range of fingerprint region in IR spectra is ---------- cm^{-1}.
5. The stretching frequency of C=N is observed at ---------- cm^{-1}.
6. The monomer of perlon is ----------
7. Give an example for a biodegradable polymer.
8. The excess nourishment of water body leading to its destruction is called ----------
9. Lung disease is mainly due to oxides of ----------
10. Give one example for an antipyretic.

Section B (Short answer)

Answer any seven questions. Each question carries 2 marks

11. What is Tyndall effect?
12. Define Gold number.
13. Order of a reaction need not be whole number always. Account.
14. Differentiate between thermoplastics and thermosetting plastics.
15. Mention the uses of kevlar, nomex and lexan.
16. What is acid rain? What are its harmful effects?
17. What are the harmful effects of CO?
18. Define the terms antihistamines and tranquilizers.
19. What is the composition of talcum powder and tooth paste?
20. What are fungicides? Give examples.

Section C (Paragraph)

Answer any four questions. Each question carries 5 marks

21. What are the applications of colloids?
22. Discuss briefly the activated complex theory of reaction rates.
23. (a) State and explain Beer-Lambert's law. (b) What are the possible electronic transitions in molecules?
24. Write a note on the structure and applications of synthetic rubbers.
25. Discuss the causes, effects and consequences of (a) depletion of ozone (b) green house effect.
26. Discuss the chemistry behind the setting of cement.

Section D (Essay)

Answer any two questions. Each question carries 10 marks

27. (a) Derive an expression for the rate constant of a bimolecular gaseous reaction using collision theory (b) The activation energy of a first order reaction is 250 $KJmol^{-1}$. The half life of the reaction is 6.5×10^6 second at 450^oC. What will be the half life at 550^oC?
28. Discuss the principle and applications of column chromatography and gas chromatography.
29. (a) Define chemical shift and spin-spin coupling (b) How NMR spectroscopy is useful in elucidating the structure of (i) ethanol and dimethyl ether (ii) Propanal and acetone.
30. (a) Discuss the theories of colour and chemical constitution (b) Discuss the manufacture of glass.

Name:.....
Reg. No.:.....

FOURTH SEMESTER B. Sc. DEGREE EXAMINATION
CHE4C05; Complimentary Course V: CHEMISTRY PRACTICAL

Time: 3 Hours **Maximum marks: 64**

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. The yellow precipitate formed on adding potassium chromate solution to Ba^{2+} salt solution is chemically ---------
5. What is/are the group reagent/s for 5^{th} group in inorganic qualitative analysis?
6. The chemical compound formed in the ash test for aluminium is ----------

(1x6 = 6 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.

(4 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.

(20 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. *(24 Marks)*

Part D

Viva-Voce *(4 marks)*

Record *(6 marks)*

SYLLABUS

FOR

OPEN COURSES

OPEN COURSE STRUCTURE

(FOR STUDENTS OTHER THAN B.Sc. CHEMISTRY)
Total Credits: 2 (Internal 20%; External 80%)

Semester	*Code No*	*Course Title*	*Hrs/ Week*	*Total Hrs*	*Marks*
V	CHE5D01	Open Course : Environmental Chemistry	2	36	50

SEMESTER V

Course Code: CHE5D01
Open Course : ENVIRONMENTAL CHEMISTRY
Total Hours: 36; Credits: 2; Hours/Week: 2

Note: *Structure and chemical equations not required.*

Module I: Environment (3 hrs)

Concept and scope of environmental chemistry – Segments of environment. Environmental pollution: Concepts and definition – Pollutant, contaminant, receptor and sink – Classification of pollutants - Global, regional, local, persistent and non-persistent pollutants.

Module II: Air Pollution (6 hrs)

Major regions of atmosphere – Tropospheric pollution and stratospheric pollution – Major air pollutants: Oxides of carbon, nitrogen and sulphur- Hydrocarbons – Chlorofluorocarbons - Particulates. Smog: London smog and photochemical smog. Automobile pollution. Effects of air pollution: Acid rain, green house effect and depletion of ozone layer. Control of air pollution - Alternate refrigerants - Bhopal Tragedy (a brief study). Causes, symptoms and drugs used for the treatment of air-borne diseases: Chickenpox, influenza, measles and tuberculosis.

Module III: Water Pollution (9 hrs)

Hydrological cycle – Importance of water - Aquatic pollution – Visible signs of aquatic pollution - Water pollution due to human activity – Pollution due to sewage, domestic wastes, industrial effluents, agricultural discharge, soaps and detergents. Eutrophication. Types of water pollutants: Biological agents, physical agents and chemical agents. Biological magnification and bioaccumulation. Water quality parameters: DO, BOD, COD, alkalianity, hardness, chloride, fluoride and nitrate. Toxic metals in water and their effects: Cadmium, lead and mercury - Minamata disaster (a brief study).

Water born diseases: Cholera, dysentery and typhoid – Symptoms and medicines.

Module IV: Soil, Noise, Thermal and Radioactive Pollutions (6 hrs)

Soil pollution: House hold, municipal and industrial solid wastes. Pollution due to plastics, pesticides, biomedical waste and E-waste (source, effects and control measures) – Non-degradable, degradable and biodegradable wastes. Hazardous waste. Noise pollution, thermal pollution and radioactive pollution (source, effects and control measures) – Hiroshima, Nagasaki and Chernobyl accidents (brief study). Endosulfan disaster in Kerala (brief study).

Module V: Pollution Control Measures (12 hrs)

Air pollution control measures – Gravitational settling chamber, fabric filter, wet scrubber, catalytic converters, stacks and chimneys, cyclone collectors, Cottrell electrostatic precipitator, extraction ventilator, zoning and green belt.Water treatment methods - Primary, secondary and tertiary methods - Aerobic and anaerobic oxidation - Sedimentation, coagulation, filtration, disinfection, desalination and ion exchange - USAB process and deep well injection.

Solid waste management: Recycling, incineration, digestion, dumping, land treatment and composting.

Introduction to Green chemistry (elementary ideas only).

Pollution Control Board: Duties and responsibilities (a brief study).

Some Environmental movements: Chipco, Narmada, Silent Valley and Plachimada.

References

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2. S.S. Dara, *A Textbook of Environmental Chemistry and Pollution Control*, 8th Edition, S. Chand and Sons, New Delhi, 2008 (Reprint).
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SCHEME OF EVALUATION

FOR

OPEN COURSES

OPEN COURSE: EVALUATION SCHEME

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

1. INTERNAL EVALUATION

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

Table 1: Components of Evaluation

Sl. No.	*Components*	*Marks*
1	Attendance	2.5
2	Test papers: I & II	2.5 + 2.5
3	Assignment / Viva	2.5
	Total Marks	10

Table 2: Percentage of Attendance and Eligible Marks

% of attendance	*Marks*
Above 90%	2.5
85-89%	2
80-84%	1.5
76-79%	1
75%	0.5

Table 3: Pattern of Test Papers

Duration	*Pattern*	*Total number of questions*	*Number of questions to be answered*	*Marks for each question*	*Marks*
1 Hour	One word	3	3	1	3
	Short answer	1	1	2	2
	Paragraph	2	1	5	5
	Essay	2	1	10	10
				Total Marks	20

obtained for internal examination to the university.

*Marks: 80% and above = 2.5, 60 to below 80% = 2, 50 to below 60% = 1.5, 40 to below 50% = 1, 35 to below 40% = 0.5, below 35% = 0.

2. EXTERNAL EVALUATION

External evaluation carries 80% marks. University examination will be conducted at the end of 5th semester.

Table 1: Pattern of Question Paper

Duration	*Pattern*	*Total number of questions*	*Number of questions to be answered*	*Marks for each question*	*Marks*
2 Hours	One word	10	10	1	10
	Short answer	7	5	2	10
	Paragraph	3	2	5	10
	Essay	2	1	10	10
				Total Marks	40

MODEL QUESTION PAPERS

FOR

OPEN COURSE

Name:.....
Reg. No.:.....

FIFTH SEMESTER B. Sc. DEGREE EXAMINATION

CHE5D01; Open Course 1: ENVIRONMENTAL CHEMISTRY

Time: 2 Hours **Maximum marks: 40**

Section A (One word)

Answer all questions. Each question carries 1 mark

1. Name a persistent pollutant.
2. The compound responsible for Bhopal Tragedy is ----------
3. Name a water-borne disease.
4. Name a pollution index in water.
5. The maximum permissible limit of fluoride in drinking water is ----------
6. Excess nourishment of water body leading to its destruction is called ----------
7. London smog is due to oxides of ----------
8. Silent Valley movement was against the construction of ----------
9. The hardness of water is due to ----------
10. The principle behind the desalination of sea water is ----------

Section B (Short answer)

Answer any five questions. Each question carries 2 marks

11. What are the different segments of environment?
12. Differentiate between a pollutant and a contaminant.
13. What is photochemical smog? What are its consequences?
14. Write a note on alternate refrigerants.
15. Write a short note on biomedical waste.
16. Discuss the working of wet scrubber.
17. Write a note on composting.

Section C (Paragraph)

Answer any two questions. Each question carries 5 marks

18. What is Green house effect? Discuss its causes and consequences.
19. What is radioactive pollution? How is it controlled?
20. Discuss the air pollution control by Cottrell electrostatic precipitator and extraction ventilator.

Section D (Essay)

Answer any one question. Each question carries 10 marks

21. (a) Discuss pollution due to soaps and detergents. (b) Name any two toxic metals in water and explain their harmful effects.
22. Discuss primary, secondary and tertiary methods of water treatment?