ST. JOSEPH'S COLLEGE (AUTONOMOUS)
DEVAGIRI, CALICUT

B.Sc. DEGREE PROGRAMME

IN

CHEMISTRY

UNDER CHOICE BASED CREDIT AND SEMESTER SYSTEM

(SJCBCSSUG 2019)

SCHEME AND SYLLABI

2019 ADMISSION ONWARDS

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 (16 instructional weeks and two weeks for examination) constitutes a **semester**.

Course means a segment of subject matter to be covered in a semester. The undergraduate programme includes 5 types of courses, *viz.*, common courses, core courses, complementary courses, open course and audit courses. **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 one Elective cource and 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. **Audit courses** are courses which are mandatory for a programme but not counted for the calculation of SGPA or CGPA. There shall be one audit course each in the first 4 semesters. Audit courses are not meant for class room study. The students can attain only pass (Grade P) for these courses. At the end of each semester there shall be examination conducted by the college from a pool of questions (Question Bank).

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. A student is required to acquire a minimum of 140 credits for the completion of the UG programme, of which 120 credits are to be acquired from class room study and shall only be counted for SGPA and CGPA. Out of the 120 credits, 38 (22 for common (English) courses + 16 for common languages other than English) credits shall be from common courses, 55 credits for core courses (including 2 credits each for project work and Elective), 24 credits for complementary courses (12 credits each) and 3 credits for the open course. Audit courses shall have 4 credits per course and a total of 16 credits in the entire programme.

Extra credits are mandatory for the programme. Extra credits will be awarded to students who participate in activities like NCC, NSS and Swatch Bharath. Those students who could not join in any of the above activities have to undergo Social Service Programme (SSP). Extra credits are not counted for SGPA or CGPA. The minimum credit acquired under extra credit shall be 4. If more Extra credit activities are done by a student that may be mentioned in the Grade card.

Each course shall have a unique alphanumeric code, which includes Letter G representing syllabus revision 2019, 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 to E) and the serial number of the course (01, 02 ……) last digit T for theory, P for practical, D for dissertation/project, V for Viva-Voce and F for Field study/Tour report. Core courses and courses in a particular complementary will be numbered continuously.

UNDERGRADUATE PROGRAMME IN CHEMISTRY

PREAMBLE

Science education is central to the development of any society. This can be achieved only by revamping the undergraduate programme to make it effective and meaningful. The development of scientific temper in society necessitates proper education and guidance. In order to achieve this, one must update the developments in the field of science. An effective science education can be imparted at the undergraduate level only by revamping the present curriculum. To achieve this goal, the curriculum should be restructured by emphasising 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 awareness and implementation of eco-friendly experiments becomes a global necessity. It is essential to ensure that laboratory chemicals are used at a minimal level without affecting the skill and understanding aimed through laboratory sessions. This creates an environmental awareness among the students and pollution free atmosphere in the campus.

During the preparation of the syllabus, the existing syllabus, the syllabi of XI^{th} & XII^{th} standards, UGC model curriculum and the syllabi of other universities have been referred. 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 given. A list of references and further readings are provided at the end of each unit.

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.

BROAD OBJECTIVES

To enable the students

- To understand basic facts and concepts in chemistry.
- To apply the principles of chemistry.
- To appreciate the achievements in chemistry and to know the role of chemistry in nature and in society.
- To familiarize with the emerging areas of chemistry and their applications in various spheres of chemical sciences and to apprise the students of its relevance in future studies.
- To develop skills in the proper handling of instruments and chemicals.
- To familiarize with the different processes used in industries and their applications.
- To develop an eco-friendly attitude by creating a sense of environmental awareness.
- To be conversant with the applications of chemistry in day-to-day life.

PSOs	PROGRAMME SPECIFIC OUTCOMES
PSO1	To achieve the knowledge about the rich history and role of chemistry in moulding the present world.
PSO2	To study the fundamentals of all the branches of chemistry
PSO3	To understand basic facts and concepts in chemistry.
PSO4	To apply the basic theoretical principles of chemistry.
PSO5	To appreciate the achievements in chemistry and to know the role of chemistry in nature and in society.
PSO6	To familiarize with the emerging areas of chemistry and their applications in various spheres of chemical sciences and to apprise the students of its relevance in future studies
PSO7	To develop skills in the proper and safe handling of instruments and chemicals.
PSO8	To familiarize with the different processes used in industries and their applications.
PSO9	To develop an eco-friendly attitude by creating a sense of environmental awareness
PSO10	To be conversant with the applications of chemistry in day-to-day life.
PSO11	To create interest in research in various field of chemistry.
PSO12	To make the student competent to clear various entrance examination for higher study such as CSIR-UGC, NET (LS) exams
PSO13	To develop the spirit of team work and effective communication skill.
PSO14	To enable the students to achieve the success through systematic planning and hard work.
PSO15	To create awareness among students regarding the future challenges before the scientific community.

PROGRAMME STRUCTURE
DISTRIBUTION OF CREDITS

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	-	-	3	12
VI	-	-	3+3+3+3+2# +4*+4*+4*+ 4*+2**	-	-	-	32
Total	**22**	**16**	**55**	**12**	**12**	**3**	**120**

*Practical **Project #Elective

Mark and Indirect Grading System

Mark and Indirect grading system is followed. After external and internal evaluations marks are entered. All other calculations, including grading, will be done by the college using the software. Indirect Grading System in 10 point scale is followed. Each course is evaluated by assigning marks with a letter grade (O, A^+, A, B^+, B, C, P, F, I or Ab) to that course by the method of indirect grading.

Mark Distribution

Sl. No.	*Course*	*Marks*
1	English	550
2	Additional Language	400
3	Core course: Chemistry	1475
4	Complementary course I: Mathematics	300
5	Complementary course II: Physics	400
6	Open Course	75
	Total Marks	3200

Ten point Indirect Grading System

% of Marks (Both Internal & external put together)	*Grade*	*Interpretation*	*Grade Point Average*	*Range of Grade points*	*Class*
95 and above	O	Outstanding	10	9.5 - 10	First Class with distinction
85 to below 95	A^+	Excellent	9	8.5 - 9.49	
75 to below 85	A	Very good	8	7.5 – 8.49	
65 to below 75	B^+	Good	7	6.5 – 7.49	First Class
55 to below 65	B	Satisfactory	6	5.5 – 6.49	
45 to below 55	C	Average	5	4.5 – 5.49	Second Class
35 to below 45	P	Pass	4	3.5 – 4.49	Third class
Below 35	F	Failure	0	0	Fail
Incomplete	I	Incomplete	0	0	Fail
Absent	Ab	Absent	0	0	Fail

CREDIT AND MARK DISTRIBUTION IN EACH SEMESTER

Total Credits: 120

Semester	*Course*	*Credit*	*Mark*
I	Common course: English	4	100
	Common course: English	3	75
	Common course: Additional Language	4	100
	Core Course I: Theoretical and Inorganic Chemistry- I	2	75
	Complementary course: Mathematics	3	75
	Complementary course: Physics	2	75
	Total	**18**	**500**
II	Common course: English	4	100
	Common course: English	3	75
	Common course: Additional Language	4	100
	Core Course II: Theoretical and Inorganic Chemistry- II	2	75
	Complementary course: Mathematics	3	75
	Complementary course: Physics	2	75
	Total	**18**	**500**
III	Common course: English	4	100
	Common course: Additional Language	4	100
	Core Course III: Physical Chemistry-I	3	75
	Complementary course: Mathematics	3	75
	Complementary course: Physics	2	75
	Total	**16**	**425**
IV	Common course: English	4	100
	Common course: Additional Language	4	100
	Core Course IV: Organic Chemistry-I	3	75
	Core Course V: Inorganic Chemistry Practical-I	4	100
	Complementary course: Mathematics	3	75
	Complementary course: Physics	2	75
	Complementary course: Physics Practical	4	100
	Total	**24**	**625**
V	Core Course VI: Inorganic Chemistry-III	3	75
	Core Course VII: Organic Chemistry-II	3	75
	Core Course VIII: Physical Chemistry-II	3	75
	Open course	3	75
	Total	**12**	**300**
VI	Core Course IX: Inorganic Chemistry-IV	3	75
	Core Course X: Organic Chemistry-III	3	75
	Core Course XI: Physical Chemistry-III	3	75
	Core Course XII: Advanced and Applied Chemistry	3	75
	Core Course XIII: Elective	2	75
	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	75
	Total	**32**	**850**

SYLLABUS

FOR

CORE COURSES

Core Course Structure - Total Credits: 55 (Internal: 20%; External: 80%)

Semester	*Code No*	*Course Title*	*Hrs/ Week*	*Total Hrs*	*Credit*	*Marks*
I	GCHE1B01T	Core Course I: Theoretical and Inorganic Chemistry- I	2	32	2	75
	-	Core Course V : Inorganic Chemistry Practical-I	2	32	-*	-
II	GCHE2B02T	Core Course II: Theoretical and Inorganic Chemistry- II	2	32	2	75
	-	Core Course V : Inorganic Chemistry Practical-I	2	32	-*	-
III	GCHE3B03T	Core Course III: Physical Chemistry-I	3	48	3	75
	-	Core Course V : Inorganic Chemistry Practical-I	2	32	-*	-
IV	GCHE4B04T	Core Course IV: Organic Chemistry-I	3	48	3	75
	GCHE4B05P	Core Course V : Inorganic Chemistry Practical-I	2	32	4	100
V	GCHE5B06T	Core Course VI: Inorganic Chemistry-III	3	48	3	75
	GCHE5B07T	Core Course VII: Organic Chemistry-II	4	64	3	75
	GCHE5B08T	Core Course VIII: Physical Chemistry-II	3	48	3	75
	-	Core Course XIV: Physical Chemistry Practical	5	80	-**	-
	-	Core Course XV: Organic Chemistry Practical	5	80	-**	-
	-	Core Course XVIII: Project Work	2	32	-**	-
VI	GCHE6B09T	Core Course IX: Inorganic Chemistry-IV	3	48	3	75
	GCHE6B10T	Core Course X: Organic Chemistry-III	3	48	3	75
	GCHE6B11T	Core Course XI: Physical Chemistry-III	3	48	3	75
	GCHE6B12T	Core Course XII: Advanced and Applied Chemistry	3	48	3	75
	GCHE6E01T	Core Course XIII: Elective*** — 1. Industrial Chemistry	3	48	2	75
	GCHE6E02T	2. Polymer Chemistry				
	GCHE6E03T	3. Medicinal and Environmental Chemistry				
	GCHE6B13P	Core Course XIV: Physical Chemistry Practical	-	-	4**	100
	GCHE6B14P	Core Course XV: Organic Chemistry Practical	-	-	4**	100
	GCHE6B15P	Core Course XVI: Inorganic Chemistry Practical-II #	5	80	4	100
	GCHE6B16P	Core Course XVII: Inorganic Chemistry Practical-III	5	80	4	100
	GCHE6B17D	Core Course XVIII: Project Work	-	-	2**	75
Total					**55**	1475

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

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

***Department 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: GCHE1B01T

Core Course I: Theoretical and Inorganic Chemistry- I

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

GCHE1B01T	Theoretical and Inorganic Chemistry-I	L*	T**	P***	C#
		2	0	0	2
Objective (s)	To gain detailed knowledge of the principle of volumetric analysis and properties of *s* and *p* block elements. To give a basic understanding of groundwork for a research project. Student will be able to analyse basic theory of acid base concept.				
Course outcome (s)					
CO1	To study the methodology of scientific research.				
CO2	To understand the principles behind volumetry				
CO3	To compare the characteristics of different elements				
CO4	To study molecular structure and bonding.				
CO5	To study and compare the properties of the compounds of some s and p block elements.				
CO6	To understand nuclear reactions and radioactivity.				

***Lecture, **Tutorial, ***Practical, #Credit**

Module I: Chemistry as a discipline of science (3 hrs)

What is Science? - Scientific statements - Scientific methods – Observation - Posing a question - Formulation of hypothesis – Experiment – Theory – Law - Revision of scientific theories and laws. Scientific research.Introduction, review of literature, scope, materials and methods, results and discussion, conclusions and bibliography.

References

1. J. A. Lee, *The Scientific Endeavor: A Primer on Scientific Principles and Practice*, PearsonEducation, 1999.

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

3. George Gamow,*One, Two, Three...Infinity: Facts and Speculations of Science*,Dover Publications, 1988.

4. *Resonance – Journal of Science Education*, Indian Academy of Sciences.

5. *Nature Chemistry*, Nature Publishing Group.

6. BBC documentary, *Chemistry: A Volatile History*.

Further reading

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.

Module II: Analytical Principles – I (7hrs)

Accuracy, precision, Types of error-absolute and relative error, methods of eliminating or minimizing errors. Methods of expressing precision: mean, median, deviation, average deviation and coefficient of variation. Significant figures and its application.

Mole concept.Equivalent mass.Methods of expressing concentration: Weight percentage, molality, molarity, normality, mole fraction, ppm and millimoles.Numerical Problems related to basic concepts.

Volumetric Analysis: Introduction - Primary and secondary standards – Standard solutions - Theory oftitrations 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 burettemethod of titration: Principle and advantages.

References

1. B.R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, 31stEdn., Milestone Publishers and Distributors, New Delhi, 2013.
2. SatyaPrakash, *Advanced Inorganic Chemistry*, *Volume 1*, 5thEdn., S. Chand and Sons, New Delhi, 2012.
3. J. Mendham, R.C. Denney, J. D. Barnes and M. Thomas, *Vogel's Text Book of Quantitative Chemical Analysis*, 6thEdn., Pearson Education, Noida, 2013.

Further reading

1. *Guidance in a Nutshell - Compilation of Safety Data Sheets*, European Chemicals Agency, Finland, Version 1.0, December 2013.
2. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, *Fundamentals of Analytical Chemistry*, 8thEdn., Brooks/Cole, Thomson Learning, Inc., USA, 2004.
3. R. H. Hill and D.Finster, *Laboratory Safety for Chemistry Students*, 1stEdn., Wiley, Hoboken, NJ, 2010.
4. M.C. Day and J. Selbin, *Theoretical Inorganic Chemistry*, East West Press, New Delhi, 2002.

Module III : Periodic Properties (3 hrs)

Modern periodic law – Long form periodic table. Periodicity in properties: Atomic and ionic radii.

Ionization enthalpy - Electron affinity (electron gain enthalpy) – Electronegativity: Pauling and Mullikan scales. Effective nuclear charge – Slater rule and its applications –Polarising power – Fajans rule.

References

1. B.R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, 31st Edn., Milestone Publishers and Distributors, New Delhi, 2013.
4. J. D. Lee, *Concise Inorganic Chemistry*, 5th Edn., Blackwell Science, London.

Module IV: Chemical bonding (6hrs)

Ionic Bond: Factors favouring the formation of ionic bonds - Lattice energy of ionic compounds - Solvation enthalpy and solubility of ionic compounds – Born-Haber cycle and its applications.

Covalent Bond: Lewis theory. Valence bond theory and formation of hydrogen molecule.VSEPR theory – hybridization of atomic orbitals. Shapes of simple molecules and ions on the basis of hybridization and VSEPR theory. Examples: sp- $BeCl_2$, sp^2 -BF_3, sp^3 -NH_3, H_2O, H_3O^+, sp^3d PCl_5, sp^3d^2 SF_6,and sp^3d^3 IF_7. Limitations of VBT. Properties of covalent compounds. Polarity of covalent bond – Percentage of ionic character – Dipole moment and molecular structure.

References

1. B.R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, 31st Edn., Milestone Publishers and Distributors, New Delhi, 2013.
2. SatyaPrakash, *Advanced Inorganic Chemistry,* Volume 1,5th Edn., S. Chand and Sons, New Delhi, 2012.
3. W. U. Malik, G.D. Tuli and R.D. Madan,*Selected Topics in Inorganic Chemistry,* S. Chand and Co., New Delhi, 2010.
4. J. D. Lee, *Concise Inorganic Chemistry*, 5th Edn., Blackwell Science, London.

Further reading

1. D. F. Shriver and P. W. Atkins, *Inorganic Chemistry*, 3rd Edn., Oxford University Press.
3. J.E. Huheey, E.A. Keitler and R.L. Keitler, *Inorganic Chemistry – Principles of Structure and Reactivity,* 4th Edn., Pearson Education, New Delhi, 2013.

Module V: Representative Elements (6 hrs)

Comparative study of s and p block elements based on electronic configuration, size, melting point, boiling point, density, ionization energy, electronegativity and oxidation state.

Standard electrodepotential, Flame colour of s block elements, Diagonal relationships- Inert pair effect.

Comparison of Lewis acidity of boron halides - Preparation, properties, structure and uses of Diborane, Boric acid, Borazine and Boron nitride – Structure of $AlCl_3$.

Structures of oxides N and P. Oxy acids of N and P. Structure of SO_2 and SO_3 - Oxy and peroxy acids of sulphur, Oxy acids of chlorine (structure and acidic strength only). Preparation, properties and uses of ammonia, nitric acid, ozone, hydrogen peroxide, sulphuric acid and hydrochloric acid.

References

1. B.R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, 31stEdn., Milestone Publishers and Distributors, New Delhi, 2013.
2. SatyaPrakash, *Advanced Inorganic Chemistry,* Volume 1,5thEdn., S. Chand and Sons, New Delhi, 2012.
3. W. U. Malik, G.D. Tuli and R.D. Madan,*Selected Topics in Inorganic Chemistry,* S. Chand and Co., New Delhi, 2010.
4. J. D. Lee, *Concise Inorganic Chemistry*, 5thEdn., Blackwell Science, London.

Further reading

1. D. F. Shriver and P. W. Atkins, *Inorganic Chemistry*, 3rdEdn., Oxford University Press.
2. M.C. Day and J. Selbin, *Theoretical Inorganic Chemistry*, East West Press, New Delhi, 2002.
3. J.E. Huheey, E.A. Keitler and R.L. Keitler, *Inorganic Chemistry – Principles of Structure and Reactivity*, 4thEdn., Pearson Education, New Delhi, 2013.

Module VI: Nuclear Chemistry (7hrs)

The atomic nucleus- nuclear forces- exchange theory- nuclear fluid theory- Nuclear stability- N/P ratio- Packing fraction- mass defect- nuclear binding energy- binding energy per nucleon- Nuclear fission- Atom bomb- Nuclear fusion- Hydrogen bomb. Nuclear reactors- Natural radioactivity- modes of decay- Group displacement law- Rate of decay and decay constant- Half- life period- Decay series.

Isotopes: Detection – Aston's mass spectrograph – Separation of isotopes by gaseous diffusion methodand thermal diffusion method – Application of radioactive isotopes – ^{14}C

dating – Rock dating – Isotopesas tracers – Study of reaction mechanism (ester hydrolysis) – Radio diagnosis and radiotherapy.

References

1. B.R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, 31stEdn., Milestone Publishers and Distributors, New Delhi, 2013.

2. H.J. Arnikar, *Essentials of Nuclear Chemistry*, 4thEdn., New Age International (P) Ltd., New Delhi, 1995.

Further reading

1. S. Glasstone, *Source Book on Atomic Energy*, 3rdEdn., East-West Press Pvt. Ltd., NewDelhi, 1967.
2. J.B. Rajam and L.D. Broglie, *Atomic Physics*, 7thEdn., S. Chand and Co. Pvt. Ltd., New Delhi, 1999.

Mark Distribution	
Module I	8 Marks
Module II	16 Marks
Module III	8 Marks
Module IV	16 Marks
Module V	15 Marks
Module VI	16 Marks

SEMESTER II

Course Code: GCHE2B02T

Core Course II: Theoretical and Inorganic Chemistry- II

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

GCHE2B02T	Theoretical and Inorganic Chemistry- II	L	T	P	C
		2	0	0	2
Objective(s)	Module I - The failures of classical physics theories in explaining many experiments and the emergence of quantum theory with which all of them could be satisfactorily explained. Module II – The basic postulates of quantum mechanics and how to solve the time-independent Schrödinger wave equation of different systems including H atom. Module III - The quantum mechanical treatment of chemical bonding in diatomic molecules using VB and MO theories. Module IV - The quantum mechanical treatment of hybridisation and bonding in polyatomic systems.				
Course outcome (s)					
CO1	To realize the importance and the impact of quantum revolution in science.				
CO2	To understand and apply the concept that the wave functions of hydrogen atom are nothing but atomic orbitals.				
CO3	To realize that chemical bonding is the mixing of wave functions of the two combining atoms.				
CO4	To understand the concept of hybridization as linear combination of orbitals of the same atom.				
CO5	To inculcate an atomic/molecular level philosophy in the mind.				

Module I: The Quantum revolution and its early impact in atomic structure (6hrs)

Experiments which led to the development and generalisation of quantum theory – black body radiation, Planck's quantum hypothesis, photoelectric effect, Einstein's generalisation of quantum theory.

Atomic model partly based on quantum theory – Bohr's theory of the atom, calculation of Bohr radius, velocity and energy of an electron. Atomic spectra of hydrogen and hydrogen like systems. Limitations of Bohr's theory. Louis de Broglie's matter waves – wave-particle duality. Electron diffraction.

Module II: Introductory Quantum Chemistry and the quantum mechanical model of the atom (10 hrs)

Operator algebra – linear and Hermitian operators, Laplacian and Hamiltonian operators, eigen functions and eigen values of an operator. Non-commuting operators and the Heisenberg's uncertainty principle.

Postulates of quantum mechanics. Well behaved functions. Time independent Schrödinger wave equation for conservative systems. 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. The wave equation in spherical polar coordinates. Separation of variables. Wave functions or atomic orbitals, Radial and angular parts of atomic orbitals. Quantum numbers (n, l, m). Radial functions, Radial distribution functions and their plots, Angular functions and their plots (1s, 2s and $2p_z$ only).

The Stern-Gerlach experiment and the concept of electron spin, spin quantum number, spin orbitals (elementary idea only). Pauli's exclusion principle.

Module III: Bonding in diatomic molecules (10 hrs)

Need for approximation methods in multi-electron systems. Born-Oppenheimer approximation. Variation theorem (elementary idea only).

Quantum mechanical concept of bonding – (mixing of wave functions of different atoms). Valence bond theory of H_2 molecule (derivation not required). Molecular orbital theory of H_2^+ ion H_2 molecule - linear combination of atomic orbitals (LCAO) and coefficients in the linear combination (derivation not required). Potential energy diagram of H_2 molecule formation – equilibrium geometry. Bonding and antibonding molecular orbitals, bond order. MO diagrams of homonuclear and heteronuclear diatomic molecules – He_2, Li_2, Be_2, B_2, C_2, N_2, O_2, F_2, CO and NO. Comparison of VB and MO theories.

Module IV: Bonding in polyatomic molecules (6 hrs)

Concept of Hybridization: Need of hybridization, Definition (mixing of wave functions of the same atom), LCAO of the central atom – coefficients of atomic orbitals in the linear combination of sp (BeH_2), sp^2 (BH_3) and sp^3 (CH_4) hybridisation (derivation not required).

Reference

1. D.A. McQuarrie and J.D. Simon, *Physical Chemistry – A Molecular Approach*, Viva, 2001.

2. I. N. Levine, *Quantum Chemistry*, 6th Edn., Pearson Education Inc., 2009.

3. P.W. Atkins and R.S. Friedman, *Molecular Quantum Mechanics*, 4th Edn., Oxford University Press, 2005.

4. R.K. Prasad, *Quantum Chemistry*, 3rd Edn., New Age International, 2006.

Further reading

1. A.K. Chandra, *Introductory Quantum Chemistry*, 4th Edn., Tata McGraw Hill Publishing Company, Noida, 1994.

Mark Distribution	
Module I	15 Marks
Module II	25 Marks
Module III	24 Marks
Module IV	15 Marks

SEMESTER III

Course Code: GCHE3B03T

Core Course III: PHYSICAL CHEMISTRY-I

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

GCHE3B03T	PHYSICAL CHEMISTRY-I	L	T	P	C
		3	0	0	3
Objective (s)	To understand the concepts of chemical thermodynamics, equilibria and group theory.				
Course outcome (s)					
CO1	To understand the properties of gases, Collision theory and how it links to thermodynamic systems				
CO2	To understand the fundamental concepts of thermodynamics, apply thermochemical principles to chemical reaction and the significance of entropy and free energy				
CO3	To analyse the concepts of chemical potential, probability and partition function				
CO4	To comprehend the concepts of law of mass action and chemical equilibria				
CO5	To apply symmetry operations to categorize different molecules				

Module I: Gaseous State (8 hrs)

Fundamentals of Gaseous state. 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.

References

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

2. P. W. Atkins, J. de Paula, *Atkin's Physical Chemistry* 8thEdn., Oxford University Press, 2006.

3. D. A. McQuarrie, J. D. Simon, *Physical Chemistry: A Molecular Approach*, University Science Books: Sausalito, CA; 1997.

4. K.L. Kapoor, *Physical Chemistry*, Volumes II and III, Macmillan Publishers, Noida, 2004.

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

6. S. Glasstone, D.H. Lewis, *Elements of Physical Chemistry*, 2nd Edn., Macmillan &Company,UK,1962.

7. F.Daniels, R.A.Alberty, *PhysicalChemistry*,5th Edn.,JohnWileyandSons,Canada, 1980.

8. P. Atkins, J. de Paula *The Elements of Physical Chemistry* 7thEdn., Oxford University Press, Oxford, 2016.

Module II: Chemical Thermodynamics–I (16 hrs)

Fundamentals of Chemical Thermodynamics. Path function and state function - Thermodynamic terms for defining System –Surroundings - Types of systems - intensive and extensive properties - Steady state and equilibrium state. Concept of thermodynamic equilibrium – 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 under isothermal and adiabatic conditions-Work done in isothermal expansion and reversible isothermal expansion - Joule-Thomson effect- significance of term $(\delta U/\delta V)_T$ – Liquefaction of gases-Derivation of the expression for Joule Thomson coefficient– Inversion temperature.

Thermochemistry: Heat changes during physicochemical processes. Kirchoff's relations. Bond dissociation energies. Resonance energy from thermochemical data- Changes of thermodynamic properties in different chemical changes. (work out problems)

Second law of thermodynamics-Need for the law-Kelvin – Planck and Clausius statements. Carnot's theorem - Carnot's cycle and its efficiency. Heat Engine

Calculation of entropy change for reversible and irreversible processes. Entropy change of systems and surroundings for various processes and transformations. Entropy change during the isothermal mixing of ideal gases. Entropy and unavailable work. Free energy functions (G and A) and their variation with T, P and V. Criteria for spontaneity and equilibrium.

Module III: Chemical Thermodynamics– II (8hrs)

Gibbs-Helmholtz equation – Partial molar free energy- Concept of chemical potential-Gibbs-Duhem equation. Maxwell relations.

Fundamental concepts of Statistical Thermodynamics – Probability– Partition function – ensembles- Boltzmann distribution derivation-Relation between entropy and probability-Stirling's approximation- Residual entropy and absolute entropy. Third law of thermodynamics-Nernst heat theorem-Statement of third law.

References

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

2. P. W. Atkins,J. de Paula, *Atkin's Physical Chemistry* 8th Edn., Oxford University Press (2006).

3. D. A. McQuarrie, J. D. Simon, Physical Chemistry: A Molecular Approach University Science Books: Sausalito, CA; 1997.

4. K.L.Kapoor, *Physical Chemistry*, Volumes II and III, Macmillan Publishers, Noida, 2004.

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

6. S. Glasstone, D.H. Lewis, *Elements of Physical Chemistry*, 2nd Edn., Macmillan &Company,UK,1962.

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

8. P.W. Atkins and J. de Paula *The Elements of Physical Chemistry* 7th Edn.,Oxford University Press, Oxford, 2016.

9. T. Engel, P. Reid, *Thermodynamics, Statistical Thermodynamics, & Kinetics* Pearson Education, Inc: New Delhi (2007).

10. D. A. McQuarrie, *Statistical Mechanics* University Science Books 2000.

11. J.Rajaram, J.C.Kuriacose, *Chemical Thermodynamics*, Pearson Education, NewDelhi, 2013.

Module IV: Chemical Equilibria (8 hrs)

Law of mass action, thermodynamic derivation of Law of chemical equilibrium. Relation between Gibbs free energy of reaction and equilibrium constant. Equilibrium constants and their quantitative dependence on temperature, pressure and thermodynamic derivation of relations between the various equilibrium constants K_p, K_c and K_x. (using chemical potential) Van't Hoff's equation - Le Chatelier principle (quantitative treatment). Homogeneous and heterogenous equilibria

References

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

2. P. W. Atkins, J. de Paula, *Atkin's Physical Chemistry* 8th Ed., Oxford University Press, 2006.

3. D. A. McQuarrie, J. D. Simon, *Physical Chemistry: A Molecular Approach*, University Science Books: Sausalito, CA; 1997.

4. G.M. Barrow, *Physical Chemistry*,5th Edn.,Tata McGraw Hill Education, NewDelhi, 2006.

5. K.L. Kapoor, *Physical Chemistry*,VolumesIIand III, Macmillan Publishers, Noida, 2004.

6. S. Glasstone, D.H. Lewis, *Elements of Physical Chemistry*, 2nd Edn., Macmillan &Company,UK,1962.

7. F.Daniels, R.A.Alberty, *PhysicalChemistry*,5th Edn., John Wiley and Sons, Canada, 1980.

8. P. W. Atkins, J. de Paula *The Elements of Physical Chemistry* 7thEdn., Oxford University Press, Oxford, 2016.

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

Module V:Molecular Symmetry and Group Theory (8 hrs)

Elements of symmetry of molecules (Identity, proper axis of rotation, plane of symmetry, centre of symmetry and improper axis of rotation) – corresponding symmetry operations – Schonflies notation – binary combinations of symmetry operations.

Rules for a set of elements to form a Mathematical group – point group classification of simple molecules– C_{nv},C_{nh},D_{nh}. Group multiplication table forC_{2v},and C_{2h}.

References

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

2. P. W. Atkins, J. de Paula, *Atkin's Physical Chemistry* 8thEdn., Oxford University Press (2006).

3. D. A. McQuarrie, J. D. Simon, *Physical Chemistry: A Molecular Approach*, University Science Books: Sausalito, CA; 1997.

4.K.L.Kapoor, *Physical Chemistry*, Volumes II and III, Macmillan Publishers, Noida, 2004.

5. B. S. Garg, *Chemical Applications of Molecular Symmetry and Group Theory*, Macmillan Publishers India Ltd., 2012.

6. G.M.Barrow, *Physical Chemistry*,5th Edn.,Tata McGraw Hill Education, NewDelhi, 2006.

7. S. Glasstone, D.H. Lewis, *Elements of Physical Chemistry*, 2nd Edn., Macmillan &Company,UK,1962.

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

9. P. W. Atkins, J. de Paula *The Elements of Physical Chemistry,* 7th Edn.,Oxford University Press, Oxford, 2016.

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

11. F.A.Cotton, *Chemical Applications of Group Theory,* 3rd Edn., JohnWiley&Sons,New Delhi.

Mark Distribution	
Module I	14 Marks
Module II	25 Marks
Module III	14 Marks
Module IV	12 Marks
Module V	14 Marks

SEMESTER IV

Course Code: GCHE4B04T

Core Course IV: ORGANIC CHEMISTRY– I

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

GCHE4B04T	ORGANIC CHEMISTRY– I	L	T	P	C
		3	0	0	3
Objective (s)	Student will be able to analyse basic theory and concepts of organic chemistry and appreciate different organic reaction mechanism and their stereochemistry				
Course outcome (s)					
CO1	To apply the concept of stereochemistry to different compounds				
CO2	To understand the basic concepts of reaction mechanism				
CO3	To understand the mechanism of a chemical reaction				
CO4	To analyse the stability and reactivity of different aromatic systems				

Module I: Reaction Mechanism: Basic Concepts (6 hrs)

Electronic effects (Inductive, Electromeric, Resonance and hyperconjugation) and steric effects and its applications in acid/base properties.

Types of reagents: Electrophiles and nucleophiles.

Types of organic reactions: Substitution, addition, elimination and rearrangement (definition and examples).

Reaction Intermediates: Structure, formation and stability of carbocations, carbanions, free radicals and carbenes. Some representative reactions.

Module II: Stereochemistry (16 hrs)

Stereoisomerism: Classification into conformational isomerism and configurational isomerism.

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

Conformational Isomerism: Conformations – Conformational analysis of ethane, propane and n-butane including energy diagrams. Conformations of cycloalkanes – Relative stability of cyclopropane, cyclobutane, cyclopentane and cyclohexane explained based on torsional strain and angle strain. Conformations of cyclohexane and their relative stability (chair, half chair, twist boat and boat)–Conformations and stability of mono and disubstituted (1,2-disubstituted, 1,3-disubstituted and 1,4-disubstituted) cyclohexanes. Cis-trans isomerism in cycloalkanes.

Configurational isomerism: Geometrical isomerism and Optical isomerism.

Geometrical Isomerism: Definition, condition, geometrical isomerism in but-2-ene, fumaric & maleic acid. *cis-trans, Syn-anti* and *E-Z* notations with examples.

Optical Isomerism: Optical activity – Concept of chirality –Enantiomers, Diastereomers and Meso compounds. Relationships between symmetry and chirality. Optical isomerism in glyceraldehyde, lactic acid and tartaric acid. Relative and absolute configuration, sequence

rules, D&L and R & S systems of nomenclature for acyclic optical isomers with one and two asymmetric carbon atoms. Erythro and threo representation with examples.
Optical isomerism in compounds lacking asymmetric carbon atoms: Biphenyls and allenes.
Racemic mixture - Resolution methods. Concept of asymmetric synthesis and enantiomeric excess.

Module III: Aliphatic Hydrocarbons and alkyl halides (16 hrs)

Alkanes: Preparation – Catalytic hydrogenation of alkenes and alkynes, from alkyl halides (Reduction of alkyl halides, Wurtz reaction and Corey-House synthesis), from carbonyl compounds (Clemmensen reduction, Wolf-kishner reduction and Kolbe reaction). Chemical reactions: Halogenation–Mechanism of free radical chlorination.
Alkenes: Preparation – Reduction of alkynes, Dehydrohalogenation of alkyl halides (Saytzeff's rule), dehalogenation of dihaloalkanes and dehydration of alcohols (Wagner-Meerwin rearrangement). Chemical reactions: Addition of halogens (electrophilic addition with mechanism and stereochemistry), addition of hydrogen halides (Markownikov and Anti-Markownikov addition with mechanism) and addition of water (mechanism expected) – conversion to alcohol (oxymercuration-reduction and hydroboration-oxidation) – Oxidation of alkenes– Epoxidation, dihydroxylation (*Cis* and *trans* hydroxylation) and oxidative cleavage (permanganate cleavage and ozonolysis) —Polymerization of alkenes.
Alkynes: Preparation from dihalides and acetylides. Chemical reactions: Addition of hydrogen using Lindlar's catalyst and Na/liquid ammonia –Electrophilic addition of halogens and hydrogen halides–Nucleophilic addition reactions– Acidity of alkynes–Oxidation reactions (Ozonolysis and reaction with alkaline $KMnO_4$). Hydration of alkynes and Hydroboration-oxidation of alkynes. Chemistry of the test for unsaturation: Bromine water and Baeyer's reagent.

Module IV: Aromatic and Heterocyclic Chemistry (10 h)

Structure and stability of benzene (Resonance and Molecular Orbital model). Huckel's rule and aromaticity. Applications of Huckel's rule to aromatic – anti-aromatic – non aromatic compounds. Aromaticity of benzenoid (benzene, naphthalene and anthracene) non-benzenoid (furan, thiophene, pyrrole, pyridine) and other cyclic systems – cyclopropene and cyclopropenyl ions, cyclopentadiene and cyclopentadienyl ions, cycloheptatriene and tropylium ion, cyclooctateraene and azulene and annulenes.
Aromatic Electrophilic substitution – General pattern of the mechanism, Mechanism of nitration, halogenation, sulphonation, Friedel-Craft's alkylation (and its limitation) and acylation. Orientation and reactivity in monosubstituted benzene – Ring activating and deactivating groups with examples - *ortho, para* and *meta* directing groups.
Electrophilic substitution reaction of Naphthalene and its derivatives
Heterocyclic chemistry: Monocyclic compounds with one hetero atom (Pyrrole, Furan, Thiophene and Pyridine). Synthesis: Paal-Knorr Synthesis of Pyrrole, Furan and Thiophene; Hantzsch synthesis of Pyridine.

Electrophilic substitution reactions: General reactivity and position of substitution with examples. Basicity of Pyridine. Nucleophilic substitution reaction of Pyridine: Chichibabin reaction.

Text Books

1. Bhupinder Mehta and Manju Mehta, *Organic Chemistry*, 2nd Edition, PHI learning Private Ltd, New Delhi, 2005.
2. Jagdamba Singh and L.D.S. Yadav, *Undergraduate Organic Chemistry* Vol-1 & Vol-II, 7th Edition, Pragathi Prakashan, Meerut
3. Peter Sykes, *A Guide Book to Mechanism in Organic Chemistry*, 6th Edition, Pearson Education, New Delhi, 2013.
4. John McMurry, *Introduction to Organic Chemistry*, Brooks/Cole, Pacific Grove, California, 2007.
5. R.T. Morrison, R.N. Boyd, *Organic Chemistry*, 7th Edition, Pearson Education, New Delhi, 2013.
6. K.S. Tewari, N.K. Vishnoi and S.N. Mehrotra, *A Textbook of Organic Chemistry*, 3rd Edn., Vikas Publishing House.
7. S.C. Sharma and M.K. Jain, *Modern Organic Chemistry*, Vishal Publishing Company, New Delhi, 2014.

Further Reading

1. J. March, *Advanced Organic Chemistry*, 4th Edn, John Wiley & Sons, NY
2. J. Clayden, N. Greeves, S. Warren, P. Wothers, *Organic Chemistry*, Oxford University Press.
3. Paula Y. Bruice, *Organic Chemistry*, 3rd Edn. Pearson Education.
4. P.S. Kalsi, *Organic Reactions, Stereochemistry and Mechanism*, 4th Edition, New Age International Publishers, New Delhi, 2006.
5. D. Nasipuri, *Stereochemistry of Organic Compounds*, New Age International Publishers.

Mark Distribution	
Module I	10 Marks
Module II	26Marks
Module III	26 Marks
Module IV	17 Marks

SEMESTER IV

Course Code: GCHE4B05P

Core Course V: INORGANIC CHEMISTRY PRACTICAL – I

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

GCHE4B05P	**INORGANIC CHEMISTRY PRACTICAL – I**	L	T	P	C
		0	0	2	4
Objective (s)	Development of skills in preparation of standard solutions and quantitative volumetric analysis.				
Course outcome (s)					
CO1	To enable the students to develop skills in quatitative analysis and preparing inorganic complexes.				
CO2	To understand the principles behind quantitative analysis				
CO3	To apply appropriate techniques of volumetric quantitative analysis in estimations				
CO4	To analyze the strength of different solutions				

General Instructions

1. Use safety coat, goggles, shoes and gloves in the laboratory.

2. For weighing electronic balance must be used.

3. Double burette titration method must be used for acid base titrations. Single burette method can be followed for other titrations.

4. Experiments may be selected in such a way to give maximum preference for Modules from IV to VII.

5. A minimum number of 1 experiment from III, 14 experiments covering IV to VII modules and 4 inorganic preparations must be done to appear forthe examination.

6. Practical examination will be conducted at the end of 4^{th} semester.

Module I: Laboratory Hygiene and Safety

Awareness of Material Safety Data Sheet (MSDS).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 tophenol and bromine. Disposal of sodium and broken mercury thermometer - Use of calcium chloride andsilica gel in desiccators. – R & S Phrases (elementaryidea only) – Safe laboratory practices – Lab safety signs.Personal Protective Equipment (PPE).

Module II: Introduction to Volumetric Analysis

1. Weighing using electronic balance.

2. Preparation of standard solutions.

Module III: Technique of Quantitative Dilution

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 IV: 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 thecomposition.

6. Estimation of borax.

Module V: 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 VI: Precipitation Titration (using adsorption indicator)

1. Estimation of chloride in neutral medium.

Module VII: Complexometric Titrations

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

Module VIII: 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 available chlorine in bleaching powder.
4. Determination of COD of water samples.
5. Estimation of citric acid in lemon or orange.

Module IX: 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. *Guidance in a Nutshell - Compilation of Safety Data Sheets*, European Chemicals Agency, Finland, Version 1.0, December 2013.
2. R. H. Hill and D.Finster, *Laboratory Safety for Chemistry Students*, 1st Edn., Wiley, Hoboken, NJ, 2010.
3. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Edn., Pearson Education, Noida, 2013.
4. D.A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, *Fundamentals of Analytical Chemistry*, 8th Edition, Brooks/Cole, Thomson Learning, Inc., USA, 2004.
5. G.D. Christian, *Analytical Chemistry*, 7th Edn., John Wiley and Sons, New York, 2013.

6. A.L. Underwood, *Quantitative Analysis*, 6thEdn., Prentice Hall of India Pvt. Ltd, New Delhi, 1999.
7. D.N. Bajpai, O. P. Pandey, S. Giri, *Practical Chemistry; For I, II & III B. Sc. Students*, S. Chand & Company Ltd, New Delhi, 2012.
8. W.G. Palmer, *Experimental Inorganic Chemistry*, Cambridge University Press, 1970.

SEMESTER V

Course Code: GCHE5B06T

Core Course VI: INORGANIC CHEMISTRY – III

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

GCHE5B06T	INORGANIC CHEMISTRY – III	L	T	P	C
		3	0	0	3
Objective (s)	To gain detailed knowledge of the chemistry of different analytical principles and to develop concerns for environment. To give a basic understanding of different metallurgical processes, interhalogen compounds and inorganic polymers.				
Course outcome (s)					
CO1	To understand the principles behind quanlitative and Gravimetric analysis				
CO2	To understand basic processes of metallurgy and to analyse the merit of different alloys				
CO3	To understand the applications of different inorganic polymers				
CO4	To analyse different polluting agents				
CO5	To apply the principles of solid waste management				

Module I: Analytical Principles II (6hrs)

Qualitative Analysis: Applications of solubility product and common ion effect in the precipitation ofcations – Interfering acid radicals and their elimination (oxalate, fluoride, borate, phosphate, chromate,arsenite and arsenate) – Introduction of micro scale experiments in inorganic and organic qualitativeanalysis & their advantages. Preparation of Na_2CO_3 extract for inorganic qualitative analysis and it's advantages.

Gravimetric analysis –Mechanism of precipitate formation.Factors affecting solubility/stability of precipitates. Co-precipitation and post precipitation. Digestion, washing, drying and ignition of precipitates.

References

1. Jeffrey A. Lee, *The Scientific Endeavor: A Primer on Scientific Principles and Practice,* Pearson Education, 1999.

2. J. Mendham, R.C. Denney, J. D. Barnes, M. Thomas, *Vogel's Text Book of Quantitative Chemical Analysis*, 6thEdn., Pearson Education, Noida, 2013.

Further reading

1. D.A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, *Fundamentals of Analytical Chemistry*, 8thEdn., Brooks/Cole, Thomson Learning, Inc., USA, 2004.
2. A.I. Vogel, *A Textbook of Quantitative Inorganic Analysis*, 3rdEdn., Longmans, Green, London, 1962.

Module II: Metallurgy (10 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, Cu Ti and U. 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).

References

1. B. R. Puri, L. R. Sharma, K. C. Kalia, *Principles of Inorganic Chemistry*, 31stEdn., Milestone Publishers, New Delhi 2010.
2. S. Prakash, G. D. Tuli, S. K. Basu, R. D. Madan, *Advanced Inorganic Chemistry*, 5thEdn.,Volume I, S Chand, 2012.

Further reading

1. A. Cottrel, *An introduction to metallurgy*, 2ndEdn., University press. 1990.

Module III: Interhalogen compounds (5hrs)

Halogens, properties, electronic configuration, electronegativity, electron affinity.

Electropositive character of iodine – General preparation and properties of interhalogen compounds (study of individual members notrequired) – Structure and hybridization and reactivity of ClF_3, ICl_3 IF_5 and IF_7- Comparison of properties of halogens and pseudohalogens (cyanogens as example) – Structure of polyhalide ions.

References

1. B. R. Puri, L. R. Sharma, K. C. Kalia, *Principles of Inorganic Chemistry*, ShobanLalNagin Chand and Co.,Delhi, 1996.
2. D. F. Shriver, P.W. Atkins, *Inorganic Chemistry*, 3rdEdn., Oxford University Press, 2006.

Further reading

1. J. E. Huheey, E. A. Keiter, R. L. Keiter, O K Medhi, *Inorganic Chemistry*, 4thEdn., Pearson. 2006.
2. F. A. Cotton, G. Wilkinson, C. Murillo, M. Bochman, *Advanced Inorganic Chemistry*, 6thEdn., John Wiley, New York, 1999.
3. F. A. Cotton, G. Wilkinson, P.L. Gaus, *Basic Inorganic Chemistry*, 3rdEdn., John Wiley, New York, 2008.

Module IV: Noble Gases (3 hrs)

Prerequisites: Why the name noble gas, electronic configuration.

Discovery – Occurrence – Separation by charcoal adsorption method – Structure ofoxides, fluorides and oxy fluorides of xenon – Reaction of xenon fluorides with water – Uses of noblegases.

References

1. B. R. Puri, L. R. Sharma, K. C. Kalia, *Principles of Inorganic Chemistry*, ShobanLalNagin Chand and Co.,Delhi, 1996.
2. D. F. Shriver, P.W. Atkins, *Inorganic Chemistry*, 3rdEdn., Oxford University Press, 2006.
3. M. N. Greenwood, A. Earnshaw, *Chemistry of the elements*, 2ndEdn, Butterworth, 1997.

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1. J. E. Huheey, E. A. Keiter, R. L. Keiter, O K Medhi, *Inorganic Chemistry*, 4thEdn., Pearson. 2006.
2. F. A. Cotton, G. Wilkinson, C. Murillo, M. Bochman, *Advanced Inorganic Chemistry*, 6thEdn., John Wiley, New York, 1999.
3. F. A. Cotton, G. Wilkinson, P.L. Gaus, *Basic Inorganic Chemistry*, 3rdEdn., John Wiley, New York, 2008.

Module V: Inorganic Polymers (5hrs)

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

References

1. B. R. Puri, L. R. Sharma, K. C. Kalia, *Principles of Inorganic Chemistry*,31stEdn. Milestone Publishers, New Delhi, 2010.
2. S. Prakash, G. D. Tuli, S. K. Basu, R. D. Madan, Advanced Inorganic Chemistry,Volume I, S Chand.

3. J. E. Huheey, E. A. Keiter, R. L. Keiter, O K Medhi, *Inorganic Chemistry*, 4thEdn., Pearson. 2006.

Further reading

1. M. Clyde Day, J. Selbin, *Theoretical Inorganic Chemistry*, 2ndEdn. Reinhold Book Corp.
2. Sisler, Harry Hall, *Chemistry in non-aqueous solvents*, Reinhold, New York, 1961.

Module VI: Acids, Bases and Non Aqueous Solvents (5 hrs)

Arrhenius definition, Bronsted- Lowry definition and conjugate acid –base pairs.Lux- Flood Definition, Solvent System Definition, Lewis definition, Usanovich definition.

Hard and soft acids and bases.Classification of acids and bases as Hard and Soft.Applications of HSAB concept, Limitations of HSAB concept.

Non-aqueous Solvents: Classification – General properties – Self ionization and leveling effect –Reactions in liquid ammonia, liquid N_2O_4, liquid SO_2 and liquid HF.

References

1.W. U. Malik, G.D. Tuli and R.vD. Madan, *Selected Topics in Inorganic Chemistry*, S. Chand and Co., New Delhi, 2010 (Reprint).
2. J. D. Lee, *Concise Inorganic Chemistry*, 5thEdn., Blackwell Science, London.
3. D. F. Shriver and P. W. Atkins, *Inorganic Chemistry*, 3rdEdn., Oxford University Press

Further reading

1. J.E. Huheey, E.A. Keitler and R.L. Keitler, *Inorganic Chemistry – Principles of Structure and Reactivity*, 4thEdn., Pearson Education, New Delhi, 2013.
2. M.C. Day and J. Selbin, *Theoretical Inorganic Chemistry*, East West Press, New Delhi, 2002.
3. Sisler, Harry Hall, *Chemistry in non-aqueous solvents*, Reinhold, New York, 1961.

Module VII: Environmental Pollution (8hrs)

Air pollution: Major air pollutants – Oxides of carbon, nitrogen and sulphur– Particulates – Londonsmog and photochemical smog. Effects of air pollution: Acid rain, greenhouse effect and depletion ofozone. 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 protectionof 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.

Solid Waste Management :House hold, municipal and industrial solid waste – Non-degradable, degradable and biodegradablewaste – Hazardous waste – Pollution due to plastics. Solid waste management: Recycling, digestion,dumping, incineration, land treatment and composting. Impacts of medical waste and E-waste & theirdisposal.Energy production from waste.

References

1. S.S. Dara, *A Textbook of Environmental Chemistry and Pollution Control*, 8thEdn., S. Chand and Sons, New Delhi, 2008.
2. A.K. De., *Environmental Chemistry*, 6thEdn., New Age International (P) Ltd., New Delhi, 2006.
3. A.K. Ahluwalia, *Environmental Chemistry*, Ane Books India, New Delhi, 2008.
4. R. C. Brunner, *Hazardous Waste Incineration*, McGraw Hill Inc. 1989.

Further reading

1. M.L. Davis, D.A. Cornwell, *Introduction to Environmental Engineering*, 3rdEdn., McGraw Hill, New Delhi, 1998.
2. S.E. Manahan, *Environmental Chemistry*, 8thEdn., CRC Press, Florida, 2004.
3. G.M. Masters, *Introduction to Environmental Engineering and Science*, 3rdEdn., Prentice-Hall Inc., New Delhi, 2007.
4. B. K. Sharma, H. Kaur, *Environmental Chemistry*, Goel Publishing House, Meerut, 1996.
5. M. N. Rao, A. K. Datta, A.K., *Waste Water treaement*, Ofxord& IBH Publ, Co. Pvt.Ltd. 1987.

Mark Distribution	
Module I	12 Marks
Module II	18 Marks
Module III	8 Marks
Module IV	8 Marks
Module V	10 Marks
Module VI	11 Marks
Module VII	12 Marks

SEMESTER V

Course Code: GCHE5B07T

Core Course VII: ORGANIC CHEMISTRY – II

Total Hours: 64; Credits: 3; Hours/Week: 4; Total Marks 75 (Internal 15 & External 60)

GCHE5B07T	ORGANIC CHEMISTRY – II	L	T	P	C
		4	0	0	3
Objective (s)	To give the students a thorough knowledge about the chemistry of selected functional groups and their applications in organic transformations				
Course outcome (s)					
CO1	To evaluate the various conditions for substitution reactions of organohalides				
CO2	To understand the characteristic properties and reactions of alcohols, phenols, ethers and epoxides				
CO3	To apply organometallic compounds in preparation of different functional groups				
CO4	To apply different reagents for the inter conversion of aldehydes, carboxylic acids and acid derivatives				
CO5	To apply active methylene compounds in organic preparations				
CO6	To study the reactivity and reactions of organo nitrogen compounds				

Module I: Alkyl and Aryl Halides (8 hrs)

Alkyl halides: Preparation – from alcohols and alkenes, allylic bromination of alkenes (NBS reagent). Reactions – Types of aliphatic nucleophilic substitution reactions – S_N1 and S_N2 – Mechanism, Kinetics, Energy profile diagram & Stereochemistry. Factors influencing substitution reactions – nature of substrate, nucleophile, solvent, and leaving group. Relative reactivities of alkyl halides Vs allyl, vinyl and aryl halides. Elimination of alkyl halides – E1 & E2 mechanism–Saytzeff rule. Substitution Vs Elimination – Structure of haloalkane and nature of base.

Aryl halides: Nuclear and side chain substitution reactions. The addition-elimination and the elimination – addition (benzyne intermediate) mechanisms of nucleophilic substitution reactions.

Module II: Organometallic Compounds (3 hrs)

Preparation and synthetic applications of organometallic reagents in organic synthesis: Grignard, organolithium, organocopper (Gilman reagent) and organozinc (Simmons-Smith reaction and reformatsky reaction) reagents.

Module III: Alcohols and Phenols (10 hrs)

Monohydric alcohols – Methods of formation by reduction of aldehydes, ketones, carboxylic acids and esters. Reaction of carbonyl compounds with Grignard reagent. Reactions of alcohols: Acidic and basic nature of alcohols, formation of ester, conversion to alkyl halides

via tosylates, reaction with hydrogen halides (Lucas test), Victor Meyer's test, dehydration, oxidation (with PCC and $KMnO_4$).

Dihydric alcohols –Methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [$Pb(OAc)_4$ and HIO_4] and pinacol-pinacolone rearrangement.

Phenols–Preparation of phenols (from cumene and aromatic sulphonic acid) and acidity of phenol (substituent effects). Reactions of phenols – electrophilic aromatic substitution (Bromination, Nitration and sulphonation), acylation (Fries rearrangement) and carboxylation (Kolbe-Schmitt reaction). Riemer-Tiemann reaction (mechanism expected), Gatterman aldehyde synthesis and dienone-phenol rearrangement.

Module IV: Ethers and Epoxides (3 hrs)

Ethers: Preparation by Williamson's ether synthesis. Chemical reactions: cleavage and autoxidation, Claisen rearrangement. Zeisel's method of estimation of methoxy groups. Importance of crown ethers in organic synthesis.

Epoxides: Synthesis of epoxides from alkenes, acid and base-catalyzed ring opening of epoxides, orientation of epoxide ring opening, reactions of Grignard and organolithium reagents with epoxides.

Module V: Aldehydes and Ketones (16 hrs)

Synthesis of aldehydes and ketones – From alcohols, cyanides, acid chlorides and calcium salts of carboxylic acids. Etard's reaction.

Nucleophilic addition reactions – Carbon nucleophiles (addition of HCN, wittig reaction), Oxygen nucleophiles (H_2O, alcohols, peroxyacids –Bayer-villiger oxidation), Nitrogen nucleophiles (NH_3 and Ammonia derivatives – 1^o amines, hydroxyl amine, hydrazine, phenylhydrazine, semicarbazide and DNP reagent) and Sulfur nucleophiles (sodium bisulfite).

Oxidation – acidified $K_2Cr_2O_7$, $KMnO_4$, CrO_3; Oppenauer oxidation. Distinguishing aldehydes and ketones (Tollen's reagent, Fehling's solution);

Reduction – Catalytic hydrogenation, Wolf-Kishner, Clemmensen, metal hydride ($LiAlH_4$ and $NaBH_4$), and MPV reduction. Reduction of ketones to pinacols.

Reactions involving α carbons of carbonyl compounds – Aldol condensation, Claisen-Schmidt reaction, Cannizzaro reaction, Benzoin condensation, Darzen reaction, Haloform reaction and Favorskii rearrangement.

Reactions of α,β-unsaturated carbonyl compounds : Examples of 1,2 and 1,4 addition reactions – Michael addition reaction.

Mechanism and synthetic applications of Wittig reaction, McMurry reaction and Beckmann rearrangement.

Module VI: Carboxylic Acids and Sulphonic Acids (8 hrs)

Carboxylic Acids: Preparation – Hydrolysis of nitrile and carboxylation of Grignard reagent. Chemical properties: Acidity (effect of substituent on the acidity of aliphatic and aromatic carboxylic acids).

Reactions of carboxylic acids – conversion to acid chlorides, esters, amides and acid anhydrides, relative reactivity. Fisher esterification (mechanism expected), HVZ reaction, Decarboxylation reaction (Kolbe electrolysis). Ascend and descend in carboxylic acid series - Arndt-Eistert Synthesis and wolf rearrangement.

Aromatic Sulphonic Acids: Preparation and reactions of benzene sulphonic acid – Preparation of Tosylates and its utility in organic transformations.

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

Module VII: Active Methylene Compounds (4 hrs)

Active Methylene Compounds: Ethylacetoacetate and Diethyl malonate. Keto-enol tautomerism and acidic character. Preparation of ethyl acetoacetate by Claisen condensation reaction. Synthetic applications of ethylacetoacetate – Preparation of monocarboxylic acids, dicarboxylic acid (Succinic acid) and α,β -unsaturated carboxylic acid (Cinnamic acid). Synthesis of ketones (acetylacetone). Applications of Diethyl malonate – Synthesis of α,β -unsaturated carboxylic acid (Knoevenagel reaction) and Barbituric acid.

Module VIII: Nitrogen Compounds (12 hrs)

Nitro compounds: Preparation of nitroalkanes and alkylnitrites by substitution reaction of haloalkanes. Difference between alkyl nitrites and nitro alkanes. Chemical reactions of nitro compounds – Reduction and Hydrolysis (Nef reaction). Reduction products of nitrobenzene in acidic, neutral and alkaline media. Selective reduction of polynitro compounds.

Amines: Basicity of substituted amines and aryl amines. Preparation of alkyl and aryl amines: Reduction of nitro and nitrile compounds, reductive amination of aldehydic and ketonic compounds. Hofmann, Curtius and lossen rearrangement reactions, Schmidt reaction and Gabriel-phthalimide reaction. Reactions of amines: Acylation to form amides, conversion of amine to alkene - Hofmann elimination. Separation and identification of amines by Hinsberg's method. Synthetic transformations of aryl diazonium salts, azo coupling.

Text Books

1. Bhupinder Mehta and Manju Mehta, *Organic Chemistry*, 2nd Edition, PHI learning Private Ltd, New Delhi, 2005.
2. Jagdamba Singh and L.D.S. Yadav, *Undergraduate Organic Chemistry* Vol-1 & Vol-II, 7th Edition, Pragathi Prakashan, Meerut
3. Peter Sykes, *A Guide Book to Mechanism in Organic Chemistry*, 6th Edition, Pearson Education, New Delhi, 2013.
4. John McMurry, *Introduction to Organic Chemistry*, Brooks/Cole, Pacific Grove, California, 2007.
5. R.T. Morrison, R.N. Boyd, *Organic Chemistry*, 7th Edition, Pearson Education, New Delhi, 2013.

6. K.S. Tewari, N.K. Vishnoi and S.N. Mehrotra, *A Textbook of Organic Chemistry*, 3rd Edn., Vikas Publishing House.
7. S.C. Sharma and M.K. Jain, *Modern Organic Chemistry*, Vishal Publishing Company, New Delhi, 2014.

Further Reading

1. J. March, *Advanced Organic Chemistry*, 4th Edn, John Wiley & Sons, NY
2. J. Clayden, N. Greeves, S. Warren, P. Wothers, *Organic Chemistry*, Oxford University Press.
3. Paula Y. Bruice, *Organic Chemistry*, 3rd Edn. Pearson Education.
4. P.S. Kalsi, *Organic Reactions, Stereochemistry and Mechanism*, 4th Edition, New Age
5. International Publishers, New Delhi, 2006.
6. D. Nasipuri, *Stereochemistry of Organic Compounds*, New Age International Publishers.

Mark Distribution	
Module I	10 Marks
Module II	4 Marks
Module III	12 Marks
Module IV	4 Marks
Module V	20 Marks
Module VI	10 Marks
Module VII	5 Marks
Module VIII	14 Marks

SEMESTER V

Course Code: GCHE5B08T

Core Course VIII: PHYSICAL CHEMISTRY–II

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

GCHE5B08T	PHYSICAL CHEMISTRY–II	L	T	P	C
		3	0	0	3
Objective (s)	To make the student understand the concept of kinetics, catalysis and photochemistry and to familiarize the applications of molecular spectroscopy and phase equilibrium.				
Course outcome (s)					
CO1	To apply the concept of kinetics, catalysis and photochemistry to various chemical and physical processes				
CO2	To characterize different molecules using spectral methods				
CO3	To understand various phase transitions and its applications				

Module I: Chemical Kinetics (10 hrs)

Introduction – 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).

Factors affecting the rate of 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)–Arrhenius equation–Effect of temperature on reaction rates Determination and significance of Arrhenius parameters (work out problems)–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.

Module II: Adsorption and Catalysis (6 hrs)

Physical and chemical adsorption, Factors affecting adsorption.

Adsorption isotherms: Freundlich and Langmuir isotherms (derivation required)–Multi layer adsorption – BET equation (derivation not needed) and its applications to surface area measurements. Applications of adsorption.

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

References

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

2. P. W. Atkins,J. de Paula, *Atkin's Physical Chemistry* 8thEdn., Oxford University Press (2006).

3. Donald A. McQuarrie, John D. Simon, *Physical Chemistry: A Molecular Approach* University Science Books: Sausalito, CA; 1997.

4. K. Laidler, *Chemical Kinetics*, 3rd Edn., PearsonEducation, New Delhi, 2004.

5. P.L.Soni,O.P.Dharmarha, U.N.Dash, *Textbook of Physical Chemistry*, 23rd Edn., Sultan Chand &Sons, New Delhi,2011.

6. K.L.Kapoor, *Physical Chemistry*, Volumes II and III, Macmillan Publishers, Noida, 2004.

Module III: Phase Equilibria (10 hrs)

Concept of phase- solid, liquid and gas-homogeneous and heterogeneous phase-component and degree of freedom.

Gibbs phase rule and its derivation. Clausius-Clapeyron equation and its applications to solid-liquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems, with applications. 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.

References

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

2. P. W. Atkins,J. de Paula, *Atkin's Physical Chemistry* 8thEdn., Oxford University Press, 2006.

3. Donald A. McQuarrie, John D. Simon, *Physical Chemistry: A Molecular Approach* University Science Books: Sausalito, CA; 1997.

4. P.L. Soni, O.P. Dharmarha, U.N.Dash, *Textbook of Physical Chemistry*,23rd Edn., Sultan Chand &Sons, New Delhi,2011.

Module IV: Molecular Spectroscopy I (12 hrs)

Electromagnetic spectrum - wavelength, frequency, wavenumber. Interaction of electromagnetic radiation with matter–Qualitative aspects, Einstein, absorption-emission and factors affecting line width and intensity of signal (elementary idea)- 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–Beer Lamberts law- Dissociation energy of diatomic molecules – Chromophore and auxochrome –Bathochromic and hypsochromic shifts.

Module V: Molecular Spectroscopy II (4 hrs)

Nuclear Magnetic Resonance (NMR) Spectroscopy: Proton NMR and ^{13}CNMR– Principle–Number and position of signals–Chemical shift– Different scales – Spin-spin coupling (qualitative idea). Eg. NMR spectra of simple molecules.

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

References

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

2. P. W. Atkins, J. de Paula, *Atkin's Physical Chemistry* 8thEdn., Oxford University Press (2006).

3. Donald A. McQuarrie, John D. Simon, *Physical Chemistry: A Molecular Approach* University Science Books: Sausalito, CA; 1997.

4. C. N. Banwell, *Fundamentals of Molecular Spectroscopy*, McGraw-Hill, 1994.

5. G.M. Barrow, *Introduction to Molecular Spectroscopy*, McGraw Hill, London, 1962.

6. K.L. Kapoor, *Physical Chemistry*, Volumes II and III, Macmillan Publishers, Noida, 2004.

7. P.R. Singh, S.K. Dixit, *Molecular Spectroscopy: Principles and Chemical Applications*, S. Chand & Company, New Delhi1980.
8. P.K. Bhattacharya, *Group Theory and its Chemical Applications*, Himalaya Publishing House, New Delhi, 1986.
9. F.A. Cotton, *Chemical Applications of Group Theory*, 3rd Edn., John Wiley & Sons, New Delhi.

Module VI: Photochemistry (6 hrs)

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 – Photochemical reactions. (hydrogen-chlorine and hydrogen-bromine).
Photo physical processes: Jablonski diagram –Fluorescence–Phosphorescence. Non-radiative processes: Internal conversion and intersystem crossing. Photosensitization–Chemiluminescence –Bioluminiscence.

References

1. B.R. Puri, L.R. Sharma, M.S. Pathania, *Principles of Physical Chemistry*, 46th Edn., Vishal Publishing Company, New Delhi, 2013.
2. P. W. Atkins, J. de Paula, *Atkin's Physical Chemistry* 8thEdn., Oxford University Press, 2006.
3. Donald A. McQuarrie, John D. Simon, *Physical Chemistry: A Molecular Approach* University Science Books: Sausalito, CA; 1997.
4. K. K. Rohatgi-Mukherjee, *Fundamentals of Photochemistry*, New Age International, 1978.

Further Reading

1. G.M. Barrow, *Physical Chemistry*,5th Edn., Tata McGraw Hill Education, New Delhi, 2006.
2. K.L. Kapoor, *Physical Chemistry*, Volumes II and III, Macmillan Publishers, Noida, 2004.
3. S. Glasstone, D.H. Lewis, *Elements of Physical Chemistry*, 2nd Edn., Macmillan & Company, UK,1962.
4. F. Daniels, R.A. Alberty, *Physical Chemistry*, 5th Edition, John Wiley and Sons, Canada, 1980.
5. Peter Atkins, Julio de Paula, *The Elements of Physical Chemistry*,7th Edn., Oxford University Press, Oxford, 2016.

6. K. Laidler, *Chemical Kinetics*, 3rd Edn., Pearson Education, New Delhi, 2004.

Mark Distribution	
Module I	17 Marks
Module II	10 Marks
Module III	17 Marks
Module IV	18 Marks
Module V	7 Marks
Module VI	10 Marks

SEMESTER VI

Course Code: GCHE6B09T

Core Course IX: INORGANIC CHEMISTRY – IV

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

GCHE6B09T	**INORGANIC CHEMISTRY – IV**	L	T	P	C
		3	0	0	3
Objective (s)	To gain detailed knowledge of the electronic configuration and properties of transition and inner transition elements and their role in biological systems. To understand the importance of different instruments used in analysis.				
Course outcome (s)					
CO1	To understand the principles behind different instrumental methods				
CO2	To distinguish between lanthanides and actinides				
CO3	To appreciate the importance of CFT				
CO4	To understand the importance of metals in living systems				
CO5	To distinguish geometries of coordination compounds				

Module I: Instrumental Methods of Analysis (8hrs)

Beer- Lambert's law

Atomic absorption spectroscopy, Flame Emission Spectroscopy–Colorimetry- Spectrophotometry- laws of Spectrophotometry- Beer- Lambert's law. -: XRD, Atomic Force Microscopy (AFM), Scanning Tunneling Microscopy(STM),Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM).

References

1.D. A. Skoog, F. James Holler, S. R. Crouch, *Principles of Instrumental Analysis*,6th Edn.,Cengage Learning; Noida, 2004.
2. H.H Willard, L.L. Merritt, J.A. Dean, F.A Settle, *Instrumental methods of Analysis*, CBS Publishers &Distributors, Delhi, 1996.
3. H.H Willard, L.L. Merritt, J.A. Dean, F. A. Steptoe,*Instrumental Methods of Analysis*, 7th Edn. Wadsworth Publishing Co. Ltd., Belmont, California, USA, 1988.
4. D. A. Skoog, F. J. Holler, T. A. Nieman, *Principles of Instrumental Analysis*, Cengage Learning India Ed.

Further reading

1. D. A. Skoog, D. M. West, F. J. Holler,*Fundamentals of Analytical Chemistry*, 6th Edn., Saunders College Publishing, Fort Worth (1992).
2. D. C. Harris, QuantitativeChemicalAnalysis, 5th Edn.;W HFree-man and Company: NewYork, 1999.

Module II: Transition and Inner Transition Elements (8 hrs)

Transition Metals: General characteristics: Metallic character, oxidation states, size, density, meltingpoints, boiling points. *Lanthanides:* Electronic configuration and general characteristics.

Transition Metals: ionization energy, colour, magnetic properties, reducing properties, catalyticproperties, non-stoichiometric compounds, complex formation and alloy formation. Difference between first row and other two rows.

Lanthanides: Occurrence of lanthanides –Importance of beach sands of Kerala – Isolation of lanthanides from monazite sand – Separation by ionexchange method. Lanthanide contraction: Causes and consequences. Industrial importance oflanthanides.

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

References

1. J. D. Lee, *Concise Inorganic Chemistry*, 5th Edn., Wiley India Pvt. Ltd. 2008.
2. B. R. Puri, L. R. Sharma, K. C. Kalia, *Principles of Inorganic Chemistry*, MilestonePublishers, New Delhi 2010.
3. J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, *Inorganic Chemistry*, Pearson 2006.

Further reading

1. F. A. Cotton, G. Wilkinson, *Advanced Inorganic Chemistry*, 6thEdn., John Wiley, New York. 1999.
2. D. F. Shriver, P.W. Atkins, *Inorganic Chemistry*, 3rdEdn., Oxford University Press. 2009.

Module III: Coordination Chemistry (16 hrs)

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 filedtheory – 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 – Distorted octahedral complexes- Jahn- Teller Theorem, CFSE –calculation and its applications. 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.

References

1. R. Gopalan, V. Ramalingam, *Concise Coordination Chemistry*, 1st Edn., Vikas Publishing House, New Delhi, 2001.
2. R. Puri, L. R. Sharma, K. C. Kalia, *Principles of Inorganic Chemistry*, 31st Edn., Milestone Publishers, New Delhi 2010.
3. J. D. Lee, *Concise Inorganic Chemistry*, 5th Edn., Wiley India Pvt. Ltd.2008.

Further reading

1. F.A. Cotton, G. Wilkinson, *Advanced Inorganic Chemistry*, 6th Edn., Wiley India Pvt. Ltd., New Delhi, 2009.
2. J.E. Huheey, E. A. Keitler, R.L. Keitler, *Inorganic Chemistry – Principles of Structure and Reactivity*, 4th Edn., Pearson Education, New Delhi, 2013.
3. D. F. Shriver, P. Atkins, *Inorganic Chemistry*, 5th Edn., Oxford University Press, New York, 2010.
2. F. Basolo, R.C. Johnson, *Coordination Chemistry*, 2nd Edn., Science Reviews, Wilmington, 1986.
5. G. L. Meissler, D.A Tarr, *Inorganic Chemistry*,3rd Edn. Pearson Education, 2004.

Module IV: Organometallic Compounds (8 hrs)

Definition – Classification based on the nature of metal-carbon bond – Zeise's salt. 18-Electron rule. Metal carbonyls — Mononuclear and Polynuclear carbonyls of Fe, Co and Ni (structure only) – Bondingin metal carbonyls.

Ferrocene: Preparation, properties and bonding (VBT only).

Catalysis: Zeigler Natta catalystin the polymerization of alkene and Wilkinson catalyst in the hydrogenation of alkene.

References

1. P. Powell, *Principles of Organometallic Compounds*, 2nd Edn., Chapman and Hall, London, 1988.
2. B. R. Puri, L. R. Sharma, K. C. Kalia, *Principles of Inorganic Chemistry*,31st Edn. Milestone Publishers, New Delhi 2010.
3. G. L. Meissler, D. A Tarr, *Inorganic Chemistry*,3rd Edn., Pearson Education, 2004.
4. J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K.Medhi, *Inorganic Chemistry*, Pearson 2006.

Further reading

1. R. C. Mehrothra, A. Singh, *Organometallic chemistry*, New age publishers.

Module V: Bioinorganic Chemistry (8 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 ofmetal ions (Pb, Hg and As). Anticancer drugs: *Cis*-platin, oxaliplatin and carboplatin – Structure andsignificance.

References

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

Further reading

1. B. Douglas, D. Mc Daniel, J. Alexander, *Concepts and models of Inorganic Chemistry*, 3rdEdn., John Wiley.
2. I.Bertini, H. B Gray, S. J. Lippard, J.Selvertone Valentine,*Bioinorganic Chemistry*, Viva Books Pvt Ltd. 2007.

Mark Distribution	
Module I	15 Marks
Module II	14 Marks
Module III	24 Marks
Module IV	12 Marks
Module V	14 Marks

SEMESTER VI

Course Code: GCHE6B10T

Core Course X: ORGANIC CHEMISTRY – III

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

GCHE6B10T	ORGANIC CHEMISTRY – III	L	T	P	C
		3	0	0	3
Objective(s)	To gain detailed knowledge of the chemistry of different bio molecules. To give a basic understanding of different spectral techniques and to apply them in simple molecules. To differentiate diverse pericyclic reactions.				
Course outcome (s)					
CO1	To elucidate structure of simple organic compounds using spectral techniques				
CO2	To understand the basic structure and tests for carbohydrates				
CO3	To understand the basic components and importance of DNA				
CO4	To understand the basic structure and applications of alkaloids and terpenes				
CO5	To distinguish different pericyclic reactions				

Module I: Structure Elucidation Using Spectral Data (10 hrs)

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

UV-Visible Spectroscopy: Electronic transitions in molecules ($\sigma\rightarrow\sigma^*$, $n\rightarrow\sigma^*$, $\pi\rightarrow\pi^*$ and $n\rightarrow\pi^*$) – Chromophore and auxochrome. Study of the UV spectra of butadiene, acetone, methyl vinyl ketone and benzene.

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

^{1}H NMR: Chemical shift – Spin-spin splitting – Interpretation of ^{1}H NMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, acetone, 1, 1, 2-tribromoethane, propanoic acid, ethyl acetate, toluene and acetophenone.

Structure elucidation of simple organic compounds using UV, IR and ^{1}H NMR spectroscopic techniques.

Text books

1. D. L. Pavia, G. M. Lampman, G. S. Kriz, *Introduction to Spectroscopy*, Thomson Brooks Cole.
2. Y. R. Sharma, *Elementary Organic Spectroscopy*, 4th Edn., S. Chand & Company Ltd., New Delhi.
3. P. S. Kalsi, *Applications of Spectroscopic Techniques in Organic Chemistry*, 6th Edn., New Age International (P) Ltd., New Delhi, 2004.
4. Jag Mohan, *Organic Spectroscopy: Principles and Applications*, 2/e,—Narosa.
5. R. M. Silverstein, F.X. Webster, *Spectrometric Identification of Organic Compounds*, 6th Edn., John Wiley and Sons, New York, 2004.
6. J. Clayden, N. Greeves, S. Warren, P. Wothers, *Organic Chemistry*, Oxford University Press.

Module II: Carbohydrates (8 hrs)

Classification– representation of monosaccharides – Fischer projection – D, L configuration– Cyclic structure of glucose and fructose –Epimers and anomeres – Mutarotation – Reactions of glucose –Conversion of aldoses to ketoses and vice versa (Killiani-Fischer synthesis and Ruff degradation) – 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, and Molisch test – Applications of carbohydrates.

Text Books

1. Bhupinder Mehta and Manju Mehta, *Organic Chemistry*, 2nd Edition, PHI learning Private Ltd, New Delhi, 2005.
2. Jagdamba Singh and L.D.S. Yadav, *Undergraduate Organic Chemistry* Vol-1 & Vol-II, 7th Edition, Pragathi Prakashan, Meerut
3. John McMurry, *Introduction to Organic Chemistry*, Brooks/Cole, Pacific Grove, California, 2007.
4. R.T. Morrison, R.N. Boyd, *Organic Chemistry*, 7th Edition, Pearson Education, New Delhi, 2013.
5. K.S. Tewari, N.K. Vishnoi and S.N. Mehrotra, *A Textbook of Organic Chemistry*, 3rd Edn., Vikas Publishing House.
6. S.C. Sharma and M.K. Jain, *Modern Organic Chemistry,* Vishal Publishing Company, New Delhi, 2014.

Further Reading

1. J. F. Robyt, *Essentials of Carbohydrate Chemistry*, Springer.
2. S. P. Bhutani, *Chemistry of Biomolecules,* Ane Books Pvt Ltd.

Module III: Amino Acids, Peptides, Proteins and Nucleic acids (11 hrs)

Amino acids – Classification – Structure of amino acids - Zwitter ion formation - Isoelectric point–Electrophoresis. Synthesis (Strecker synthesis and amino malonate synthesis) and reactions of α-amino acids.

Peptides and Proteins – Structure determination of peptides: Edmann degradation and Sanger's methods. Peptide synthesis: Solid phase synthesis. Levels of protein structure - Primary, secondary, tertiary and quaternary structure of proteins. Denaturation of proteins. Chemistry of Xanthoproteic test, Biuret test and Ninhydrin test.

Nucleic acids: Introduction, constituents of nucleic acids – nitrogenous bases, nucleosides and nucleotides. Double helical structure of DNA – DNA replication and protein synthesis – Codon and genetic code – DNA replication – Difference between DNA & RNA – DNA finger printing and its applications.

Module IV: Biomolecules (5 hrs)

Lipids: Classification – Fats and oils – Hydrogenation –Analysing fats and oils– Acid value, Saponification value, Iodine value. Phospholipids: Structure of Lecithin. Biological functions of lipids.

Steroids: Classification – Structure and biological functions of Cholesterol, testosterone, estradiol and progesterone – Elementary idea of HDL and LDL.

Hormones: Definition, examples and functions of steroid, peptide and amine hormones.

Vitamins: Classification – Sources and deficiency diseases – Structure of vitamin C.

Note: Structural elucidation not expected in any case.

Text Books

1. Bhupinder Mehta and Manju Mehta, *Organic Chemistry*, 2nd Edition, PHI learning Private Ltd, New Delhi, 2005.
2. Jagdamba Singh and L.D.S. Yadav, *Undergraduate Organic Chemistry* Vol-1 & Vol-II, 7th Edition, Pragathi Prakashan, Meerut
3. John McMurry, *Introduction to Organic Chemistry*, Brooks/Cole, Pacific Grove, California, 2007.
4. R.T. Morrison, R.N. Boyd, *Organic Chemistry*, 7th Edition, Pearson Education, New Delhi, 2013.
5. K.S. Tewari, N.K. Vishnoi and S.N. Mehrotra, *A Textbook of Organic Chemistry*, 3rd Edn., Vikas Publishing House.
6. S.C. Sharma and M.K. Jain, *Modern Organic Chemistry*, Vishal Publishing Company, New Delhi, 2014.
7. S. P. Bhutani, *Chemistry of Biomolecules*, Ane Books Pvt Ltd.

Module V: Terpenes and Alkaloids (6 hrs)

Terpenes - Classification - Isoprene rule - Essential oils - Isolation of essential oils by steam distillation and enfleurage process. Source, structure and uses of citral, geraniol, menthol, limonene and camphor. General methods of determination of structure. Structural elucidation and synthesis of citral. Structure of natural rubber – Vulcanization and its advantages. *Alkaloids* – Classification based on structure of heterocyclic ring – Source, general methods of isolation, structure and physiological functions of nicotine, coniine and piperine. General methods of determination of structure of alkaloids.

References

1. L. Finar, *Organic Chemistry*, Volume I & II, Pearson Education.
2. O. P. Agarwal, *Chemistry of Natural Products* – Goel Publications.
3. Bhupinder Mehta and Manju Mehta, *Organic Chemistry*, 2nd Edition, PHI learning Private Ltd, New Delhi, 2005.
4. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co.
5. K. S. Tewari, N. K. Vishnoi, *Organic Chemistry*, 3rd Edn., Vikas Publishing House.
6. R. T. Morrison, R.N. Boyd, *Organic Chemistry*, 6th Edn., Prentice Hall of India.

Further reading

1. O. P. Agarwal, *Chemistry of Natural Products*, Goel Publications.

Module VI: Pericyclic Reactions (8 hrs)

Introduction – Molecular orbitals of conjugated π systems (C2, C3, C4, C5 and C6 systems). Frontier Molecular Orbitals (FMOs). Types of pericyclic reactions. Electrocyclic reactions: Butadiene-cyclobutene and hexatriene-cyclohexadiene interconversions. Dis and con rotation. Cycloaddition reactions: Dimerisation of ethylene and Diel's-Alder reaction- Analysis with FMO method. Supra-supra and supra-antara interactions. Sigmatropic reactions: [1,3], [1,5] and [3,3] rearrangements. FMO explanations and Wooward-Hoffmann selection rules for the above reactions. Cope and Claisen rearrangements (mechanism expected). Pericyclic reactions in human body – Vitamin D from cholesterol.

Text books

1. Jagdamba Singh, Jaya Singh, *Photochemistry and Pericyclic Reactions*, 3rd Edn., New Age Science Ltd., New Delhi, 2009.
2. S. Sankararaman, *Pericyclic Reactions-A Textbook: Reactions, Applications and Theory*,Wiley VCH, 2005.
3. G.M. Louden, *Organic Chemistry*, 4th Edition, Oxford University Press, New York.

Mark Distribution	
Module I	16 Marks
Module II	14 Marks
Module III	18 Marks
Module IV	8 Marks
Module V	10 Marks
Module VI	13 Marks

SEMESTER VI

Course Code: GCHE6B11T

Core Course XI: PHYSICAL CHEMISTRY–III

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

GCHE6B11T	PHYSICAL CHEMISTRY–III	L	T	P	C
		3	0	0	3
Objective (s)	To get a thorough knowledge of electrochemistry, colligative properties and solid state				
Course outcome (s)					
CO1	To apply the basic concepts of electrochemistry, Conductivity measurements and its applications				
CO2	To realize the importance of colligative properties				
CO3	To relate the properties of material/solids to the geometrical properties and chemical compositions				

Module I: Electrochemistry – I (12 hrs)

Fundamentals of Electrochemistry. Introduction (Faradays law, types of conductance) – Measurement of equivalent conductance –Variation of conductance with dilution– Kohlrausch'slaw–Arrheniustheoryofelectrolytedissociationandits limitations.

Weak and strong electrolytes–Ostwald's dilution law, its uses and limitations–Debye-Huckel-Onsager's equation for strong electrolytes (elementary treatment only, derivation is not required)–Debye-Falkenhagen and Wein effects– Migration of ions and Transport number (work out problems) 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 (work out problems)– Conductometric titrations, strong acid – strong base, weak acid-strong base, strong acid –weak base and weak acid –weak base.

Module II: Electrochemistry–II (10 hrs)

Introduction – types of cell and electrodes (Reversible- SHE, calomel and quinhydrone electrode) – Standard electrode potential– Electrochemical series–Nernst equation for electrode potential and EMF of a cell (Review)–Relationship between free energy and electrical energy (work out problems).

Gibbs Helmholtz equation of 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.

References

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

2. P. W. Atkins, J. de Paula, *Atkin's Physical Chemistry,* 8thEdn., Oxford University Press (2006).

3. Donald A. McQuarrie, John D. Simon, *Physical Chemistry: A Molecular Approach* University Science Books: Sausalito, CA; 1997.

4. S. Glasstone, *An Introduction to Electrochemistry,* East-West Press Pvt.Ltd., New Delhi,2007.

5. J. Bockris, A.K.N. Reddy, *Modern Electrochemistry*, Kluwer Academic/PlenumPublishers, New York, 2000.

Module III: Solutions (10 hrs)

Fundamentals of solutions. Solute, solvent, kinds of solutions– Vapour pressure- 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. Surface tension: Explanation and its determination. Viscosity: Determination of molecular mass from viscosity measurements. Refraction: Refractive index – Molar refraction and optical exaltation – Application.

References

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

2. P. W. Atkins, J. de Paula, *Atkin's Physical Chemistry,* 8thEdn., Oxford University Press (2006).

3. Donald A. McQuarrie, John D. Simon, *Physical Chemistry: A Molecular Approach* University Science Books: Sausalito, CA; 1997.

4. P.L.Soni, O.P. Dharmarha, U.N. Dash, *Textbook of Physical Chemistry*,23rd Edn., Sultan Chand &Sons, New Delhi,2011.

5. G.M.Barrow, *Physical Chemistry*, 5th Edn., Tata McGraw Hill Education, NewDelhi, 2006.

6. K.L.Kapoor, *Physical Chemistry*, Volumes II and III, Macmillan Publishers, Noida, 2004.

7. S. Glasstone, D.H. Lewis, *Elements of Physical Chemistry*, 2nd Edition, Macmillan &Company,UK,1962.

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

Module IV:Ionic Equilibria (3 hrs)

Introduction to acid base theories– pKa, pKb and pH– Buffer solutions.
Mechanism of buffer action–Buffer index–Henderson equation–Applications of buffers-Hydrolysis of salts of all types – Degree of hydrolysis –Hydrolysis constant and its relation with k_W.- Solubility product and common ion effect. (Work out problems).

References

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

2. P. W. Atkins, J. de Paula, *Atkin's Physical Chemistry,* 8thEdn., Oxford University Press (2006).

3. Donald A. McQuarrie, John D. Simon, *Physical Chemistry: A Molecular Approach* University Science Books: Sausalito, CA; 1997.

4. P.L. Soni, O.P. Dharmarha, U.N.Dash, *Textbook of Physical Chemistry*, 23rd Edn., Sultan Chand &Sons, New Delhi,2011.

Module V: Solid State – I (10 hrs)

Introduction (Amorphous and crystalline solids–Law of constancy of interfacial angles and rational indices)– Space lattice and unit cell.
Direct and reciprocal lattice (Miller indices) – Seven crystal systems and fourteen Bravais lattices–X-ray diffraction–Bragg's law (derivation required)–Planes-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)

Band theory (qualitative idea) for Metal Insulators and Semiconductors: Intrinsic and extrinsic conduction (elementary idea). Non-stoichiometric defects. Liquid crystals: Classification and applications (elementary idea).

References

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

2. P. W. Atkins, J. de Paula, *Atkin's Physical Chemistry*, 8thEdn., Oxford University Press. 2006.

3. Donald A. McQuarrie, John D. Simon, *Physical Chemistry: A Molecular Approach* University Science Books: Sausalito, CA; 1997.

4. Anthony R. West, *Solid State Chemistry and its Applications*, 2ndEdn., Student edition Wiley-Blackwell, 2014.

5. L.V. Azaroff, *Introduction to Solids*, Tata McGraw Hill Publishing Company, New Delhi,1960.

Further reading

1. Gordon M. Barrow, *Physical Chemistry*, 5th Edn., Tata McGraw Hill Education,NewDelhi, 2006.

2. K.L. Kapoor, *Physical Chemistry*, Volumes II and III, Macmillan Publishers, Noida, 2004.

3. S. Glasstone, D.H. Lewis, *Elements of Physical Chemistry*, 2nd Edn., Macmillan &Company,UK,1962.

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

5. Peter Atkins, Julio de Paula, *The Elements of Physical Chemistry*, 7th Edn., Oxford University Press, Oxford, 2016.

Mark Distribution	
Module I	17 Marks
Module II	14 Marks
Module III	14 Marks
Module IV	8 Marks
Module V	17 Marks
Module VI	9 Marks

SEMESTER VI

CourseCode: GCHE6B12T

CoreCourseXII: Advanced and Applied Chemistry

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

GCHE6B12T	Advanced and Applied Chemistry	L	T	P	C
		3	0	0	3
Objective (s)	Student will be able to 54earn the role and opportunities of chemistry as a discipline in modern civilization.				
Course outcome (s)					
CO1	To understand the importance of nanomaterials				
CO2	To appreciate the importance of green approach in chemistry				
CO3	To reviewvarious methods used in computational Chemistry and their importance in molecular design				
CO4	To realize the extent of chemistry in happiness index and life expectancy				
CO5	To list various sources information for scientific writing and to practice scientific writing.				

Module I: Colloids and Nanomaterials (6 hrs)

Colloids: Introduction - Stability – electrical double layer – zeta potential- Aggregation – flocculation – purification of colloids- Properties and applications of colloids.

Nanomaterials: Classification of nanomaterials (0D, 1D, 2D and 3D) –Top down and bottom up approaches in the synthesis – Size dependence of material properties (optical, electrical and catalytic). Variation in electronic and optical properties – Surface area to volume ratio(aspect ratio) and its significance – Metal and semiconductor nanoparticles and carbon nanotubes.

Characterization of nanomaterials - XRD, Atomic Force Microscopy (AFM), Scanning Tunneling Microscopy(STM),Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM).

Applications of nanomaterials (general idea only).

References

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

2. T. Pradeep, *A Textbook of Nanoscience and Nanotechnology*, McGrawhill, New Delhi, 2012.

3. Paras N. Prasad, *Nanophotonics*, John Wiley & Sons, 2004.

4. P. W. Atkins, J. de Paula, *Atkin's Physical Chemistry*, 8thEdn., Oxford University Press, 2006.

Further reading

1. V.S. Muralidharan, A. Subramania, *Nano Science and Technology*,CRC Press, London.

2. V.R. Raghavan, *Materials Science and Engineering*, Prentice Hall (India) Ltd, 2001.

3. Jonathan W. Steed, David R. Turner, Karl J. Wallace, *Core Concepts in Supramolecular Chemistry and Nanochemistry*, John Wiley & Sons Ltd. 2007.

Module II: New vistas in chemistry (8hrs)

Green Chemistry: Introduction – need of green chemistry approach – 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: Diels- Alder reaction and Cannizaro reaction.

Supramolecular chemistry: Introduction—types of non- covalent interactions – Molecular recognition – Host-guest interactions.Applications of supramolecular assemblies in molecular sensors, materials technology, catalysis, medicine and data storage.

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

References

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

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

3. W. Bannwarth, B. Hinzen, *Combinatorial Chemistry – From Theory to Application*, 2nd Edn., Wiley-VCH, 2006.

4. Jonathan W. Steed, David R. Turner, Karl J. Wallace, *Core Concepts in Supramolecular Chemistry and Nanochemistry*, John Wiley & Sons Ltd. 2007.

Further reading

1. Paul T. Anastas, T. C. Williamson, *Green Chemistry – Designing Chemistry for the Environment*, 2nd Edn., 1998.

2. Andrew P. Dicks, *Green Organic Chemistry in Lecture and Laboratory*, CRC Press, Universityof Toronto, Ontario, Canada, 2011.

3. Helena Dodziuk, *Introduction to Supramolecular Chemistry*,Springer, New York, 2002.

Module III: Introduction to Computational Chemistry (6 hours)

Computational chemistry as a tool and its scope. Classification of Computational Chemistry methods – Molecular mechanics methods (basic idea of force field and examples) and Electronic Structure methods (basic idea of ab initio and semi empirical methods), potential energy surface – local minima, global minima, saddle point and transition states. Geometry optimization. Software used in computational chemistry calculations.

Reference

1. I. N. Levine, Quantum Chemistry, 6th Edn., Pearson Education Inc., 2009.

2. Frank Jensen, *Introduction to Computational Chemistry*, John Wiley & Sons LTD 1999.

3. C. J. Cramer, *Essentials of Computational Chemistry: Theories and models*, John Wiley & Sons 2002.

4. P. W. Atkins, *Molecular Quantum Mechanics*, Oxford University Press, New York, 2005.

5. R. K. Prasad, *Quantum Chemistry*, Oscar Publications, New Delhi, 2000.

Further reading

1. E. G. Lewars, *Computational Chemistry: Introduction to the theory and applications of molecular quantum mechanics*, 2nd Edn., Springer 2011.
2. Andrew R. Leach, *Molecular Modelling: Principles and Applications*, 2nd Edn., Prentice Hall, 2001.
3. S. Wilson, *Chemistry by Computer: An Overview of the Applications of Computers in Chemistry*, Plenum Publishing, New York, 1986.

Module IV: Medicinal Chemistry (6hrs)

Drugs (chemical, generic and trade names with examples).

Terminology: Pharmacy, pharmacology, pharmacodynamics and pharmacokinetics (elementary idea only). Classification of drugs - Antipyretics, analgesics, antacids, antihistamines, antibiotics, antiseptics, disinfectants, (definition and examples, structures not expected)

Drug design: Development of new drugs, general steps involved in rational drug design, concepts of lead compound and lead modification, prodrugs and introduction to QSAR.LD50 and ED50 therapeutic index.

Drug synthesis: Preparation of paracetamol and aspirin.

References

1. Jayashree Ghosh, *A Textbook of Pharmaceutical Chemistry*, 3rd Edn., S. Chand and Company Ltd., New Delhi, 1999.
2. Richard B. Silverman and Mark W. Holladay, *The Organic Chemistry of Drug Design and Drug Action* 3rd ed., San Diego, CA: Academic Press, 2014.
3. Gareth Thomas, *Medicinal Chemistry. An introduction* II nd Edition. (Wiley India)2011.

Further reading

1. G. Thomas, *Fundamentals of Medicinal Chemistry*, John Wiley & Sons Ltd., 2006.
2. Robert M. Rydzewski, *Real World Drug Discovery.A Chemist's Guide to Biotech and Pharmaceutical Research*, Elsevier, 2008.

Module V: Applied inorganic chemistry (7hrs)

Cement: Manufacture, composition and setting.

Glass: Manufacture, annealing, types of glasses and uses.

Refractory materials: borides and carbides.

Inorganic fertilizers: Essential nutrients for plants – nitrogeneous, phosphaticand potash fertilizers – examples with formula.

Chemical industries in kerala: Location, raw materials, chemistry involved in the preparation and uses of the following. Caustic soda and chlorine – Travacore Cochin Chemicals Ltd., TiO_2 pigment from ilmenite – Travancore Titanium Products Ltd.

References

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.

2. R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.

Further reading

1.W. D. Kingery, H. K. Bowen, D. R. Uhlmann: *Introduction to Ceramics*, Wiley Publishers, New Delhi.

2. J. A. Kent,*Riegel's Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.

3. P. C. Jain, M. Jain, *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.

4. R. Gopalan, D. Venkatappayya, S. Nagarajan,*Engineering Chemistry*,Vikas Publications, New Delhi.

5. B. K. Sharma,*Engineering Chemistry*, Goel Publishing House, Meerut.

6. S.L. Tisdale; W.L.Nelson, J.D. Beaton,*Soil Fertility and Fertilizers*, Macmillan Publishing Company, New York, 1990

Module VI: Applied organic chemistry – I (10hrs)

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.

Cleansing Agents: Soaps and detergents: Preparation soap by saponification of oils and fats, classification, advantages and disadvantages of soaps and detergents – TFM of soap – Cleaning action.

Pesticides: Insecticides, rodenticides and fungicides (definition and examples) – Organo chlorine pesticides – Structure of Endosulfan, DDT and BHC. Organo phosphorus pesticides – malathion, parathion. Harmful effects of pesticides.

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.

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.

References

1. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rdEdn., Vishal Publishing Company Co.

2. K. S. Tewari, N. K. Vishnoi, *Organic Chemistry*, 3rdEdn.,Vikas Publishing House.

3. A. W. A. Brown, *Insect Control by Chemicals*, New York: Wiley; London: Chapman & Hall, 1951.

4. B. Srilakshmi, *Food Science*, 5ndEdn., New Age Publishers, New Delhi, 2010.

Further reading

1. K. H. Buchel,*Chemistry of Pesticides*, John Wiley & Sons, New York, 1983.
2. B. Sivasankar, *Food processing and preservation*, Prentice – Hall of India Pvt. Ltd. New Delhi, 2002.
3. SrinivasanDamodaran, Kirk L. Parkin, Owen R. Fennema, *Food Chemistry*, 4nd Edn., CRC Press, New York, 2007.
4. K. Singh, *Chemistry in Daily Life*; Prentice Hall of India, New Delhi, 2008.

Module VII: Research Methodology in Chemistry (5 hrs)

Science and scientific method. The choice and statement of a research problem.

Searching the literature.

Print: Sources of information: Primary, secondary, tertiary sources; Journals: Journal abbreviations, abstracts, monographs, text-books.

Digital: Web resources, E-journals, Journal access, TOC alerts, E-consortium, UGC infonet, E-books, Google Scholar, ChemIndustry, Wiki- Databases, ChemSpider, Web of science, PubMed,SciFinder, Scopus. INFLIBNET etc.

Formulation of hypothesis. Research plans. Design of experiment. Design of apparatus. The execution of experiments. Analysis of the experimental data. Interpretation and generalization of the findings.

Patenting and reporting the results of research.

Scientific writing – research reports, journal articles, books and thesis. Type of journal publications−articles, communications, reviews. Organization of reports – general format, the title, authors, abstract, text (introduction, method, results, discussion, conclusions), acknowledgement, references. Abbreviations, foot notes, Tables, Figures, Proof reading. Important scientific and chemistry journals. Impact factor, H-index.

Intellectual property Rights (IPR) – (Basic idea only).

References

1. Michael Jay Katz, From Research to Manuscript- A Guide to Scientific Writing, Springer Netherlands, 2009.
2. Joseph E. Harmon and Alan G. Gross, The craft of scientific communication, Chicago ; London : The University of Chicago Press, 2010.
3. Coghill, Anne M., and Lorrin R. Garson, ACS Style Guide: Effective Communication of Information (3rd ed.), Washington, DC: American Chemical Society, 2006.
4. Marin S. Robinson, Write like a chemist: a guide and resource, Oxford; New York: Oxford University Press, 2008.
5. Jen Tsi.Yang, Janet N.Yang, An outline of scientific writing: for researchers with English as a foreign language, Singapore ; River Edge, NJ : World Scientific, 1995.

Mark Distribution	
Module I	10 Marks
Module II	14 Marks
Module III	10 Marks
Module IV	8 Marks
Module V	12 Marks
Module VI	13 Marks
Module VII	12 Marks

SEMESTER VI
Course Code: GCHE6E01T
Core Course XIII: Elective 1. INDUSTRIAL CHEMISTRY

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

GCHE6E01T	INDUSTRIAL CHEMISTRY	L	T	P	C
		3	0	0	2
Objective (s)	To familiarise the students with the role and opportunities of chemistry as a discipline in modern civilization. To create awareness among the students about different chemical industries.				
Course outcome (s)					
CO1	To understand the importance of petrochemicals.				
CO2	To appreciate the importance and to familiarise the opportunities of pharmaceutical, leather and sugar industries.				
CO3	To analyse the role of catalysts in industrial processes.				

Module I: Introduction (4 hrs)

Requirements of an industry – location – water – industrial water treatment – safety measures – pilot plants – ISO certification.

References

1. B. K. Sharma, *Industrial chemistry*, 11th Edn., Goel publishing House, Meerut, 2000.
2. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edn., Vikas Publishing House (Pvt.) Ltd., New Delhi, 2004.

Further reading

1. Marshal Sittig, M. Gopala Rao, *Outlines of Chemical Technology for the 21st Century*, 3rd Edn., East-West Press Pvt. Ltd., New Delhi, 2010.
2. A. K. Ahluwalia, *Environmental Chemistry*, Ane Books India, New Delhi, 2008.
3. B. K. Sharma, H. Kaur, *Environmental Chemistry*, Goel Publishing House, Meerut, 1996.

Module II: Petrochemical Industry (12 hrs)

Introduction. Natural gas – CNG, LNG and LPG.

Coal: Classification based on carbon content – carbonisation of coal – composition and uses of various fractions.

Crude Oil: Constitution and distillation – composition and uses of different distillates – ignition point, flash point and octane number – cracking.

Catalysts used in Petroleum Industries: Structure, selectivity and applications.

Synthetic Petrol: Manufacture by Bergius and Fischer-Tropsch processes.

Manufacture of petrochemicals: Ethylene glycol, glycerine, acetone, phenol, vinyl acetate, toluene, linear alkyl benzenes and their sulphonates.

Usage and depletion of petroleum products – need for alternative fuel – hydrogen as the future fuel.

References

1. E. Stocchi, *Industrial Chemistry*, Vol. I, Ellis Horwood Ltd. UK, 1990.
2. P. C. Jain, M. Jain, *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi, 2015.
3. B. K. Sharma, H. Gaur, *Industrial Chemistry*, Goel Publishing House, Meerut, 1996.

Further reading

1. B. K. B. Rao, *Modern Petroleum Refining Processes*, 4th Edn., Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 2002.
2. R. A. Meyers, *Handbook of Petroleum Refining Processes*, 3rd Edn., McGraw-Hill, Noida, 2004.

Module III: Pharmaceutical Industry (8 hrs)

Drugs: Definition – History of drugs – Prodrug – Drug toxicity – Thalidomide tragedy (a brief study) – Routes of drug administration – Effective use of drugs – Over dosage – Prescription and non-prescription drugs – Drug abuse. Cancer: Definition – Lung cancer (causes, symptoms and treatment). Medical applications of nanomaterials.

References

1. G. L. Patrick, *Introduction to Medicinal Chemistry*, 6th Edn., Oxford University Press, UK, 2017.
2. Hakishan Singh, V. K. Kapoor, *Medicinal and Pharmaceutical Chemistry*, Vallabh Prakashan, Pitampura, New Delhi, 2005.
3. Thomas L. Lemke, David A. William, *Foye's Principles of Medicinal Chemistry*, 6th Edn., Wolters Kluwer Health, 2006.
4. Jayashree Ghosh, *A Text Book of Pharmaceutical Chemistry*, S. Chand and Co. Ltd, 1999.
5. O. Le. Roy, *Natural and synthetic organic medicinal compounds*, Ealemi, 1976.

Further reading

1. R. S. Satoskar, *Pharmacology and Pharmatherapeutics*, Vol. I and Vol. II, Popular Prakashan, 1973.
2. O. Kleiner, J. Martin, *Bio-Chemistry*, Prentice-Hall of India (P) Ltd, New Delhi, 1974.
3. Ashutosh Kar, *Medicinal Chemistry*, Wiley Eastern Limited, New Delhi, 1993.
4. Gurdeep R. Chatwal, *Synthetic Drugs*, Himalaya Publishing House, Bombay, 1995.
5. D. Sriram, P. Yogeeswari, *Medicinal Chemistry*, 2nd Edn., Pearson, 2011.

Module IV: Industrial Catalysis (6 hrs)

Types of catalysts: Homo catalysis and hetero catalysis – Applications of phase transfer catalysis and nano particle catalysts – Zeigler Natta catalyst and Wilkinson catalyst

(mechanism not expected). Applications of raney nickel, platinum, palladium, ruthenium and TiO_2 based catalysts.

References

1. P. H. Groggins, *Unit Process in Organic Synthesis*, 5th Edn., McGraw Hill, New York, 2001.
2. L. K. Doraiswamy, *Organic Synthesis Engineering*, Academic Press, New York, 2001.
3. M. Gopalarao, M. Sitting, *Dryden's Outlines of Chemical Tech*., 2nd Edn., EastWest Pub., New Delhi, 1997.

Further reading

1. G. T. Austin, *Shreve's Chemical Process Industries*, 5th Edn., McGraw-Hill Pub., 1994.
2. J. A. Kent, *Riggel's Handbook of Industrial Chemistry*, Van Nostrant Reinhold, 1974.

Module V: Leather and Sugar Industries (8 hrs)

Leather Industry: Manufacture of leather: Preparatory stages, tanning (vegetable and chrome tanning), crusting and surface coating – Tannery effluent and byproduct problems.

Sugar Industry: Manufacture of sugar from cane sugar – Double sulphitation process – Refining and grading of sugar.

References

1. D. Woodroffe, *Fundamental of Leather Science*, 1st Edn., A Harvey, 1942.
2. N. J. Park Ridge, *Chemical treatment of hides and leather*, Noyes Publications, 1985.

Further reading

1. Jayashree Ghosh, *Fundamental concept of Applied Chemistry*, S. Chand & Company Ltd., 2012.

Module VI: Textiles, Paints and Pigments (10 hrs)

Textile Industry: Production of viscose fibre from cellulose – Properties and uses of nylon and polyester fibers – Introduction to dyeing – Chromophore, auxochrome and chromogen – Primary and secondary colours – Chromatic and achromatic colours – Dyeing of nylon with acid dyes.

Paints: Primary constituents – Binders and solvents – Requirements of a good paint – Oil based paints, latex paints, luminescent paints, fire retardant paints and heat resistant paints. Varnishes: Spirit varnishes and oleo resinous varnishes – Raw materials – Enamels and lacquers (brief study).

Pigments: Definition – white lead, lithopone, ultramarine, red lead, guignet's green and chrome yellow (composition and uses).

References

1. Sara J. Kadolph, Anna L. Langford, *Textiles*, 10th Edn., Pearson/Prentice-Hall, New Delhi, 2007.

2. A. A. Vidya, *Production of Synthetic Fibers*, Prentice-Hall of India, New-Delhi, 1988.

Mark Distribution	
Module I	4 Marks
Module II	18 Marks
Module III	13 Marks
Module IV	12 Marks
Module V	14 Marks
Module VI	18 Marks

SEMESTER VI

Course Code: GCHE6E02T

Core Course XIII: Elective 2. POLYMER CHEMISTRY

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

GCHE6E02T	**POLYMER CHEMISTRY**	L	T	P	C
		3	0	0	2
Objective (s)	To gain detailed knowledge about classification of polymers and various mechanisms and technology adopted for 64evlar64ization. To give a basic understanding of properties of polymers like glass transition temperature, molecular weight and degradation of polymers. To give detailed idea about different commercial polymers.				
Course outcome (s)					
CO1	To understand various classification of polymers and types of polymerization methods.				
CO2	To understand the important characteristics of polymers such as average molecular weight, glass transition temperature, viscoelasticity and degradation				
CO3	To appreciate the importance of processing techniques				
CO4	To familiarize different commercial polymers and to understand the significance of recycling				

Module I: Introduction (4 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 (10 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 (Mechanism not needed).

Module III: Properties and Degradation of Polymers (10 hrs)

Molecular weights of polymers- Average molecular weights –Number average, Weight average, Sedimentation average (Method of determination not required) and Viscosity average molecular weight – determination of viscosity average molecular weight; Poly dispersity index and molecular weight distribution; Molecular weight and Degree of polymerization.

Glass transition temperature –definition, factors affecting Tg, importance of Tg

Viscoelasticity of polymers (Basic Concepts only)

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

Module IV: Polymerisation Techniques (6 hrs)

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

Module V: Polymer Processing (6 hrs)

Calendering, rotational moulding, compression, injection moulding, blow moulding and thermoforming.

Module VI: Commercial Polymers (12 hrs)

Preparation, Structure , properties and applications of- Polyolefins (HDPE, LDPE, PP and PS); Vinyl polymers (PVC, PVP and EVA, Saran); fluoro polymers (Teflon); Acrylic polymers (PAN and PMMA); Aliphatic polyamides (nylon6,6 and nylon 6); Aromatic polyamides (Kevlar); Polyester (terylene); Polycarbonate (lexan); Polyurethanes; Resins- Glyptal and formaldehyde resins (UF, MF and PF); Rubbers (NR- Vulcanisation, EPDM, BR, SBR, nitrile rubber, Neoprene, Butyl rubber and silicone rubber); Conducting polymers- Dopping (Conduction mechanism not required).

Pollution due to plastics – Recycling of plastics- Plastic identification codes.

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, M.S. Yadav, *Polymer Chemistry*, 2nd Revised Edition, Anmolublications Private Ltd., New Delhi, 1989.

5. K.J. Saunders, *Organic Polymer Chemistry*, 2ndEdn., Chapman and Hall, London, 1988.

6. Malcolm P. Stevens, *Polymer Chemistry: An Introduction*, 3rdEdn., Oxford University Press, USA, 1998.

7. Gowri Sankar Misra, *Introductory Polymer Chemistry*, New Age International, New Delhi,1993.

Further reading

1. R. B. Seymour, C. E. Carraher, *Polymer Chemistry: An Introduction*, Marcel Dekker, Inc. New York, 1981.

2. G. Odian, *Principles of Polymerization*, 4th Edn. Wiley, 2004.

3. P. Ghosh, *Polymer Science & Technology*, Tata McGraw-Hill Education, 1991.

4. R. W. Lenz, *Organic Chemistry of Synthetic High Polymers*, Interscience Publishers, New York, 1967.

5. M.P. Stevens, *Polymer Chemistry: An Introduction*, 3rdEdn. Oxford University Press (2005).

Mark Distribution	
Module I	4 Marks
Module II	16 Marks
Module III	17 Marks
Module IV	12 Marks
Module V	10 Marks
Module VI	20 Marks

SEMESTER VI

Course Code: GCHE6E03T

Core Course XIII: Elective 3. MEDICINAL AND ENVIRONMENTAL CHEMISTRY

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

GCHE6E03T	**MEDICINAL AND ENVIRONMENTAL CHEMISTRY**	L	T	P	C
		3	0	0	2
Objective (s)	To introduce the students to the importance of chemistry in medicinal field and to get ideas about various diseases. To help the students to get information about various toxic substances in environment and their control.				
Course outcome (s)					
CO1	To understand the importance of drugs in human health.				
CO2	To understand the facts about common diseases and treatment.				
CO3	To identify the presence of toxic substances in atmosphere.				
CO4	To apply chemistry in treatment of water and sewage.				

Module I: Health and Biochemical Analysis (6 hrs)

Definition of health - WHO standard - Sterilization of surgical instruments - Biochemical analysis of urine and serum.

Blood: Composition, grouping and Rh factor - Blood transfusion.

Module II: Drugs (4 hrs)

Definition – History of drugs – Prodrug – Prescription and non-prescription drugs – Routes of drug administration - Drug dosage - Effective use of drugs – Over dosage - Drug toxicity – Thalidomide tragedy (a brief study) – Drug abuse. Assay of Drugs: Chemical, biological and immunological assays - LD50 and ED50 and therapeutic index.

Module III: Common Diseases and Treatment (10 hrs)

Diseases - Communicable and non-communicable diseases - Causes, symptoms and drugs used for the treatment of air-borne diseases (anthrax, chickenpox, influenza, measles and tuberculosis), water and food borne diseases (cholera, dysentery, typhoid fever and hepatitis A), bronchial asthma, kidney stone, diabetes – Drugs used in the treatment for systemic hypertension and hypercholesterolemia.

Cancer: Definition - Lung cancer (causes, symptoms and treatment) – Avenues for the treatment of terminal cancer.

Module IV: Environmental Toxicology (6 hrs)

Introduction – Threshold Limiting Value – Source and toxicological effects of inorganic compounds (H_2S, Cl_2 and asbestos), organic compounds (CCl_4, phenol, benzene, phenylene diamines, nitroso amines and *p*-dichlorobenzene), persistent organic pollutants (dioxins, TCDD, pesticides: Endosulphan, carbaryl and DDT), phthalates and heavy metals (As and Hg). Endosulfan disaster in Kerala (brief study).

Module V: Control and Monitoring of Air Pollutants (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.

Air Pollutant Monitoring: Sampling methods for particulate analysis - Filtration, sedimentation, electrostatic samplers, thermal precipitators and impingers. Sampling methods for gases and vapours – Cold trapping, absorption and adsorption. Analytical methods for the determination of CO, NOx, SOx, H_2S, hydrocarbons and particulate matter.

Module VI: Water Treatment Processes (10 hrs)

Types and characteristics of industrial waste water - Aerobic and anaerobic oxidation - Sedimentation, coagulation, filtration, disinfection, desalination and ion exchange. Primary treatment - Secondary treatment - Trickling filters, activated sludge process and sludge digestion - Tertiary treatment - USAB process and deep well injection. Sewage and sewage analysis - Total solids, settlable solids, suspended solids - Protection of surface waters from pollution with industrial sewage.

References

1. G. Thomas, *Fundamentals of Medicinal Chemistry*, John Wiley & Sons Ltd., London, 2003.

2. Arthur C. Guyton, John E. Hall, Textbook of Medical Physiology, 12th Edn., Saunders, US, 2010.

3. D. J. Abraham, *Burger's Medicinal Chemistry and Drug Discovery*, Vol.1-6, Wiley Interscience, Hoboken, NJ, 2003.

4. B. L. Oser, *Hawk's Physiological Chemistry*, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 1979.

5. S. C. Rastogi, *Biochemistry*, 2nd Edn., Tata McGraw Hill Publishing Co., New Delhi, 2007.

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

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

8. Rasheeduz Zafar, *Medicinal Plants of India*, 1st Edn., CBS Publishers & Distributors Pvt. Ltd., New Delhi, 2009.

9. A. K. De, *Environmental Chemistry*, 6th Edn., New Age International (P) Ltd., New Delhi, 2006.

10. M. L. Davis, D. A. Cornwell, *Introduction to Environmental Engineering*, 3rd Edn., McGraw Hill, New Delhi, 1998.

11. S. E. Manahan, *Environmental Chemistry*, 8th Edn., CRC Press, Florida, 2004.

12. G. M. Masters, *Introduction to Environmental Engineering and Science*, 3rd Edn., Prentice-Hall Inc., New Delhi, 2007.

13. A. K. Ahluwalia, *Environmental Chemistry*, Ane Books India, New Delhi, 2008.

14. B. K. Sharma, H. Kaur, *Environmental Chemistry*, Goel Publishing House, Meerut, 1996.

Mark Distribution	
Module I	6 Marks
Module II	8 Marks
Module III	17 Marks
Module IV	12 Marks
Module V	18 Marks
Module VI	18 Marks

SEMESTER VI

Course Code: GCHE6B13P

Core Course XIV: PHYSICAL CHEMISTRY PRACTICAL

Total Hours:80;Credits:4;Hours/Week:5(Semester V); Total Marks 100

(Internal 20& External 80)

GCHE6B13P	**PHYSICAL CHEMISTRY PRACTICAL**	L	T	P	C
		0	0	5	4
Objective (s)	The relation between physical properties and chemical composition is used for analysis. Get an idea of designing experimental methods to analyze the physical properties of molecules or materials.				
Course outcome (s)					
CO1	To enable the students to develop analytical skills in determining the physical properties (Physical constants)				
CO2	To develop skill in setting up a experimental methods to determine the physical properties				
CO3	To understand the principles of Refractometry, Potentiometry, Conductometry, Kinetics, Polarimetry, Adsorption and PH-metry				

General Instructions

1. For weighing, electronic 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 at least six 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 and Surface tension

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).
3. Determination of the surface tension of a liquid or a dilute solution (NaCl / surfactant) using a stalagmometer (drop number method).

Module II:Colligative properties (Cooling curve method)

1. Determination of cryoscopic constant (Kf) 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 (Kf).

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 (Kt) of salt hydrate using solute of known molecular mass.
2. Determination of molecular mass of the solute using a solvent of known molal transition constant (Kt).

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

Module IV: Phase Equilibria

1. Construction of phase diagram & determination of eutectic composition and eutectic temperature: *Naphthalene-biphenylsystem,Naphthelene-diphenylaminesystem,Biphenyl–diphenylaminesystem.*
2. Influence of KCl impurity on miscibility temperature of phenol–water system and determination of concentration of given KCl solution.

Module V: Spectroscopy

1. Verify Lambert-Beer's law and determine molar extinction coefficient, concentration of any one, $CuSO_4$/ Ferric alum / $KMnO_4$ / $K_2Cr_2O_7$ in a solution. Find out the unknown concentration of the given solution. (Five standards may be prepared).

Module VI: Conductometry and Potentiometry

1. Determine the end point of titration of a strong acid (HCl) against strong base (NaOH) by conductometric method.
2. Determine the end point of titration of a weak acid (CH_3COOH) against strong base (NaOH) by conductometric method
3. Determine the equivalent conductance of the given electrolyte of known concentration using a digital conductometer.
4. Determine the end point of titration of a strong acid (HCl) against strong base (NaOH) by potentiometric method.
5. Dtermine the concentration of Fe^{2+} ions in the given solution by titrating it potentiometrically against standard $K_2Cr_2O_7$.

Module VII: pHmetry

1. Preparation of acidic /alkaline buffer solutions and measure the pH.
2. pHmetric titration of strong acid with strong base.

Module VIII: Kinetics (Demonstration)

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

Module IX: Polarimtery (Demonstration)

1. Study of the kinetics of inversion of cane sugar, catalyzed by acid, polarimetrically.
2. Determine the specific rate constant for the hydrolysis of sucrose, in the presence of acid, using polarimetry.

Module X: Refractomtery (Demonstration)

1. Determination of the refractive indices of the given liquids and hence to calculate the specific and molar refractivities.
2. Determination of composition of glycerine-water mixture by refractive index method.

Module X1: Adsorption (Demonstration)

1. To verify the Freundlich and Langmuir adsorption isotherms for the adsorption of oxalic acid on charcoal.
2. Determine the concentration of the given oxalic acid solution by studying the adsorption of oxalic acid over charcoal.

References

1. A.Findlay, *Findlay's Practical Physical Chemistry*,9th Edn., John Wiley and Sons, NewYork, 1972.
2. J. B. Yadav, *Advanced Practical Physical Chemistry*, Goel Publications, Meerut, 2008.
3. D.P. Shoemaker, 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, B. Behra, *Experiments in Physical Chemistry*, Tata McGraw Hill, New Delhi,1983.
6. D.A. Skoog, D.M. West, F.J. Holler, S.R.Crouch, *Fundamentals of Analytical Chemistry*, 8th Edn., Brooks/Cole, Thomson Learning, Inc., USA, 2004.
7. P. S. Sindhu, *Practicals in Physical Chemistry A Modern Approach*, Macmillan India Ltd. 2006.

SEMESTER VI

Course Code: GCHE6B14P

Core Course XV: ORGANIC CHEMISTRY PRACTICAL

Total Hours: 80; Credits: 4; Hours/Week: 5 (Semester V); Total Marks 100 (Internal 20 & External 80)

GCHE6B14P	ORGANIC CHEMISTRY PRACTICAL	L	T	P	C
		0	0	5	4
Objective (s)	To empower the students to prepare different compounds without compromising yield. Characterisation and analysis of different organic compounds based on functional groups. To develop skill in separation and purification of mixtures.				
Course outcome (s)					
CO1	To enable the students to develop analytical skills in organic qualitative analysis.				
CO2	To develop talent in organic preparations to ensure maximum yield.				
CO3	To apply the concept of melting or boiling points to check the purity of compounds.				
CO4	To analyse and characterise simple organic functional groups.				
CO5	To analyse individual amino acids from a mixture using chromatography.				

General Instructions

1. Semimicro 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 on tiles, wherever possible.

4. A minimum number of 7 organic analysis, 6 organic preparations and 1 chromatographic separation shall be done to appear for the examination.

5. The practical must be completed in semester V. Practical examination will be conducted at the end of semester VI.

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.
3. Extraction of caffeine from tea leaves.

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).
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, benzophenone).
6. Carboxylic acid (benzoic acid, cinnamic acid, phthalic acid, salicylic acid).
7. Carbohydrates (glucose, sucrose).
8. Amides (benzamide, urea).
9. Esters (ethyl benzoate, methyl salicylate).
10. Hydrocarbons (naphthalene, anthracene).

Analysis of about 10 organic compounds containing the above functional groups.

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 VIII: Organic Preparations - Green Method

1. Electrophilic aromatic substitution reaction – Bromination of acetanilide
2. Electrophilic aromatic substitution reaction – Nitration of phenol
3. Base catalyzed aldol condensation reaction – Synthesis of dibenzalpropanone
4. Acetylation of primary amine – Preparation of acetanilide
5. Green photochemical reaction – Photoreduction of benzophenone to benzopinacol

Module IX: Chromatography

1. Paper chromatographic separation of mixture of two amino acids.
2. Qualitative analysis of mixtures using TLC
3. Quantitative separation of mixtures using column chromatography.

References

1. B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatchell, *Vogel's Textbook of Practical Organic Chemistry*, 5th Edn., Pearson Education, Noida, 2014.

2. F. G. Mann, B. C. Saunders, *Practical Organic Chemistry*, 4th Edn., Pearson Education, Noida, 2011.

3. Arthur I. Vogel, *Elementary Practical Organic Chemistry- Small Scale Preparations*, 2nd Edn., Pearson Education, Noida, 2013.

4. V. K. Ahluwalia, S. Dhingra, *Comprehensive Practical Organic Chemistry*, Universities Press, Hyderabad, 2004.

SEMESTER VI

Course Code: GCHE6B15P

Core Course XVI: INORGANIC CHEMISTRY PRACTCAL-II

Total Hours: 80; Credits: 4; Hours/Week: 5; Total Marks 100 (Internal 20 & External 80)

GCHE6B15P	**INORGANIC CHEMISTRY PRACTCAL-II**	L	T	P	C
		0	0	5	4
Objective (s)	To develop skill in quantitative analysis using gravimetric and colorimetric methods.				
Course outcome (s)					
CO1	To enable the students to develop analytical skills in inorganic quantitative analysis.				
CO2	To understand the principles behind gravimetry and to apply it in quantitative analysis.				
CO3	To understand the principles behind colorimetry and to apply it in quantitative analysis.				

General Instructions

1. For weighing, electronic balance may be used.

2. Use safety coat, goggles, shoes and gloves in the laboratory.

3. A minimum number of 7 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, M. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Edn., Pearson Education, Noida, 2013.

2. D. N Bajpai, O. P. Pandey, S. Giri, *Practical Chemistry for I, II & III B. Sc. Students*, S. Chand & Company Ltd., New Delhi, 2012.

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

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

SEMESTER VI

Course Code: CHE6B16P
Core Course XVII: INORGANIC CHEMISTRY PRACTCAL-III

Total Hours: 80; Credits: 4; Hours/Week: 5; Total Marks 100 (Internal 20 & External 80)

CHE6B16P	INORGANIC CHEMISTRY PRACTCAL-III	L	T	P	C
		0	0	5	4
Objective (s)	To develop skill in quanlitative analysis of inorganic compounds.				
Course outcome (s)					
CO1	To enable the students to develop skills in inorganic quanlitative analysis.				
CO2	To understand the principles behind inorganic mixture analysis and to apply it in quanlitative analysis.				
CO3	To analyse systematically mixtures containing two cations and two anions.				

General Instructions

1. Semimicro 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 7 inorganic mixtures 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. Na_2CO_3 extract procedure may be adopted.

References

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

SEMESTER VI

Course Code: GCHE6B17D

Core Course XVIII: PROJECT WORK

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

GCHE6B17D	PROJECT WORK	L	T	P	C
		0	0	2	2
Objective (s)	To develop skill in scientific research, critical thinking and reasoning.				
Course outcome (s)					
CO1	To understand the scientific methods of research project.				
CO2	To apply the scientific method in life situations.				
CO3	To analyse scientific problems systematically.				

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 semester V. However, the evaluation of the project report will be carried out at the end of semester VI.
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 be kept 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 COURSE

CORE COURSE THEORY: EVALUATION SCHEME

The evaluation scheme for each course contains two parts: *viz.,* internal evaluation and external evaluation. 20% weightage shall be given to the internal assessment. The remaining 80% weightage shall be for the external evaluation.

1. INTERNAL EVALUATION

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

Table 1: Components of Evaluation

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

**Viva:* GCHE1B01T, GCHE2B02T, GCHE3B03T, GCHE4B04T, GCHE5B06T, GCHE6B10T, GCHE6B11T, GCHE6B12T and elective course; *Seminar:* GCHE5B07T, GCHE5B08T and GCHE6B09T.

Table 2: Percentage of attendance based on class room participation and Eligible Marks

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

Table 3: Pattern of Test Papers

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

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

2. EXTERNAL EVALUATION

External evaluation carries 80% marks. University examinations will be conducted at the end of each semester. Duration of each external examination is two hours for 2/3 credit.

Table 1: Pattern of Question Paper

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

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	Record (60%)	12
2	Lab involvement (40%)	8
Total Marks		**20**

Table 2: Lab involvement

Component	**Mark**
Viva	4
Performance	2
Punctuality	2
Total	8

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***
Volumetry	***Preparation***					
19-20 (9)	6 (3)	14 (12)	10 (8)	8 (4)	10-11 (12)	10 (12)
18 (8)	5 (2)	13 (11)	9 (7)	7 (3)	9 (11)	9 (11)
17 (7)	4 (1)	12 (10)	8 (6)	6 (2)	8 (10)	8 (10)
16 (6)		11 (9)	7 (5)		7 (9)	7 (9)
15 (5)		10 (8)				

2. EXTERNAL EVALUATION

External evaluation carries 80% marks. Practical examinations along with viva-voce will be conducted at the end of IVth and VIth 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 for volumetry	8	
	Procedure for inorganic preparation	4	
	Inorganic preparation	5	
	Result	35	
	Calculation	4	
	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: 35 marks; between 1.51 – 2%: 30 marks; between 2.1 – 2.5%: 25 marks; between 2.51– 3%: 15 marks; greater than 3%: 4 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 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.

4. Marks for inorganic preparation procedure: Six to seven points – 4 marks. 1) Balanced equation of the reaction; 2) Requirements; 3) Solvent used; 4) Reaction condition; 5) Precipitating agent; 6) Recrystallisation; 7) Solvent for recrystallisation.

5. Marks for inorganic preparation: The students shall exhibit the prepared compound for inspection. Yield: 3 marks; colour: 2 marks.

Table 2: Physical Chemistry Practical

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

Guidelines

1. *Valuation of Principle and procedure:* 8 marks (4 marks for principle and 4 marks for procedure).

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***
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
	Identification tests for ions	16	
	Confirmation tests for ions	16	
	Identification of cation group	4	
	Chemistry of identification tests	8	
	Chemistry of confirmation tests	8	
	Systematic procedure	8	
	Record	8	
	Viva-Voce	8	

Guidelines

1. *Identification Tests:* 4 Marks each for two anions two cations.
2. *Identification of Cation Group:* 2 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***
Volumetry	***Preparation***		***Analysis***	***Preparation***		***Mixture***
19-20 (6)	6 (2)	14 (8)	10 (4)	8 (4)	10-11 (8)	10 (8)
18 (5)	5 (1)	13 (7)	9 (3)	7 (3)	9 (7)	9 (7)
17 (4)		12 (6)	8 (2)	6 (2)	8 (6)	8 (6)
16 (3)		11 (5)			7 (5)	7 (5)
						6 (4)

CORE COURSE PROJECT: EVALUATION SCHEME

Project evaluation will be conducted at the end of sixth semester. Evaluation of the project report shall be done under mark system.

a) Supervising teachers will assess the project and award internal marks.

b) External evaluation by examiner appointed by university.

c) Grade for the project will be awarded to candidates, combining the internal and external marks.

Table 1: Internal Evaluation

Sl. No	***Criteria***	***Marks***
1	Originality of content (20%)	3
2	Methodology of presentation (20%)	3
3	Organization of report and conclusion (30%)	4.5
4	Viva-voce (30%)	4.5
Total Marks		**15**

Table 2: External Evaluation

Sl. No	***Criteria***	***Marks***
1	Content and relevance of the project (20%)	12
2	Presentation and quality of analysis (20%)	12
3	Findings and recommendations (30%)	18
4	Viva-voce (30%)	18
Total Marks		**60**

1) Submission of the project report and presence of the student for viva are compulsory for internal evaluation. No marks shall be awarded to a candidate if she/he fails to submit the project report for external evaluation

2) The student should get a minimum P grade in aggregate of external and internal.

3) There shall be no improvement chance for the marks obtained in the project report.

4) In the extent of student failing to obtain a minimum of pass grade, the project work may be re-done and a new internal mark may be submitted by the parent department. External examination may be conducted along with the subsequent batch.

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	GCHE1C01T	Complementary Course I: General Chemistry	2	32	2	75
	-	Complementary Course V: Chemistry Practical	2	32	-*	-
II	GCHE2C02T	Complementary Course II: Physical Chemistry	2	32	2	75
	-	Complementary Course V: Chemistry Practical	2	32	-*	-
III	GCHE3C03T	Complementary Course III: Organic Chemistry	3	48	2	75
	-	Complementary Course V: Chemistry Practical	2	32	-*	-
IV	GCHE4C04T	Complementary Course IV: Physical and Applied Chemistry	3	48	2	75
	GCHE4C05P	Complementary Course V: Chemistry Practical	2	32	4*	100
Total					**12**	**400**

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

SEMESTER I

Course Code: GCHE1C01T

Complementary Course I: GENERAL CHEMISTRY

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

GCHE1C01T	**GENERAL CHEMISTRY**	L	T	P	C
		2	0	0	2
Objective(s)	To provide the students a thorough knowledge about the chemistry of quantitative and qualitative analysis and the theories of chemical bonding. It will also impart the ideas about atomic nucleus and the importance of metals in biological systems.				
Course outcome (s)					
CO1	To understand and to apply the theories of quantitative and qualitative analysis.				
CO2	To understand the theories of chemical bonding.				
CO3	To appreciate the uses of radioactive isotopes.				
CO4	To understand the importance of metals in biological systems.				

Module I: Analytical Chemistry (10 hrs)

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

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

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

Accuracy & Precision (mention only).

References

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

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

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

Atomic Structure: Bohr atom model and its limitations, de Broglie equation - Heisenberg uncertainty principle - Schrödinger wave equation (mention only) - Atomic orbitals - Quantum numbers and their significance - Pauli's Exclusion principle - Hund's rule of maximum multiplicity - Aufbau principle – Electronic configuration of atoms.

Chemical Bonding: Introduction – Type of bonds.

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

Covalent bond: Lewis theory – Coordinate bond.

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

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

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

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

References

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

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

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

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

Module III: Nuclear Chemistry (6 hrs)

Natural radioactivity – Modes of decay – Group displacement law.

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

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

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

References

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

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

Module IV: Bioinorganic Chemistry (6 hrs)

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

References

1. B. R. Puri, L. R. Sharma, K. C. Kalia, *Principles of Inorganic Chemistry*, Milestone Publishers, New Delhi, 2010.

2. G. L. Meissler, D. A. Tarr, *Inorganic Chemistry*, 3rd Edn. Pearson Education, 2004.

3. J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, *Inorganic Chemistry*, 5th Edn., Pearson, 2009.

4. F. A. Cotton, G. Wilkinson, P. L. Gaus, *Basic Inorganic Chemistry*, 3rd Edn., John – Wiley, 1995.

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

SEMESTER II

Course Code: GCHE2C02T

Complementary Course II: PHYSICAL CHEMISTRY

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

GCHE2C02T	**PHYSICAL CHEMISTRY**	L	T	P	C
		2	0	0	2
Objective(s)	To provide the students a thorough knowledge about different terminologies in thermodynamics and the continuity between different states of matter. It will also impart an idea behind basic principles of electrochemistry.				
Course outcome (s)					
CO1	To understand the importance of free energy in defining spontaneity				
CO2	To realize the theories behind different states of matter and their implication				
CO3	To understand the basic principles of electrochemistry				

Module I: Thermodynamics (6 hrs)

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

References

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

Module II: Gaseous and Solid States (10 hrs)

Gaseous State: Introduction - Kinetic molecular model of gases – Maxwell distribution of velocities and its use in calculating molecular velocities – Average velocity, RMS velocity and most probable velocity (derivations not required) – Boyle's law – Charles's law – Ideal gas equation – Behaviour of real gases – Deviation from ideal behavior - Van der Waals equation (derivation not required).
Solid State: Introduction - Isotropy and anisotropy - Symmetry elements in crystals - The seven crystal systems – Miller indices - Bravais lattices – Bragg's equation (derivation

required) and its applications (mention only). Defects in crystals: Non-stoichiometric and stoichiometric defects - Extrinsic and intrinsic defects.

References

1. K. L. Kapoor, *A Textbook of Physical chemistry*, Volumes 1, Macmillan India Ltd.
2. B. R. Puri, L. R. Sharma, M. S. Pathania, *Elements of Physical chemistry*, Vishal Pub. Co.

Module III: Liquid State and Solutions (6 hrs)

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

References

1. K. L. Kapoor, *A Textbook of Physical chemistry*, Volumes 1, Macmillan India Ltd.
2. B. R. Puri, L. R. Sharma, M. S. Pathania, *Elements of Physical Chemistry*, Vishal Pub. Co.

Module IV: Electrochemistry (10 hrs)

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

References

1. P. Atkins. J. Paula, Atkins, *Physical Chemistry*. 8th Edn.Oxford University Press, 2006.
3. K. K. Sharma, L.K. Sharma, *A Textbook of Physical Chemistry*, 5th Edn., Vikas Publishing House, New Delhi, 2012.
4. Gordon M. Barrow, *Physical Chemistry*, 5thEdn., Tata McGraw Hill Education, New Delhi, 2006.
5. F. Daniels, R.A. Alberty, *Physical Chemistry*, 5th Edn., John Wiley and Sons, Canada, 1980.

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

SEMESTER III

Course Code: GCHE3C03T

Complementary Course III: ORGANIC CHEMISTRY

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

GCHE3C03T	**ORGANIC CHEMISTRY**	L	T	P	C
		3	0	0	2
Objective(s)	To provide the students a thorough knowledge about basic theory and concepts of organic chemistry.				
Course outcome (s)					
CO1	To understand the basic concepts involved in reaction intermediates.				
CO2	To realise the importance of optical activity and chirality.				
CO3	To appreciate the importance of functional groups and aromatic stability.				
CO4	To understand the basic structure and importance of carbohydrates, nucleic acids, alkaloids and terpenes.				

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

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

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

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

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

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

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

References

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

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

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

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

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

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

Module II: Stereochemistry (6 hrs)

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

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

Module III: Aromatic Hydrocarbons (5 hrs)
Nomenclature and isomerism in substituted benzene. Structure and stability of benzene: Kekule, resonance and molecular orbital description.
Mechanism of aromatic electrophilic substitution: Halogenation, nitration, sulphonation and Friedel-Craft's reactions – orientation effect of substituents.
Aromaticity and Huckel's rule: Application to benzenoid (benzene, naphthalene and anthracene) and nonbenzenoid (pyrrole, pyridine and indol) aromatic compounds.

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

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

Halogen Compounds: Preparation of alkyl halides from alkanes and alkenes – Wurtz reaction and Fittig's reaction – Mechanism of S_N1 and S_N2 reactions of alkyl halides – Effect of substrate and stereochemistry.

Alcohols: Preparation from Grignard reagent – Preparation of ethanol from molasses – Wash, rectified spirit, absolute alcohol, denatured spirit, proof spirit and power alcohol (mention only) – Comparison of acidity of ethanol, isopropyl alcohol and *tert*-butyl alcohol – Haloform reaction and iodoform test – Luca's test – Chemistry of methanol poisoning – Harmful effects of ethanol in the human body.
Phenols: Preparation from chlorobenzene – Comparison of acidity of phenol, *p*-nitrophenol and *p*-methoxyphenol – Preparation and uses of phenolphthalein.

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

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

References

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

Module VI: Biomolecules (8 hrs)

*Carbohydrates: C*lassification with examples - cyclic structures of glucose and fructose - Applications of carbohydrates.
Proteins: Amino acids – Classification – Zwitter ion formation – Peptide linkage – Polypeptides and proteins – Primary, secondary and tertiary structure of proteins – Globular and fibrous proteins – Denaturation of proteins.
Enzymes: Characteristics and examples.
Nucleic acids: Structure of pentose sugar, nitrogenous base, nucleoside and nucleotide – Double-helical structure of DNA – Difference between DNA and RNA – DNA fingerprinting and its applications.

References

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

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

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

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

Moldule VII: Alkaloids and Terpenes (3 hrs)

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

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

Note: Structural elucidation not expected in any case.

References

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

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

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

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

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

SEMESTER IV

Course Code: GCHE4C04T

Complementary Course IV: PHYSICAL AND APPLIED CHEMISTRY

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

GCHE4C04T	**PHYSICAL AND APPLIED CHEMISTRY**	L	T	P	C
		3	0	0	2
Objective (s)	To provide the students a thorough knowledge about colloidal chemistry, nanochemistry and the importance of chemistry in daily life. It also provides a basic idea related to separation and spectral techniques. It also imparts the idea of green processes with special emphasis on environment.				
Course outcome (s)					
CO1	To understand the basic concepts behind colloidal state and nanochemistry.				
CO2	To understand the importance of green chemistry and pollution prevention.				
CO3	To appreciate the importance of different separation methods and spectral techniques.				
CO4	To understand the extent of chemistry in daily life.				

Module I: Colloidal Chemistry (6 hrs)

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

References

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

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

Module II: New Vistas in Chemistry (6 hrs)

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

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

References

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

Module III: Chromatography (6 hrs)

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

References

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

Module IV: Spectroscopy (10 hrs)

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

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

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

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

References

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

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

Module V: Polymers (4 hrs)

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

References

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

Module VI: Environmental Pollution (6 hrs)

Definition – Types of pollution.

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

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

Soil pollution – Pollution due to plastics.

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

References

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

Module VII: Chemistry in Daily Life (10 hrs)

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

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

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

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

Cement: Manufacture, composition and setting.
Glass: Types of glasses and uses.

References

1. Gurdeep R. Chatwal, *Synthetic Drugs*, Himalaya Publishing House, Bombay, 1995.
2. Jayashree Ghosh, *A Textbook of Pharmaceutical Chemistry*, 3rd Edn., S. Chand and Company Ltd., New Delhi, 1999.
3. B. Sivasankar, *Food processing and preservation*, Prentice – Hall of India Pvt. Ltd., New Delhi, 2002.
4. Srinivasan Damodaran, Kirk L. Parkin, Owen R. Fennema, *Food Chemistry*, 4th Edn., CRC Press, New York, 2007.

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

SEMESTER IV

Course Code: GCHE4C05P

Complementary Course V: CHEMISTRY PRACTICAL

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

GCHE4C05P	**CHEMISTRY PRACTICAL**	L	T	P	C
		0	0	2	4
Objective (s)	To develop proficiency in quantitative and qualitative analysis and expertise in organic preparation and determination of physical constants.				
Course outcome (s)					
CO1	To understand the basic concepts of inter group separation.				
CO2	To enable the students to develop analytical and preparation skills.				

General Instructions

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

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

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

Module II: Volumetric Analysis

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

Permanganometry:

(i) Estimation of oxalic acid.

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

Dichrometry:

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

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

Iodimetry and Iodometry:

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

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

Module III: Gravimetric Analysis

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

Module IV: Inorganic Qualitative Analysis

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

Module V: Determination of Physical Constants

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

Module VI: Organic Preparations

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

References

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

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

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

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

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

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

EVALUATION SCHEME

FOR

COMPLEMENTARY COURSES

COMPLEMENTARY COURSE THEORY: EVALUATION SCHEME

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

1. INTERNAL EVALUATION

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

Table 1: Components of Evaluation

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

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

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

Table 3: Pattern of Test Papers

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

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

2. EXTERNAL EVALUATION

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

Table 1: Pattern of Question Papers

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

COMPLEMENTARY COURSE PRACTICAL: EVALUATION SCHEME

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

1. INTERNAL EVALUATION

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

Table 1: Components of Evaluation

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

Table 2: Number of Experiments and Marks for Practical Records

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

2. EXTERNAL EVALUATION

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

Table 1: Pattern of Question Paper

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

Guidelines

1. *Valuation of Volumetric Procedure*: Eight points – 6 marks. 1. Correct intermediate; 2. Preparation of standard solution; 3. Standardisation of intermediate; 4.

Indicator and end point of standardization; 5. Making up of given solution; 6. Titration of made up solution; 7. Indicator; 8. End point/any other relevant points.

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

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

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

Table 2: Evaluation of Records

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

SYLLABUS

FOR

OPEN COURSES

OPEN COURSE STRUCTURE

(FOR STUDENTS OTHER THAN B.Sc. CHEMISTRY)

Total Credits: 3 (Internal 20%; External 80%)

Semester	*Code No*	*Course Title*	*Hrs/ Week*	*Total Hrs*	*Marks*
V	GCHE5D01T	Open Course 1: Environmental Chemistry	3	48	75
	GCHE5D02T	Open Course 2: Chemistry in Daily Life			
	GCHE5D03T	Open Course 3: Food Science and Medicinal Chemistry			

SEMESTER V

Course Code: GCHE5D01T

Open Course 1: ENVIRONMENTAL CHEMISTRY

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

GCHE5D01T	ENVIRONMENTAL CHEMISTRY	L	T	P	C
		3	0	0	3
Course outcome (s)					
CO1	Recall the technical/scientific terms involved in pollution.				
CO2	Understand the causes and effects of air pollution.				
CO3	Understand the sources, types and effects of water pollution.				
CO4	Describe water quality parameters.				
CO5	Know soil, noise, thermal and radioactive pollutions and their effects.				
CO6	Study various pollution control measures				
CO7	Understand the basics of green chemistry				

Module I: Introduction to Environment and Environmental pollution (4 hrs)

Environmental chemistry - introduction, Environmental segments – Lithosphere: components of soils, Hydrosphere: water resources, Biosphere, Atmosphere - regions of atmosphere – Troposphere, stratosphere, mesosphere, thermosphere.

Environmental pollution – Concepts and definition – Pollutant, contaminant, receptor and sink – Classification of pollutants – Global, regional, local, persistent and non-persistent pollutants.

References

1. A. K. De, *Environmental Chemistry*, 7th Edn., New Age International, 2012.
2. A. K. Ahluwalia, *Environmental Chemistry*, The Energy and Resources Institute, 2017.
3. Balram Pani, *Textbook of Environmental Chemistry*, I. K. International Pvt Ltd, 2010.

Module II: Air Pollution (8 hrs)

Tropospheric pollution – Gaseous air pollutants – Hydrocarbons, oxides of sulphur, nitrogen and carbon – Global warming, green house effect, acid rain – Particulates – Smog: London smog and photochemical smog – effects and control of photochemical smog – stratospheric pollution - depletion of ozone layer, chlorofluorocarbons - Automobile pollution. Control of air pollution – Alternate refrigerants – Bhopal Tragedy (a brief study). Air pollution in Indian cities (Delhi, Agra and Kanpur).

References

1. S. K. Banergy, *Environmental Chemistry*, 2nd Edn., Prentice-Hall of India Pvt. Ltd., New Delhi, 2005.
2. V. N. Bashkin, *Environmental Chemistry: Asian Lessons*, Springer Science & Business

Media, 2003.
3. S. E. Manahan, *Environmental Chemistry*, 8th Edn., CRC Press, Florida, 2004.
4. A. K. Ahluwalia, *Environmental Chemistry*, The Energy and Resources Institute, 2017.
5. Balram Pani, *Textbook of Environmental Chemistry*, I. K. International Pvt. Ltd., 2010.

Module III: Water Pollution (10 hrs)

Impurities in water – cause of pollution – natural and anthropogenic – Marine water pollution – Underground water pollution.

Source of water pollution – Industrial waste, Municipal waste, Agricultural waste, Radioactive waste, Petroleum, Pharmaceutical, heavy metal, pesticides, soaps and detergents.

Types of water pollutants: Biological agents, physical agents and chemical agents – Eutrophication - biomagnification 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), itai-itai disease, oil pollution in water. International standards for drinking water.

References

1. S. K. Banergy, *Environmental Chemistry*, 2nd Edn., Prentice-Hall of India Pvt. Ltd., New Delhi, 2005.
2. J. M. H. Selendy, *Water and Sanitation-Related Diseases and the Changing Environment*, John Wiley & Sons, 2011.
3. P. K. Goel, *Water Pollution: Causes, Effects and Control*, New Age International, 2006.
4. V. N. Bashkin, *Environmental Chemistry: Asian Lessons*, Springer Science & Business Media, 2003.
5. S. E. Manahan, *Environmental Chemistry*, 8th Edn., CRC Press, Florida, 2004.
6. A. K. Ahluwalia, *Environmental Chemistry*, The Energy and Resources Institute, 2017.
7. Balram Pani, *Textbook of Environmental Chemistry*, I. K. International Pvt. Ltd., 2010.

Module IV: Soil, Noise, Thermal, light and Radioactive Pollutions (8 hrs)

Soil pollution: Sources by industrial and urban wastes. Pollution due to plastics, pesticides, biomedical waste and *e-waste* (source, effects and control measures) – Control of soil pollution - Solid waste Management – Open dumping, landfilling, incineration, re-use, reclamation, recycle, composting.

Non-degradable, degradable and biodegradable wastes. Hazardous waste.

Noise Pollution – physiological response to noise, Noise categories - effect of noise – biological effects.

Thermal pollution – definition, sources, harmful effects and prevention. Light pollution.

Radioactive pollution (source, effects and control measures) – Hiroshima, Nagasaki and Chernobyl accidents (brief study). Endosulfan disaster in Kerala (brief study).

References

1. S. E. Manahan, *Environmental Chemistry*, 8th Edn., CRC Press, Florida, 2004.
2. A. K. Ahluwalia, *Environmental Chemistry*, The Energy and Resources Institute, 2017.
3. A. K. De, *Environmental Chemistry*, 6th Edn., New Age International.
4. Balram Pani, *Textbook of Environmental Chemistry*, I. K. International Pvt. Ltd., 2010.
5. Anindita Basak, *Environmental Studies*, Pearson Education India, 2009.
6. Pallavi Saxena, Vaishali Naik, *Air Pollution: Sources, Impacts and Controls*, CAB International, 2018.

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.

References

1. N. P Cheremisinoff , *Handbook of Air Pollution Prevention and Control*, 2002.
2. M. Senapati, *Advanced Engineering Chemistry*, 2006.
3. K. C. Schifftner, *Air Pollution Control Equipment Selection Guide*, CRC Press, 2013.
4. K. B. Schnelle, C. A. Brown, *Air Pollution Control Technology Handbook*, CRC Press, 2016.

Module VI: Green Chemistry (6 hrs)

Introduction- Definition of green Chemistry, need of green chemistry, basic principles of green chemistry. Applications of green chemistry in daily life.

References

1. V.K. Ahluwalia, M. Kidwai, *New Trends in Green Chemistry*, Springer Science & Business Media, 2012.
2. M. Lancaster, *Green Chemistry*: *An Introductory Text*, Royal Society of Chemistry, 2010.
3. S. C. Ameta, R. Ameta, *Green Chemistry*: *Fundamentals and Applications*, CRC Press, 2013.

Scheme of Examinations:

The external question paper carries 60 marks and internal examination is of 15 marks. Duration of each external examination is 2 Hrs. The pattern of External Examination is as given below:

Section A

Short answer type carries 2 marks each – 12 questions Ceiling – 20

Section B

Paragraph/ Problem type carries 5 marks each – 7 questions Ceiling – 30

Section C

Essay type carries 10 marks (1 out of 2) 1x10=10

The students can answer all the questions in sections A & B but there shall be ceiling.

Mark Distribution	
Module I	9 Marks
Module II	14 Marks
Module III	18 Marks
Module IV	14 Marks
Module V	16 Marks
Module VI	8 Marks

SEMESTER V

Course Code: GCHE5D02T

Open Course 2: CHEMISTRY IN DAILY LIFE

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

GCHE5D02T	**CHEMISTRY IN DAILY LIFE**	L	T	P	C
		3	0	0	3
Course outcome (s)					
CO1	Understand the basics of polymer chemistry				
CO2	Explain the functions of biomolecules, vitamins, enzymes, hormones and nucleic acid				
CO3	Describe food additives and food habits				
CO4	Explain the uses of pesticides and fertilizers and their impacts on the environment				
CO5	Understand advantages and disadvantages of cleansing agents and cosmetics				
CO6	Recognize the common classes of drugs in pharmaceutical industry and their application				
CO7	Understand the basic concepts and processes in petroleum industry				

Module I: Polymers (8 hrs)

Classification of polymers: Origin, structure, synthesis, molecular forces. Commercially important polymers: Application of polyethylene, polystyrene, polyhaloolefines, Nylon 6, Nylon 66, Melamine, Terylene, Bakelite, natural and synthetic rubber, vulcanization, Advantages of vulcanized rubber, natural silk and artificial silk, inorganic polymer: (Examples Only) - Plastic identification codes – Applications of biodegradable polymers (PGA, PLA and PHBV) – Importance of plastic recycling.

References

1. B. K. Sharma, *Industrial Chemistry*, 11th Edn., Goel publishing House, Meerut, 2000.
2. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edn., Vikas Publishing House (Pvt.) Ltd., New Delhi, 2004.
3. V. R. Gowarikar, *Polymer Chemistry*, New Age International Pvt. Ltd., New Delhi, 2010.
4. B. K. Sharma, *Polymer Chemistry*, Goel Publishing House, Meerut, 1989.
5. M. G. Arora, M. Singh, M. S. Yadav, *Polymer Chemistry*, 2nd Revised Edn., Anmol Publications Private Ltd., New Delhi, 1989.
6. Catia Bastioli, *Handbook of Biodegradable Polymers*, Smithers Rapra Publishing, 2005.

Module II: Chemistry in Biological Systems (8 hrs)

Vitamins: Name, source, function and deficiency diseases. Enzymes - Classifications, characteristics, role, examples. Hormones - Sex hormones - Androgens, oestrogens, progesterone, example, function. Cortical hormones - a few examples with function.

Nucleic acid - RNA, DNA: Introduction - role in life process (No structure or chemical reactions needed).

References

1. M. V. Kulkarni, *Biochemistry*, Pragati Books Pvt. Ltd., 2008.
2. S. C. Rastogi, *Biochemistry*, 2nd Edn., Tata McGraw Hill Publishing Co., New Delhi, 2007.
3. U. Satyanarayana, U. Chakrapani, *Biochemistry*, Elsevier Health Sciences, 2014.
4. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edn., Vikas Publishing House (Pvt.) Ltd., New Delhi, 2004.
5. D. Sriram, *Medicinal Chemistry*, Pearson Education India, 2010.
6. N. V. Bhagavan, *Medical Biochemistry*, Academic Press, 2002.

Module III: Food Chemistry (8 hrs)

Common adulterants in different foods: Milk and milk products, vegetable oils, cereals, tea, coffee powder, chilly powder and beverages.

Food Additives: Antioxidants and food preservatives – Commonly used permitted and non-permitted food colours – Artificial sweeteners – Taste enhancers – Artificial ripening of fruits and its side effects.

Modern Food Habits: Definition and health effects of fast foods, instant foods, dehydrated foods and junk foods. Harmful effects of modern food habits.

Importance of milk, coconut water and Neera.

References

1. Lillian Hoagland Meyer, *Food Chemistry*, 1st Edn., CBS Publishers & Distributors, New Delhi, 2004.
2. B. A. Fox, A. G. Cameron, E. Arnold, *Food Science*, Nutrition and Health, 6th Edn., Edward Arnold, London, 1995.
3. A. Siddiqui, N. Anusha, *Deleterious Effects of Food Habits in Present Era*, J. Aller. Ther. 3:114, 2012.
4. H. S. Ramaswamy, M. Marcotte, *Food Processing: Principles and Applications*, CRC Press, 2005.
5. A. F. Smith, *Encyclopedia of Junk Food and Fast Food*, Greenwood Publishing Group, 2006.
6. T. A. M. Sagati, The Chemistry of Food Additives and Preservatives, John Wiley & Sons, 2012.
7. S. N. Mahindru, *Food Additives*, APH Publishing, 2009.
8. Biju Mathew, *Anchor India*, Info Kerala Communications Pvt. Ltd., 2015.

Module IV: Agriculture (4 hrs)

Fertilizers: Essential nutrients for plants – NPK value – Natural and synthetic fertilizers – Nitrogenous, phosphatic and potash fertilizers (examples) – Impact of excessive use of

fertilizers on environment – Biofertilizers.

Pesticides: Classification – Insecticides, herbicides, rodenticides and fungicides (definition and examples only) – Non-degradable pesticides – Pesticide pollution and its impact on environment – Endosulfan disaster in Kerala (brief study). Pheromones.

References

1. H. S. Rathore, L. M. L. Nollet, *Pesticides: Evaluation of Environmental Pollution*, CRC Press, USA, 2012.

2. Murray Park, *The Fertilizer Industry*, Elsevier, 2001.

3. B. K. Sharma, *Industrial Chemistry*, Krishna Prakashan Media, 1991.

Module V: Cleansing Agents and Cosmetics (6 hrs)

Cleansing Agents: Soaps – Hard and soft soaps – Alkali content – TFM – Detergents (classification) – Cleaning action – Advantages and disadvantages of soaps and detergents – Shaving creams. Shampoos: Ingredients and functions – Different kinds of shampoos (Anti-dandruff, anti-lice, herbal and baby shampoos). Tooth paste: Composition and health effects.

Cosmetics: Hair dye: Chemicals used and its harmful effects. Face and skin powders: Types, ingredients and functions. Cleansing creams: Cold creams, vanishing creams and bleach creams. Perfumes, antiperspirants, sun screen preparations, nail polishes, lipsticks, rouges, eyebrow pencils and eye liners (ingredients and functions) – Harmful effects of cosmetics.

References

1. B. K. Sharma, *Industrial Chemistry*, Krishna Prakashan Media, 1991.

2. M. S. R. Winter, *A Consumer's Dictionary of Cosmetic Ingredients*, 7th Edn., Three Rivers Press, New York, 2009.

Module VI: Pharmaceuticals and Dyes (8 hrs)

Drug: Chemical name, generic name and trade names with examples. Terminology: Prodrug, pharmacy, pharmacology, pharmacophore, pharmacognosy, pharmacodynamics and pharmacokinetics (elementary idea only). Antipyretics, analgesics, antacids, antihistamines, antibiotics, antiseptics, disinfectants, anaesthetics, tranquilizers, narcotics, antidepressants and psychedelic drugs (definition and examples).

Dyes: classification based on constitution, application, examples, uses.

Dyes: Requirements of a dye – Classification based on mode of application to the fabric – Applications of dyes (general study). Ancient and modern colours – Mention of indigo and alizarin.

References

1. B. K. Sharma, *Industrial Chemistry*, Krishna Prakashan Media, 1991.

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

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

Module VII: Fuels (6 hrs)

Definition and classification of fuels – Characteristics of a good fuel – Combustion – Calorific value – Wood.

Coal: Classification based on carbon content – Fractional distillation products of coal and uses of various fractions.

Petroleum: Origin – Fractional distillation – Different fractions, their composition and uses. Petrol: Knocking – Octane number – Aviation fuel. Diesel: Cetane number. Flash point. Natural gas, biogas and LPG: Composition and uses.

Pollution due to burning of fossil fuels.

Solar energy and solar cells (applications only).

References

1. B. K. B. Rao, *Modern Petroleum Refining Processes*, 4th Edn., Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 2002.

2. B. K. Sharma, *Industrial Chemistry*, Krishna Prakashan Media, 1991.

Scheme of Examinations:

The external question paper carries 60 marks and internal examination is of 15 marks. Duration of each external examination is 2 Hrs. The pattern of External Examination is as given below:

Section A

Short answer type carries 2 marks each – 12 questions Ceiling – 20

Section B

Paragraph/ Problem type carries 5 marks each – 7 questions Ceiling – 30

Section C

Essay type carries 10 marks (1 out of 2) 1x10=10

The students can answer all the questions in sections A & B but there shall be ceiling.

Mark Distribution	
Module I	14 Marks
Module II	12 Marks
Module III	12 Marks
Module IV	8 Marks
Module V	11 Marks
Module VI	12 Marks
Module VII	10 Marks

SEMESTER V

Course Code: GCHE5D03T

Open Course 3: FOOD SCIENCE AND MEDICINAL CHEMISTRY

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

GCHE5D03T	**FOOD SCIENCE AND MEDICINAL CHEMISTRY**	L	T	P	C
		3	0	0	3
Course outcome (s)					
CO1	Understand food adulteration and preservation methods				
CO2	Understand food additives				
CO3	Compare modern food with natural food				
CO4	Describe the harmful effects of alcohol and modern food habits				
CO5	Exhibit a broad and coherent body of knowledge on the biomolecules, vitamins, enzymes, hormones and nucleic acids				
CO6	Recognize the uses of Indian medicinal plants and plant extracts				
CO7	Recall the chemical, generic and trade names of drugs and their uses				
CO8	Describe the treatment methods used in medical field				
CO9	Illustrate first aids and the safety steps to be taken for common illnesses				

Module I: Food Adulteration and Preservation (6 hrs)

Common adulterants in different foods and their identification*:* Milk and milk products, vegetable oils and fats, spices and condiments, cereals, pulses, tea, coffee powder, chilly powder, turmeric powder and beverages - Contamination with toxic chemicals, pesticides and insecticides.

Methods of preservation*:* Need for preservation - Classification - Freezing, smoking, use of sugar, pickling, artificial food additives, canning and bottling, high pressure, burial in the ground, controlled use of micro organism and bio-preservation.

Packaging of foods*:* Classification - Materials used for packaging – Harmful effects.

References

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

2. Shyam Narayan Jha, *Rapid Detection of Food Adulterants and Contaminants: Theory and Practice*, Academic Press, 2015.

3. *Encyclopedia of Food Chemistry*, Elsevier, 2018.

4. B. Srilakshmi, *Food Science*, 5th Edn., New Age Publishers, New Delhi, 2010.

Module II: Chemistry of Food (10 hrs)

Food additives*:* Antioxidants and food preservatives – Commonly used permitted and non-permitted food colours - Artificial sweeteners - Taste enhancers – Monosodium glutamate – Vinegar - Artificial ripening of fruits and its health effects.

Modern food habits*:* Introduction – Definition and health effects of fast foods, instant foods, dehydrated foods, junk foods and condiments - Composition and health effects of chocolates, soft drinks and soda water.

Natural Food*:* Importance of milk, coconut water and Neera - Importance of regional and seasonal fruits - Traditional Kerala foods and their advantages.

References

1. B. Siva Sankar, *Food Processing and Preservation*, Prentice–Hall of India Pvt. Ltd., New Delhi, 2002.
2. Lillian Hoagland Meyer, *Food Chemistry*, 1st Edn., CBS Publishers & Distributors, New Delhi, 2004.
3. B. A. Fox, A. G. Cameron, E. Arnold, *Food Science, Nutrition and Health*, 6th Edn., Edward Arnold, London, 1995.

Module III: Beverages (4 hrs)

Definition and examples - Classification of beverages - fruit beverages - milk based beverages - malted beverages - alcoholic and non alcoholic beverages - examples. Appetizers - definition - classification - examples.

Addiction to alcohol - Cirrhosis of liver and social problems. Harmful effects of modern food habits.

References

1. B. Siva Sankar, *Food Processing and Preservation*, Prentice–Hall of India Pvt. Ltd., New Delhi, 2002.
2. Srilakshmi, *Food Science*, 5th Edn., New Age Publishers, New Delhi, 2010.
3. Lillian Hoagland Meyer, *Food Chemistry*, 1st Edn., CBS Publishers & Distributors, New Delhi, 2004.
4. B. A. Fox, A. G. Cameron, E. Arnold, *Food Science, Nutrition and Health*, 6th Edn., Edward Arnold, London, 1995.

Module IV: Biochemistry (5 hrs)

Vitamins (name, source, function and deficiency diseases). Enzymes (classification, characteristics, function and examples) - Hormones (classification, organ of secretion and functions) - Nucleic acids (introduction and role in life processes) – DNA finger printing (a brief study).

References

1. S. C. Rastogi, *Biochemistry,* 2nd Edn., Tata McGraw Hill Publishing Co., New Delhi,

2007.
2. M. V. Kulkarni, *Biochemistry*, Pragati Books Pvt. Ltd., 2008.
3. U. Satyanarayana, U. Chakrapani, *Biochemistry*, Elsevier Health Sciences, 2014.
4. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edn., Vikas Publishing House (Pvt.) Ltd., New Delhi, 2004.

Module V: Medicinal Chemistry – I (5 hrs)

Health and Biochemical Analysis*:* Definition of health - WHO standard - Biochemical analysis of urine and serum. Blood: Composition, grouping and Rh factor - Blood transfusion.

Indian Medicinal Plants*:* Kizharnelli, Thumbai, Hibiscus, Adathodai, Nochi, Thulasi, Brahmi, Aloe Vera and Neem plant (major chemical constituents and medicinal uses).

Essential Oils*:* Extraction by steam distillation – Source and medicinal uses of eucalyptus oil, sandalwood oil and lemongrass oil.

References

1. Guyton and Hall, *Textbook of Medical Physiology*, 12th Edn., Saunders, US, 2010.
2. B. L. Oser, *Hawk's Physiological Chemistry*, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 1979.
3. S. C. Rastogi, *Biochemistry*, 2nd Edn., Tata McGraw Hill Publishing Co., New Delhi, 2007.
4. Rasheeduz Zafar, *Medicinal Plants of India*, 1st Edn., CBS Publishers & Distributors Pvt. Ltd., New Delhi, 2009.
5. *https://en.wikipedia.org.*

Module VI: Medicinal Chemistry – II (12 hrs)

Medicines*:* Drug - Chemical name, generic name and trade names with examples – Terminology: Prodrug, pharmacy, pharmacology, pharmacophore, pharmacognosy, pharmacodynamics and pharmacokinetics (elementary idea only). Routes of drug administration: Topical, enteral and parenteral. Definition and examples of antacids, antipyretics, analgesics, antibiotics, antiseptics, disinfectants, antihistamines, tranquilizers, narcotics, antidepressants and hallucinogenic drugs – Drug toxicity – Thalidomide tragedy (a brief study) - Effective use of drugs – Prescription and non-prescription drugs – Over dosage – Drug abuse.

Some Diseases and Treatment*:* Causes, symptoms and drugs used for the treatment of influenza, measles, tuberculosis, cholera, dysentery, bronchial asthma, kidney stone, diabetes and myocardial infection – Drugs used in the treatment for systemic hypertension and hypercholesterolemia. Cancer: Definition - Lung cancer (causes, symptoms and treatment) – Avenues for the treatment of terminal cancer.

Medical applications of nanomaterials. Radio diagnosis: Benefits and risks. Biodegradable

polymers used in surgical sutures and capsule covers.

References

1. Gurdeep R. Chatwal, *Synthetic Drugs*, Himalaya Publishing House, Bombay, 1995.
2. Jayashree Ghosh, *A Textbook of Pharmaceutical Chemistry*, 3rd Edn., S. Chand and Company Ltd., New Delhi, 1999.
3. A. H. Beckett, J. B Stenlake, *Practical Pharmaceutical Chemistry*, 4th Edn., CBS Publishers and Distributors, New Delhi, 2000.

Module VII: Clinical chemistry (6 hrs)

First aid to prevent bleeding and maintain breathing, Causes and symptoms of food poisoning, botulism - mushroom and plant poisoning - first aid. Causes, symptoms and treatment of anemia, diabetes, tuberculosis, asthma, jaundice.

First Aid and Safety*:* Electric shocks, hemorrhage, cuts, wounds, burns and snake bite.

References

1. Jayashree Ghosh, *A Textbook of Pharmaceutical Chemistry*, 3rd Edn., S. Chand and Company Ltd., New Delhi, 1999.
2. A. H. Beckett, J. B Stenlake, *Practical Pharmaceutical Chemistry*, 4th Edn., CBS Publishers and Distributors, New Delhi, 2000.
3. *https://en.wikipedia.org.*

Scheme of Examinations:

The external question paper carries 60 marks and internal examination is of 15 marks. Duration of each external examination is 2 Hrs. The pattern of External Examination is as given below:

Section A	
Short answer type carries 2 marks each - 12 questions	Ceiling - 20
Section B	
Paragraph/ Problem type carries 5 marks each - 7 questions	Ceiling - 30
Section C	
Essay type carries 10 marks (1 out of 2)	1x10=10

The students can answer all the questions in sections A & B but there shall be ceiling.

Mark Distribution	
Module I	13 Marks
Module II	16 Marks
Module III	6 Marks
Module IV	8 Marks
Module V	8 Marks
Module VI	18 Marks
Module VII	10 Marks

SCHEME OF EVALUATION

FOR

OPEN COURSES

OPEN COURSE: 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 department shall send only the marks obtained for internal examination to the COE.

Table 1: Components of Evaluation

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

Table 2: Percentage of attendance based on class room participation and Eligible Marks

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

Table 3: Pattern of Test Papers

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

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

45% = 2, below 35% = 1

2. EXTERNAL EVALUATION

External evaluation carries 80% marks. External examinations will be conducted at the end of each semester. Duration of each external examination is 2 hours.

Table 1: Pattern of Question Paper

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

MODEL QUESTION PAPERS

FIRST SEMESTER B.Sc DEGREE EXAMINATION

CBCSSUG - CHEMISTRY

GCHE1B01T - Core Course I

THEORETICAL AND INORGANIC CHEMISTRY - I

Time: Two Hours **Maximum: 60 Marks**

Section A (Short answers)

(Answer all questions. Each question carries 2 marks)

1. Differentiate between scientific theory and law.
2. Predict the shape of H_3O^+ usibng VSEPR theory.
3. What do the terms absolute error and relative error mean with regard to an analytical determination?
4. Calculate the mole fractions of the components in a solution made up of 1 mole of ethanol and 9 moles of water?
5. Explain a redox titration with example.
6. What is meant by ionization enthalpy?
7. Explain the principles behind hydrogen bomb and atom bomb.
8. How will you prepare nitric acid?
9. Write a note on inert pair effect.
10. Explain how dipole moment measurement can be used in the determination of molecular structure.
11. Write note on radioactive tracer.
12. Draw the structure of boric acid. **[Ceiling of marks: 20]**

Section B (Paragraph)

(Answer all questions. Each question carries 5 marks)

13. Explain the term scientific observation and its role in science.
14. Discuss the Ostwald's theory of acid –base indicators.
15. An item of old wooden furniture shows a C-14 activity which is 45% of the activity found in fresh wood. Calculate the age of the wood.
16. Explain with example the calculation of effective nuclear charge.
17. Describe the structure, properties and applications of diboranes.
18. What is Born-Haber cycle? Discuss wth resepect to NaCl.
19. Write note on complexometric titration **[Ceiling of marks: 30]**

Section C (Essay)

(Answer any one. Each question carries 10 marks)

20. a) Correlate N/P ratio and nuclear stability. b) Write a note on nuclear reactor.
21. a) Compare the electro negativity and ionization energy of s and p block elements. b) Explain the structure of oxides of N and P. **[1 X 10 = 10]**

SECOND SEMESTER B.Sc DEGREE EXAMINATION

CBCSSUG - CHEMISTRY

GCHE2B02T - Core Course II

THEORETICAL AND INORGANIC CHEMISTRY - II

Time: Two Hours **Maximum: 60 Marks**

Section A (Short answers)

(Answer all questions. Each question carries 2 marks)

1. How does MOT explain the paramagneism of O_2?

2. Briefly explain Einstein interpretation of photoelectric effect.

3. State Bohr quantization of orbits.

4. What is de-Broglie's wavelength of an electron with speed of 4.12×10^6 m/s? (mass of electron: 9.1×10^{-31} Kg).

5. Explain the importance of normalization.

6. Pick the molecule/molecules which exist as stable species: Ne_2, C_2, Li_2 and He_2^+. Give suitable explanation.

7. Describe the importance of Born-Oppenheimer approximation.

8. Explain the term Hermitian operator.

9. Sketch the radial probability plot of 1s and 3s orbital.

10. State Heisenberg's uncertainty principle. Does it have measurable consequence in the macroscopic world?

11. What is an Eigen value? Are the Eigen value of Hamiltonian operator always real?

12. Mention four limitation of Bohr theory. **[Ceiling of marks: 20]**

Section B (Paragraph)

(Answer all questions. Each question carries 5 marks)

13. Explain the postulates of quantum mechanics.

14. Write a note on quantum numbers. What are the four quantum numbers that represent an electron in 2p orbital?

15. Draw the molecular orbital diagram of NO. Predict its bond order?

16. Explain the hybridization of BH_3 and CH_4 by applying LCAO treatment.

17. A particle is confined in a 3D box that has side a=b=1.5c, a) Write the expression for wave function and energy, b) Predict its degeneracy for first four energy level.

18. Explain the required qualities of well behaved function with an example.

19. Distinguish VBT and MOT. **[Ceiling of marks: 30]**

Section C (Essay)

(Answer any one. Each question carries 10 marks)

20. Discuss briefly the concept of particle in 1D box. Using Schrodinger equation predicts its energy and wave function.

21. a) Write a note on atomic spectrum of hydrogen, b) A line of the Lyman series of the spectrum of hydrogen has a wavelength of 9.50×10^{-8} m. Calcualte the n_i involved in the associated electron transition. **[1 X 10 = 10]**

THIRD SEMESTER B.Sc DEGREE EXAMINATION

CBCSSUG - CHEMISTRY

GCHE3B03T- Core Course III

PHYSICAL CHEMISTRY – I

Time: Two Hours **Maximum: 60 Marks**

Section A (Short answers)

(Answer all questions. Each question carries 2 marks)

1. Calculate the temperature at which O_2 molecule will have the same RMS velocity as CO_2 molecule.

2. 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^oC.

3. Write Clapeyron - Clausius equation (integrated form) for liquid-vapour equilibrium and explain the terms.

4. Write Gibbs-Duhem equation and explain the terms.

5. Explain the physical significance of entropy.

6. Define third law of thermodynamics.

7. Calculate the entropy of vapourisation of a liquid which boils at 120^oC. Given enthalpy of vapourisation is 3600 $Jmol^{-1}$.

8. What is optical exaltation?

9. Give the equation for molar refraction of a liquid and explain the terms.

10. Why chemical equilibrium is termed dynamic?

11. State Le Chatelier's principle.

12. What is homogeneous equilibrium? Give example. **[Ceiling of marks: 20]**

Section B (Paragraph)

(Answer all questions. Each question carries 5 marks)

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

14. Derive the expressions for critical constants in terms of vander-Waals constants.

15. Derive the relation between temperature and pressure for an adiabatic process.

16. 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.)

17. Discuss the variation of free energy with temperature and pressure.

18. Derive an expression for the relation between entropy and probability?

19. What is Parachor? How is it used for structure elucidation? **[Ceiling of marks: 30]**

Section C (Essay)

(Answer any one. Each question carries 10 marks)

20. Derive the relationship between K_p and K_c.

21. What is Joule-Thomson effect? Describe Linde's method and Claude's method for the liquifaction of gases. **[1 X 10 = 10]**

FOURTH SEMESTER B.Sc DEGREE EXAMINATION

CBCSSUG - CHEMISTRY

GCHE4B04T - Core Course IV

ORGANIC CHEMISTRY – I

Time: Two Hours **Maximum: 60 Marks**

Section A (Short answers)

(Answer all questions. Each question carries 2 marks)

1. Distinguish between chain and position isomerism with an example.
2. Draw the Newman projections of the two extreme conformations of butane.
3. Explain the isomerism exhibited by fumaric and maleic acids.
4. Explain the terms electrophile and nucleophile with examples for each.
5. Compare the basicities of aniline, p-nitroaniline and *p*-anisidine.
6. What is the product formed when isopropyl bromide is treated with metallic sodium in ether solvent? Write equation and IUPAC name of the product.
7. State and illustrate Saytzeff's rule of elimination.
8. Why are 1-alkynes acidic?
9. Write two tests to distinguish between alkanes and alkenes.
10. What is Lindlar's catalyst? What is its use in organic synthesis?
11. Explain the aromaticity of pyrrole.
12. Write the mechanism of nitration of benzene.

[Ceiling of marks: 20]

Section B (Paragraph)

(Answer all questions. Each question carries 5 marks)

13. What is Huckel's rule of aromaticity. Using it discuss the aromaticity of azulene and annulenes.
14. (a) Write any three methods of resolution racemic mixtures.
    (b) Distinguish between absolute and partial asymmetric synthesis
15. What is hyperconjugation? Write the order of stability of propene, 1-butene and 2-butene. Explain why?
16. Write a short note on hybridisation, structure, formation and stability of carbenes.
17. (a) What is Corey – House synthesis? b) Write the mechanism of free radical chlorination of methane.
18. What is ozonolysis? One mole of alkene, C_6H_{12} on ozonolysis yields 1mole each of propanal and propanone. Find the structure of the parent alkene and write equation for the ozonolysis sequence.
19. Suggest a synthetic method each for the synthesis of Furan and Thiophene.

[Ceiling of marks: 30]

Section C (Essay)

(Answer any one. Each question carries 10 marks)

20. (a) Differenciate between Friedel-Craft's alkylation and acylation reactions. Write the mechanism of each reaction. (b) Explain the elimination-addition mechanism (benzyne) of aromatic nucleophilic substitution.
21. (a) Explain the Markownikov and Anti-Markownikov addition to alkenes with mechanism. (b) Explain with structure about the various stereoisomers of tartaric acid.

[1 X 10 = 10]

FOURTH SEMESTER B.Sc DEGREE EXAMINATION
CBCSSUG - CHEMISTRY
GCHE4B05P - 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 Mohr's salt required to prepare 500 mL of its 0.5 N solution?
2. Calculate the normality of $K_2Cr_2O_7$ solution when 0.49 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 $K_2Cr_2O_7$ against $FeSO_4$.
5. Write the balanced chemical equation for the titration of I_2 solution against $Na_2S_2O_3$.
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 structure of Phenolphthalein. (1x8 = 8 Marks)

Section B
Answer the following questions in 15 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)
10. Write a brief outline of the method for the preparation of ferric alum. (4 Marks)

Part C
11. Estimate the weight of Fe^{3+} in the whole of the given solution of ferric alum, being provided with AR Mohr's salt. (39 Marks)

Part D
12. Prepare the inorganic complex …….. Exhibit the crude and recrystallised sample. (5 marks)

Part E
Viva-Voce (8 marks)
Record (8 marks)

FIFTH SEMESTER BSc. DEGREE EXAMINATION
CBCSSUG - CHEMISTRY
GCHE5B06T -Core Course VI
INORGANIC CHEMISTRY – III

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

Section A (Short answers)

(Answer all questions. Each question carries 2 marks)

1. The solubility of magnesium hydroxide at 298 K is 1.71 x 10^{-4}mol dm^{-3}. Calculate the solubility product.
2. Explain the terms co precipitation and post precipitation with examples.
3. Explain zone refining with example.
4. Give composition of gunmetal.
5. What are pseudo halogen compounds? Give examples.
6. Iodine is electropositive. Justify.
7. What are silicones? Give its applications.
8. Explain autoionisation of liquid SO_2 and liquid HF with equations.
9. Explain the relation between acid rain and pollution.
10. What are BOD and COD? How it can be measured?
11. Triple R is an important term in managing waste. Justify.
12. What is leveling effect of solvents? **[Ceiling of marks: 20]**

Section B (Paragraph)

(Answer all questions. Each question carries 5 marks)

13. What are Interfering acid radicals? How they can be eliminated?
14.(a) Discuss the use of Ellingham diagram in extraction of elements.(b) Using the Ellingham diagram of oxides, determine whether Aluminum can be used to reduce MgO.
15. Explain structure and hybridization of ClF_3, ICl_3.
16. Discuss the separation of noble gas by charcoal adsorption method.
17. Give an account of preparation, properties and structure of S_4N_4.
18. What are Hard and soft acids and bases? Explain HSAB principle.
19. Discuss the challenges in managing solid waste. **[Ceiling of marks: 30]**

Section C (Essay)

(Answer any one. Each question carries 10 marks)

20. Explain the applications of common ion effect and solubility product in separation and identification of cations.
21. (a) Explain the sources of water pollution. (b) What are the control measures for water pollution? **[1 X 10 = 10]**

FIFTH SEMESTER BSc. DEGREE EXAMINATION
CBCSSUG - CHEMISTRY
GCHE5B07T -Core Course VII
ORGANIC CHEMISTRY – II

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

Section A (Short answers)
(Answer all questions. Each question carries 2 marks)

1. How are alcohols prepared by the hydroboration oxidation?
2. What is Lucas test?
3. How are ethers prepared from alkyl halides?
4. Explain the Zeisel's method of estimation of methoxy groups.
5. What is Etard's reaction?
6. Write two tests to distinguish between aldehydes and ketones.
7. Acetic acid or formic acid ,which is more acidic? Why?
8. What is HVZ reaction? Write an example.
9. What is tosylation reaction?
10. What is nitro – aci tautomerism? Explain.
11. What is Hoffmann bromamide reaction?
12. Explain the benzyne mechanism of aromatic nucleophilic substitution reaction.

[Ceiling of marks: 20]

Section B (Paragraph)
(Answer all questions. Each question carries 5 marks)

13. What is pinacol- pinacolone rearrangement? Explain with mechanism.
14. What are crown ethers? What are their applications in organic synthesis and catalysis?
15. Explain the synthetic utility of Wittig reaction and Beckmann rearrangement.
16. How is citric acid prepared using Reformatsky reaction? What are the uses of it?
17. Explain the separation of primary, secondary and tertiary amines by the Hinsberg's method.

18 How is ethyl acetoacetate prepared by Claisen condensation? Write the mechanism.

19. Write the $S_N1$and S_N2 mechanisms of aliphatic nucleophilic substitution reactions with stereochemical aspects.

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[Ceiling of marks: 30]

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

20. a) Explain the important synthetic applications of Grignard's reagent. b) Explain the Aldol and Benzoin condensations.

21. Explain the following reactions with mechanism. a)Riemer – Tiemann reaction. b) Haloform reaction c) Kolbe electrolysis d) Hofmann elimination.

[1 X 10 = 10]

FIFTH SEMESTER B.Sc DEGREE EXAMINATION

CBCSSUG - CHEMISTRY

GCHE5B08T - Core Course VIII

PHYSICAL CHEMISTRY – II

Time: Two Hours **Maximum: 60 Marks**

Section A (Short answers)

(Answer all questions. Each question carries 2 marks)

1. Order of a reaction need not be whole number always. Account.
2. Give one example each for (i) a parallel reaction; (ii) a consecutive reaction.
3. What is chemiluminescence? Give one example.
4. Explain Bredig's method for the preparation of gold sol.
5. What is meant by Dorn Effect?
6. Name the different symmetry elements implied by C_6 axis.
7. Discuss the principle of gel permeation chromatography.
8. What type of molecules gives rotational Raman spectra?
9. What is Frank – Condon principle?
10. Write any two advantages of Raman spectra over IR spectra.
11. Discuss the ESR spectra of methyl radical.
12. What is proper axis of rotation? **[Ceiling of marks: 20]**

Section B (Paragraph)

(Answer all questions. Each question carries 5 marks)

13. Draw the group multiplication table of C_{2V} point group.
14. Discuss briefly the activated complex theory of reaction rates.
15. Certain reactions have very high quantum yield whereas others have very low quantum yield. Explain.
16. Draw phase diagram of sulphur system. Explain it.
17. Draw and explain the phase diagram of Zn-Mg system.
18. Explain how rotational spectroscopy can be used to find the bond length.
19. Explain the term chemical shift. **[Ceiling of marks: 30]**

Section C (Essay)

(Answer any one. Each question carries 10 marks)

20. (a) Give methods for purification of colloids (b) Derive Langmuir isotherm.
21. (a) Derive an expression for the rate constant of a bimolecular gaseous reaction using collision theory (b) E_a for 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? **[1 X 10 = 10]**

SIXTH SEMESTER BSc. DEGREE EXAMINATION

CBCSSUG - CHEMISTRY

GCHE6B09T - Core Course IX

INORGANIC CHEMISTRY – IV

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

Section A (Short answers)

(Answer all questions. Each question carries 2 marks)

1. Calculate the CFSE in $[Mn(H_2O)_6]^{2+}$.
2. Explain Bragg's Law.
3. Why do transition metals show catalytic properties?
4. While $MnSO_4 \cdot 4H_2O$ is pale pink in colour, $KMnO_4$ exhibits dark violet colour. Why?
5. The absorbance of an iron thiocyanate solution containing 0.00500 mg Fe/mL was reported as 0.4900 at 540 nm. Calculate the specific absorptivity of iron thyocyanate assuming that a 1.00 cm cuvette was used.
6. What is Spectrochemical series?
7. Distinguish high spin and low spin among $[Co(en)_3]^{3+}$ and $[CoF_6]^{3-}$. Give reason [en-ethylenediammine].
8. While $[Co(H_2O)_6]^{2+}$ is pink in colour, $[CoCl_4]^{2}$ is blue in colour. Why?
9. Name the catalyst used for (i) polymerization of alkene and (ii) hydrogenation of alkene.
10. What is Zeise's salt?
11. Explain the significance of zinc in biological systems.
12. Why is lead considered as a toxic metal? **[Ceiling of marks: 20]**

Section B (Paragraph)

(Answer all questions. Each question carries 5 marks)

13. Discuss the structure and oxygen binding mechanism of Haemoglobin.
14. Differentiate between Scanning Electron Microscopy and Transmission Electron Microscopy.
15. Explain the process involved in separation of lanthanides.
16. Discuss any five factors influencing stability of complexes.
17. (i) Explain the hybridization and structure of (a) $[Ni(CN)_4]^{2-}$ and (b) $[NiCl_4]^{2-}$ based on VBT. (ii) Which of the two is diamagnetic in nature?
18. What is 18- Electron rule? Justify how $Fe(CO)_5$ and $Fe_2(CO)_9$ obey 18- Electron rule.
19. Explain the principle and working of Atomic Force Microscope.**[Ceiling of marks: 30]**

Section C (Essay)

(Answer any one. Each question carries 10 marks)

20. Write an account on the MOT of octahedral complexes containing only sigma bonds?
21. (i) Discuss the structure and significance of *Cis*-platin. (ii) Explain the preparation and properties of Ferrocene. **[1 X 10 = 10]**

SIXTH SEMESTER BSc. DEGREE EXAMINATION

CBCSSUG - CHEMISTRY

GCHE6B10T - Core Course X

ORGANIC CHEMISTRY - III

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

Section A (Short answers)

(Answer all questions. Each question carries 2 marks)

1. Write note on chromophore and auxochrome.
2. Distinguish ethanol and acetone using NMR spectroscopy.
3. Write short note on mutarotation.
4. Write short note on reducing and non-reducing sugar.
5. Explain the chemistry of tollens test and molisch test.
6. Explain strecker synthesis of aminoacids.
7. Write short note on denaturation of proteins.
8. Draw the structures of purine bases present in the DNA.
9. Write note on saponification value and iodine value.
10. Draw the structure of vitamine C and cholesterol.
11. Explain the physiological action of nicotine and quinine.
12. Write short note on vulcanization.

[Ceiling of marks: 20]

Section B (Paragraph)

(Answer all questions. Each question carries 5 marks)

13. How will you distinguish ethyl acetate and propanoic acid by IR and ^{1}H NMR spectroscopy?
14. Explain the structure of Sucorse and Starch.
15. Write short note on Killani –Fischer synthesis.
16. Write note on Sangers method for structure elucidation of peptides.
17. Write note on structure and uses of citral,geraniol and menthol.
18. Explain cope and claisen rearrangement with mechanism.
19. Write note on replication of DNA.

[Ceiling of marks: 30]

Section C (Essay)

(Answer any one. Each question carries 10 marks)

20. (a) Explain the structure of DNA. (b) Explain DNA finger printing and its application?
21. (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.

[1 X 10 = 10]

SIXTH SEMESTER B.Sc DEGREE EXAMINATION
CBCSSUG - CHEMISTRY
GCHE6B11T - Core Course XI
PHYSICAL CHEMISTRY – III

Time: Two Hours **Maximum: 60**

Marks

Section A (Short answers)

(Answer all questions. Each question carries 2 marks)

1. What is the molality of a solution prepared by dissolving 5.0g of toluene in 225 g of benzene?

2. How does band theory distinguish semiconductors from insulators and conductors?

3. 0.0654 g of a metal was deposited by the passage of a current of 0.4 amperes for 30 minutes through its salt solution. Calculate the equivalent mass of the metal.

4. Explain the term electrophoretic effect based on Debye –Huckel theory of strong electrolytes.

5. Explain leveling effect of a solvent with a suitable example.

6. State Henry's law and explain one of its applicaions.

7. Explain the principle behind the purification of sea water by reverse osmosis method.

8. 2% solution of an organic solute A is found to be isotonic with a 3% solution of of sucrose. Calculate the molar mass of A.

9. Distinguish between an electrode concentration cell and electrolyte concentration cell.

10. Explain the principle behind the conductometric titration of a weak acid against a strong base.

11. Discuss the effect of dilution on molar conductivity of an electrolytic solution

12. What is an ideal solution? **[Ceiling of marks: 20]**

Section B (Paragraph)

(Answer all questions. Each question carries 5 marks)

13. State and explain Kohlrausch's law. Based on it determine the molar conductivity at infinite dilution of acetic acid.

14. What is meant by salt hydrolysis? Explain why an aqueous solution of sodium carbonate is basic while that of ammonium nitrate is acidic.

15. The emf of the cell $Ag \mid AgI$ in 0.045 M $KI \| 0.045$ M $AgNO_3 \mid Ag$ is 0.788 at 25^0C. Calculate (i) the solubility product of AgI and the (ii) solubility of AgI in water at 25^0C.

16. Explain the electrochemical theory of corrosion with a suitable example

17. (a) Explain the term buffer index with regard to buffer solutions. (b) Derive the Henderson equation for the pH of an acidic buffer.

18. (a) Explain common ion effect with an example (b) Calculate the degree of hydrolysis of deci molar solution of ammonium acetate at 28°C.Dissociation constants of acetic acid and ammonium hydroxide are 1.75×10^{-5} and 1.85×10^{-5} respectively and $K_w = 1.008\times10^{-14}$ at 28°C.

19. (a) Discuss H_2-O_2 fuel cell (b) How can you determine pH of a solution using standard hydrogen electrode (SHE)? **[Ceiling of marks: 30]**

Section C (Essay)

(Answer any one. Each question carries 10 marks)

20. (a) Calomel electrode is used as a reference electrode. Describe its construction and working. (b) Differentiate between hexagonal close packing and cubic close packing of uniform spheres.

21. (a) Discuss the structures of two AB type compounds (b) Discuss the salient features of different types of liquid crystals. **[1 X 10 = 10]**

SIXTH SEMESTER BSc.DEGREE EXAMINATION

CBCSSUG – CHEMISTRY

GCHE6B12T - Core Course XII

ADVANCED AND APPLIED CHEMISTRY

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

Section A (Short answers)

(Answer all questions. Each question carries 2 marks)

1. Explain the term global minimum in computational chemistry.
2. Describe the change melting point when the particle size of a material approaches nanoscale rang.
3. What are the advantages of microwave assisted organic synthesis?
4. Explain any two principles of green chemistry.
5. Draw the structure of endosulphan and DDT.
6. Explain the uses of nanomaterials.
7. Describe the term prodrugs with example.
8. What are BHA and BHT? Mention their important applications.
9. Name two software used in computational chemistry.
10. What is talc? What is its composition?
11. Name one nitrogenous fertilizer and one potash fertilizer.
12. Explain the importance of combinatorial synthesis. **[Ceiling of marks: 20]**

Section B (Paragraph)

(Answer all questions. Each question carries 5 marks)

13. Distinguish between the bottom up and top down methods of nanoscale synthesis.
14. Explain different host-guest interactions in supramolecules.
15. Explain with example the difference between percentage yield and atom economy.
16. Distinguish between molecular mechanics method and electronic structure method in computational chemistry.
17. Explain the term PHBV and PGA. Discuss its significance and applications.
18. Write a short note on the role of water in setting of cement.
19. Explain the theories behind color of dyeing compounds. **[Ceiling of marks: 30]**

Section C (Essay)

(Answer any one. Each question carries 10 marks)

20. a) Describe a method for the purification of collide. b) Explain the advantages of Zeigler Natta polymerization.

21) Write a short note on

a) zeta potential, b) artificial ripening, c) Travancore Cochin Chemicals, d) Flash point of a liquid fuel. **[1 X 10 = 10]**

SIXTH SEMESTER B. Sc. DEGREE EXAMINATION

CBCSSUG - CHEMISTRY

GCHE6E01T - Core Course XIII (Elective)

INDUSTRIAL CHEMISTRY

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

Section A (Short answers)

(Answer all questions. Each question carries 2 marks)

1. Describe the term pilot plant?
2. How we can convert wash to rectified spirit?
3. How coal is classified based on carbon content?
4. Differentiate between paraffin base and asphalt base.
5. What are the different routes of drug administration?
6. Explain the term prodrug with example?
7. What is Zeigler Natta catalyst? Mention its important application.
8. Mention the applications of ruthenium based catalysts.
9. What is a nanoparticle catalyst? Give examples.
10. Explain the term denatured spirit and mention it's applications.
11. What are chromatic and achromatic colours?
12. Describe the components of paint. **[Ceiling of marks: 20]**

Section B (Paragraph)

(Answer all questions. Each question carries 5 marks)

13. What are the important features of environmental management systems?
14. Discuss the various steps involved in the manufacture of leather.
15. What are anti-knocking compounds? Discuss their mechanism of action.
16. Discuss the composition and uses white lead, ultramarine and guignet's green.
17. Discuss the causes, symptoms and treatment of lung cancer.
18. What is meant by phase transfer catalysis? What are its important applications?
19. Discuss briefly the medical applications of nanomaterials. **[Ceiling of marks: 30]**

Section C (Essay)

(Answer any one. Each question carries 10 marks)

20. Write notes on (a) oil based paints (b) luminescent paints (c) fire retardant paints.
21. (a) What is synthetic petrol? How is it manufactured? (b) Discuss the manufacture of ethylene glycol. **[1 X 10 = 10]**

SIXTH SEMESTER B. Sc. DEGREE EXAMINATION

CBCSSUG - CHEMISTRY

GCHE6E02T - Core Course XIII (Elective)

POLYMER CHEMISTRY

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

Section A (Short answers)

(Answer all questions. Each question carries 2 marks)

1. Describe the term tacticity of polymers.
2. Explain ring opening polymerization? Give an example.
3. Distinguish between thermoplastics and thermosetting plastics.
4. What is bulk polymerization?
5. What is meant by average molecular weight of polymers? Give mathematical expression for weight average molecular weight.
6. Define Tg. What are the factors affecting Tg?
7. What is meant by degradation of polymers?
8. What is Kevlar. Give two applications.
9. Give the structure of nylon 6 and nylon 66.
10. Explain the importance of vulcanization.
11. How silicones are prepared?
12. What is meant by resins? Give an example. **[Ceiling of marks: 20]**

Section B (Paragraph)

(Answer all questions. Each question carries 5 marks)

13. Distinguish between plastics, fibers and elastomers with examples.
14. Write a short note on suspension polymerization.
15. How can you determine the molecular weight of polymers by viscosity method?
16. What is meant by recycling of plastics? What are its advantages?
17. Explain thermal and oxidative degradation of polymers with examples.
18. What is meant by dopping of polymers.
19. Distinguish between addition and condensation polymerization. **[Ceiling of marks: 30]**

Section C (Essay)

(Answer any one. Each question carries 10 marks)

20. Explain Zeigler Natta polymerization with mechanism.
21. Explain any three polymer processing techniques with neat diagram. **[1 X 10 = 10]**

SIXTH SEMESTER B. Sc. DEGREE EXAMINATION

CBCSSUG - CHEMISTRY

GCHE6E03T - Core Course XIII (Elective)

MEDICINAL AND ENVIRONMENTAL CHEMISTRY

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

Section A (Short answers)

(Answer all questions. Each question carries 2 marks)

1. Explain the importance in sterilization of surgical instruments.
2. What precautions are to be taken during blood transfusion?
3. What is difference between LD50 and ED50?
4. What is systemic hypertension? Name a drug used for its treatment.
5. What is hepatitis A? What are its causes and symptoms?
6. What are the toxicological effects of phenol and benzene?
7. What are the analytical methods used for the detection of hydrocarbons?
8. Write a note on activated sludge process
9. Explain the working of Cottrell electrostatic precipitator.
10. What is BOD? How is it determined by Winkler's titration method?
11. What is USAB process?
12. Discuss the sources and harmful effects of Hg. **[Ceiling of marks: 20]**

Section B (Paragraph)

(Answer all questions. Each question carries 5 marks)

13. How is sugar content in urine determined?
14. Write notes on (a) Rain water harvesting (b) Sea water for agriculture.
15. Discuss the toxicological effects of phenylene diamines and nitroso amines.
16. Discuss the sampling methods used for gases.
17. Discuss how gravitational settling chamber and fabric filter are used in air pollution control.
18. Write notes on settlable solids and suspended solids related to water pollution.
19. Discuss the treatment for poisons due to snake bite. **[Ceiling of marks: 30]**

Section C (Essay)

(Answer any one. Each question carries 10 marks)

20. Discuss the major chemical constituents and medicinal uses of any five Indian medicinal plants.
21. Discuss the causes and drugs used for the treatment of influenza, cholera, kidney stone and myocardial infarction. **[1 X 10 = 10]**

SIXTH SEMESTER B. Sc. DEGREE EXAMINATION

CBCSSUG - CHEMISTRY

GCHE6B13P - Core Course XIV

PHYSICAL CHEMISTRY PRACTICAL

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

Section A

A. Write in the first ten minutes the principle and procedure for the question marked in Section B (4 + 4 Marks)

Section B

B. Conduct the experiment for the question marked below and records 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)

SIXTH SEMESTER B. Sc. DEGREE EXAMINATION

CBCSSUG - CHEMISTRY

GCHE6B14P - Core Course XV

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. Diazotisation of sulphanilic acid followed by coupling with N,N-dimethyl aniline yield ----
7. The structural formula of the compound formed by the acetylation of salicylic acid is ----
8. The electrophile during nitration is ---------- (8x1 = 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)

SIXTH SEMESTER B. Sc. DEGREE EXAMINATION

CBCSSUG - CHEMISTRY

GCHE6B15P - Core Course XVI

INORGANIC CHEMISTRY PRACTCAL - II

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

Section A

Answer the following question in 15 minutes

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)

SIXTH SEMESTER B. Sc. DEGREE EXAMINATION

CBCSSUG - CHEMISTRY

GCHE6B16P - Core Course XVII

INORGANIC CHEMISTRY PRACTICAL - III

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

Section A

Answer the following questions in 10 minutes

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. Analyse qualitatively the given mixture by semimicro method to identify and confirm the two cations and two anions present in it. Record the data systematically including chemistry of identification tests and confirmation tests

(60 Marks)

Section C

Viva-Voce (8 marks)

Record (8 marks)

FIRST SEMESTER BSc. DEGREE EXAMINATION

CBCSSUG - CHEMISTRY-Complementary course: I

GCHE1C01T: GENERAL CHEMISTRY

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

Section A (Short answers)

(Answer all questions. Each question carries 2 marks)

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

Section B (Paragraph)

(Answer all questions. Each question carries 5 marks)

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

Section C (Essay)

(Answer any one. Each question carries 10 marks)

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

SECOND SEMESTER B. Sc. DEGREE EXAMINATION

CBCSSUG - CHEMISTRY- Complementary course: II

GCHE2C02T: Physical Chemistry

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

Section A (Short answers)

(Answer all questions. Each question carries 2 marks)

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

Section B (Paragraph)

(Answer all questions. Each question carries 5 marks)

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

Section C (Essay)

(Answer any one. Each question carries 10 marks)

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

THIRD SEMESTER BSc. DEGREE EXAMINATION
CBCSSUG - CHEMISTRY-Complementary course: III
GCHE3C03T: ORGANIC CHEMISTRY

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

Section A (Short answers)
(Answer all questions. Each question carries 2 marks)

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

Section B (Paragraph)
(Answer all questions. Each question carries 5 marks)

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

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

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

FOURTH SEMESTER BSc. DEGREE EXAMINATION
CBCSSUG - CHEMISTRY- Complementary course: IV
GCHE4C04T: PHYSICAL AND APPLIED CHEMISTRY

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

Section A (Short answers)
(Answer all questions. Each question carries 2 marks)

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

Section B (Paragraph)
(Answer all questions. Each question carries 5 marks)

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

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

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

FOURTH SEMESTER BSc. DEGREE EXAMINATION
CBCSSUG - CHEMISTRY- Complimentary Course V
GCHE4C05P: CHEMISTRY PRACTICAL

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

Section A
Answer the following questions in 6 minutes.

1. Calculate the mass of Mohr's salt required to prepare 100 ml of its 0.05 N solution?
2. Calculate the normality of oxalic acid solution when 0.63 g of it is dissolved in water in a 100 ml standard flask?
3. Name the indicator used for the titration of Na_2CO_3 against HCl.
4. Write the balanced chemical equation for any permanganometric titration.
5. The yellow precipitate formed on adding potassium chromate solution to Ba^{2+} salt solution is chemically ---------
6. What is/are the group reagent/s for 5^{th} group in inorganic qualitative analysis?
7. The chemical compound formed in the ash test for Aluminium is
8. The pink colour in permanganic acid test is ……. (8x1 = 8 Marks)

Section B
Answer the following question in 10 minutes

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

Section C

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

Section D

Record (10 marks)

FIFTH SEMESTER B. Sc. DEGREE EXAMINATION
CBCSSUG - CHEMISTRY- Open Course 1
GCHE5D01T: ENVIRONMENTAL CHEMISTRY

Time: 2 Hours **Maximum marks: 60**

Section A (Short answers)

(Answer all questions. Each question carries 2 marks)

1. Explain why troposphere is a turbulent region.
2. Discuss about the different regions of atmosphere.
3. What are the main sources of particulates?
4. What is meant by photochemical smog?
5. Write a note on alternate refrigerants.
6. What is eutrophication?
7. How can the marine water be polluted?
8. Define thermal pollution.
9. How can we classify the wastes on the basis of their biodegradability?
10. Write a short note on biomedical waste.
11. Define green chemistry.
12. Discuss the working of wet scrubber. **[Ceiling of marks: 20]**

Section B (Paragraph)

(Answer all questions. Each question carries 5 marks)

13. Write the causes and symptoms of any two air-borne diseases.
14. Describe any three water quality parameters.
15. What are the main sources of water pollution
16. Write a note on solid waste management.
17. What is Green house effect? Discuss its causes and consequences.
18. Discuss the depletion of ozone layer.
19. Discuss the basic principles of green chemistry. **[Ceiling of marks: 30]**

Section C (Essay)

(Answer any one. Each question carries 10 marks)

20. Discuss the air pollution control by Cottrell electrostatic precipitator and extraction ventilator.

21. (a) Name any two toxic metals in water and explain their harmful effects. (b) What is radioactive pollution? How is it controlled? **[1 X 10 = 10]**

FIFTH SEMESTER B. Sc. DEGREE EXAMINATION
CBCSSUG - CHEMISTRY- Open Course 2
GCHE5D02T: CHEMISTRY IN DAILY LIFE

Time: 2 Hours **Maximum marks: 60**

Section A (Short answers)

(Answer all questions. Each question carries 2 marks)

1. Explain vulcanization and it's advantages.
2. Describe the applications of bakelite?
3. Descibe the main functions of vitamin C.
4. Explain the main characteristics of enzymes.
5. What are the common adulterants in tea?
6. Which are the essential nutrients for plants?
7. Define biofertilizers.
8. Discuss the TFM value in soap.
9. Explain the terms pharmacology and pharmacognosy.
10. What is meant by antipyretics? Give one example.
11. How coal is classified based on carbon content?
12. Define the term octane number. **[Ceiling of marks: 20]**

Section B (Paragraph)

(Answer all questions. Each question carries 5 marks)

13. Explain the classifiation of polymers on the basis of molecular forces.
14. Describe any three water quality parameters.
15. Write a note on the importance of DNA.
16. Give a short note on classification of dyes based on constitution and their applications.
17. Briefly explain the pesticide pollution and its impact on environment.
18. Describe the cleaning action of soaps and detergents.
19. Discuss the health effects of fast food. **[Ceiling of marks: 30]**

Section C (Essay)

(Answer any one. Each question carries 10 marks)

20. (a) What are shampoos? How are they classified? Discuss their ingredients and functions. (b) What is radioactive pollution? How is it controlled?
21. (a) Write a note on pollution due to burning of fossil fuels. (b) Discuss the applications of solar energy and solar cells. **[1 X 10 = 10]**

FIFTH SEMESTER B. Sc. DEGREE EXAMINATION
CBCSSUG - CHEMISTRY- Open Course 3
GCHE5D03T: FOOD SCIENCE AND MEDICINAL CHEMISTRY

Time: 2 Hours **Maximum marks: 60**

Section A (Short answers)

(Answer all questions. Each question carries 2 marks)

1. What is the need for the preservation of food?
2. Which are the main materials used for packaging?
3. What are artificial sweeteners? Give an example.
4. Discuss about the artificial ripening of fruits and its health effects.
5. How can beverages be classified?
6. Define appetizers.
7. What is meant by DNA finger printing?
8. Give a note on blood transfusion.
9. Explain the terms pharmacology and pharmacognosy.
10. What are prescription and non-prescription drugs?
11. Define antacids with an example.
12. Describe the causes and symptoms of food poisoning. **[Ceiling of marks: 20]**

Section B (Paragraph)

(Answer all questions. Each question carries 5 marks)

13. How can food be contaminated by toxic chemicals?
14. Discribe the harmful effects of modern food habits.
15. Write a note on the importance of DNA.
16. Give the characteristics of enzymes. Discuss their classification.
17. Explain the source and medicinal uses of eucalyptus oil.
18. Explain the causes, symptoms and drugs used for the treatment of influenza, cholera, bronchial asthma and diabetes.
19. What are the first aids given to prevent bleeding? **[Ceiling of marks: 30]**

Section C (Essay)

(Answer any one. Each question carries 10 marks)

20. Name any three Indian medicinal plants. List their major chemical constituents and medicinal uses.
21. Discuss (a) Medical applications of nanomaterials. (b) Applications of radioactive isotopes. **[1 X 10 = 10]**