UNIVERSITY OF CALICUT

Abstract

General and Academic - Faculty of Science - Syllabus of BSc Polymer Chemistry Programme (LRP Pattern) under CBCSS UG Regulations 2019 with effect from 2019 Admission onwards - Implemented - Orders Issued

G & A - IV - J

U.O.No. 9085/2019/Admn Dated, Calicut University.P.O, 09.07.2019

Read:-1. U.O.No. 4368/2019/Admn dated 23.03.2019

2. Item No. 1 of the minutes of the meeting of the Board of Studies in Polymer Chemistry held on 24.06.2019

3. Item No. I.34 of the minutes of the meeting of Faculty of Science held on 27.06.2019

ORDER

The Regulations for Choice Based Credit and Semester System for Under Graduate (UG) Curriculum 2019 (CBCSS UG Regulations 2019) for all UG Programmes under CBCSS-Regular and SDE/Private Registration w.e.f. 2019 admission has been implemented vide paper read first above.

The meeting of Board of Studies in Polymer Chemistry held on 24/06/2019 has approved the Syllabus of B Sc Polymer Chemistry Programme (LRP Pattern) in tune with the new CBCSS UG Regulations with effect from 2019 Admission onwards, vide paper read second above.

The Faculty of Science at its meeting held on 27/06/2019 has approved the minutes of the meeting of the Board of Studies in Polymer Chemistry held on 24/06/2019, vide paper read third above.

Under these circumstances, considering the urgency, the Vice Chancellor has accorded sanction to implement the Scheme and Syllabus of B Sc Polymer Chemistry Programme (LRP Pattern) in accordance with the new CBCSS UG Regulations 2019, in the University with effect from 2019 Admission onwards, subject to ratification by the Academic Council.

The Scheme and Syllabus of B Sc Polymer Chemistry Programme (LRP Pattern) in accordance with CBCSS UG Regulations 2019, is therefore implemented in the University with effect from 2019 Admission onwards.

Orders are issued accordingly. (Syllabus appended).

Biju George K

Assistant Registrar

To

The Principals of all Affiliated Colleges

Copy to: PS to VC/PA to PVC/ PA to Registrar/PA to CE/JCE I/JCE IV/DoA/EX and EG Sections/GA I F/CHMK Library/Information Centres/SF/DF/FC

Forwarded / By Order

Section Officer

UNIVERSITY OF CALICUT

B.Sc. DEGREE PROGRAMME

IN

POLYMER CHEMISTRY

(LRP Pattern)

(CBCSSUG 2019)

UNDER CHOICE BASED CREDIT AND SEMESTER SYSTEM

SCHEME AND SYLLABI

2019 ADMISSION ONWARDS

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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 2 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 course** means a course that comes under the category of courses, including compulsory English and additional language courses and a set of **General courses** applicable for **Language Reduced Pattern** (LRP) programmes, the selection of which is compulsory for all students undergoing UG programmes. **Core courses** comprise compulsory course in a subject related to a particular degree programme offered by the parent department. There are 18 core courses including a project work. **Complementary courses** cover two disciplines that are related to the core subject and are distributed in the first four semesters. There shall be one **open course** in the 5^{th} semester. Students can opt one open course of their choice offered by any department in the institution other than their parent department. **Audit courses** are courses which are mandatory for a programme but not conducted 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 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. In the case of LRP Programmes 14 credits are given for common courses (English), 8 credits for additional language courses and 16 credits for General courses.

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 Calicut University Social Service Programme (CUSSP). Extra credits are not counted for SGPA or CGPA. The maximum credits acquired under extra credits 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 number**, which includes abbreviation of the subject in three letters, the semester number (1 to 6) in which the course is offered, the code of the course (A: Common course, B: Core course, C: Complementary course, D: Open course and E: Audit course) and the serial number of the course (01, 02, *etc.*). For example, CHE5B06 represents a core course of serial number 06 offered in 5^{th} semester in B.Sc. Chemistry Programme.

UNDERGRADUATE PROGRAMME IN POLYMER 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.

The name of the programme shall be 'BSc **Polymer Chemistry**'. The syllabus for the programme includes 80 % syllabus of B. Sc Chemistry Programme of Calicut University along with special topics related to Polymer in theory. The successful candidates will be eligible for post graduate studies in Chemistry (M.Sc. chemistry) and allied subjects.

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 which excludes pre-requisites. The pre-requisites provided at the beginning of the units

guides the students to what he/she should know before exploring the topic. This can be assessed by the teacher either before delivering the particular topic or as a bridge course at the beginning of each semester. **These shall not be considered for the external evaluation**. A list of references and further readings are provided at the end of each unit.

AIMS

For the B.Sc. Polymer Chemistry programme, Chemistry forms the basic content together with special courses on Polymer Chemistry. 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.

Course Structure

Credit Distribution

Semester	*Common course*			*Core course*	*Complementary course*		*Open course*	*Total*
	English	*Additional Language*	General Course		*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	**14**	**8**	**16**	**55**	**12**	**12**	**3**	**120**

*Practical **Project #Elective

Mark and Indirect Grading System

Mark system is followed instead of direct grading for each question. After external and internal evaluations marks are entered in the answer scripts. All other calculations, including grading, will be done by the university using the software. Indirect Grading System in 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	350
2	Additional Language	200
3	General Course	400
4	Core course: Chemistry and Polymer Chemistry	1475
5	Complementary course: Mathematics	300
6	Complementary course: Physics	400
7	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

CREDITS AND MARKS DISTRIBUTION IN EACH SEMESTER

Total Credits: 120

Semester	*Course*	*Credits*	*Marks*
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	General course I	4	100
	General course II	4	100
	Core Course III: Physical Chemistry-I	3	75
	Complementary course: Mathematics	3	75
	Complementary course: Physics	2	75
	Total	**16**	**425**
IV	General course III	4	100
	General course IV	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: Polymer Chemistry-I	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 COURSE

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

Semester	*Code No*	*Course Title*	*Hrs/ Week*	*Total Hrs*	*Credit*	*Marks*
I	CHE1B01	Core Course I: Theoretical and Inorganic Chemistry- I	2	32	2	75
	-	Core Course V : Inorganic Chemistry Practical-I	2	32	-*	-
II	CHE2B02	Core Course II: Theoretical and Inorganic Chemistry- II	2	32	2	75
	-	Core Course V : Inorganic Chemistry Practical-I	2	32	-*	-
III	CHE3B03	Core Course III: Physical Chemistry-I	3	48	3	75
	-	Core Course V : Inorganic Chemistry Practical-I	2	32	-*	-
IV	CHE4B04	Core Course IV: Organic Chemistry-I	3	48	3	75
	CHE4B05(P)	Core Course V : Inorganic Chemistry Practical-I	2	32	4	100
V	CHE5B06	Core Course VI: Inorganic Chemistry-III	3	48	3	75
	CHE5B07	Core Course VII: Organic Chemistry-II	4	64	3	75
	CHE5B08	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	CHE6B09	Core Course IX: Inorganic Chemistry-IV	3	48	3	75
	CHE6B10	Core Course X: Organic Chemistry-III	3	48	3	75
	CHE6B11	Core Course XI: Physical Chemistry-III	3	48	3	75
	PCH6B01	Core Course XII: Polymer Chemistry-I	3	48	3	75
	PCH6B02(E1)	Core Course XIII: Elective*** — 1. Polymer Processing & Technology	3	48	2	75
	PCH6B02(E2)	Core Course XIII: Elective*** — 2. Polymer Blends and Composites				
	CHE6B14(P)	Core Course XIV: Physical Chemistry Practical	-	-	4**	100
	CHE6B15(P)	Core Course XV: Organic Chemistry Practical	-	-	4**	100
	CHE6B16(P)	Core Course XVI: Inorganic Chemistry Practical-II #	5	80	4	100
	CHE6B17(P)	Core Course XVII: Inorganic Chemistry Practical-III	5	80	4	100
	CHE6B18(Pr)	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

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

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

SEMESTER I

Course Code: CHE1B01

Core Course I: Theoretical and Inorganic Chemistry- I

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

CHE1B01	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 provide the basic groundwork for a research project. Students will be able to analyse basic theory of acid base concept.				
Course outcome (s)					
CO1	To apply the methods of a research project.				
CO2	To understand the principles behind volumetry.				
CO3	To analyse the characteristics of different elements.				
CO4	To distinguish between different acid base concepts.				
CO5	To analyse the stability of different nuclei.				

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

Module I: Chemistry as a discipline of science (5 hrs)

[Prerequisites: Evolution of chemistry – early form of chemistry: the *panch tatvas* and alchemy, idea of some technologies that eventually formed the basis of the various branches of chemistry, ancient speculations to particulate nature of matter, laws of chemical combination. Scope of chemistry, branches of chemistry, interdisciplinary areas involving Chemistry.]

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: selecting a topic for research, design of an experiment, sampling, use of controls, experimental bias, analysis, results and discussion of results, statistical analysis of experimental data, preparation of seminar papers, major publishers in chemical science, author citation, reviews and keywords.

Publishing a research work: 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*, Pearson Education, 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. *Chemistry: A Volatile History*, BBC documentary.

7. http://www.vlab.co.in
8. http://nptel.iitm.ac.in

Further reading

1. T. F. Gieryn, *Cultural Boundaries of Science*, University of Chicago Press, Chicago, 1999.
2. H. Collins, 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 (10 hrs)

[Prerequisites: Awareness on nature of experiments performed in chemical laboratories. The health risks and hazards associated with chemicals. Concentrated and dilute solutions. Acids and bases, Organic and Inorganic chemicals]

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 to phenol and bromine. Disposal of sodium and broken mercury thermometer - Use of calcium chloride and silica gel in desiccators. – R & S Phrases (elementary idea only) – Safe laboratory practices – Lab safety signs. Personal Protective Equipment (PPE).

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 of titrations involving acids and bases, $KMnO_4$, $K_2Cr_2O_7$, I_2 and liberated I_2 - Complexometric titrations. Indicators: Theory of acid-base, redox, adsorption and complexometric indicators. Double burette method of titration: Principle and advantages.

References

1. B. R. Puri, L. R. Sharma, K. C. Kalia, *Principles of Inorganic Chemistry*, 31st Edn., Milestone Publishers and Distributors, New Delhi, 2013.
2. Satya Prakash, *Advanced Inorganic Chemistry,* Vol. 1, 5th Edn., S. Chand and Sons, New Delhi, 2012.
3. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, *Vogel's Text Book of Quantitative Chemical Analysis,* 6th Edn., 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, S. R. Crouch, *Fundamentals of Analytical Chemistry*, 8th Edn., Brooks/Cole, Thomson Learning, Inc., USA, 2004.
3. R. H. Hill, D. Finster, *Laboratory Safety for Chemistry Students*, 1st Edn., Wiley, Hoboken, NJ, 2010.
4. M. C. Day, J. Selbin, *Theoretical Inorganic Chemistry*, East West Press, New Delhi, 2002.

Module III: Periodic Properties (3 hrs)

[Prerequisites: Name and symbol of elements, Law of triads, octaves, X-ray studies of Henrry Mosley, Mosleys periodic law - 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.

Module IV: Representative Elements (6 hrs)

[Prerequisites: 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 electrode potential, flame colour of s block elements, diagonal relationships - Inert pair effect.

Ionic compounds: Lattice energy of ionic compounds - BornLande equation (derivation not expected) - Solvation enthalpy and solubility of ionic compounds - Born-Haber cycle and its applications - Properties of ionic compounds.

Polarity in covalent compounds - Percentage of ionic character - Dipole moment and molecular structure, Polarising power - Fajans rule.

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 of N and P, oxy acids of N and P, structure of SO_2 and SO_3. Structure and acidic strength of oxy and peroxy acids of sulphur, oxy acids of chlorine. Preparation, properties and uses of ammonia, nitric acid, ozone, hydrogen peroxide, sulphuric acid and hydrochloric acid.

References

1. B. R. Puri, L. R. Sharma, K. C. Kalia, *Principles of Inorganic Chemistry*, 31st Edn., Milestone Publishers and Distributors, New Delhi, 2013.
2. Satya Prakash, *Advanced Inorganic Chemistry*, Vol. 1, 5th Edn., S. Chand and Sons, New Delhi, 2012.
3. W. U. Malik, G. D. Tuli, R. D. Madan, *Selected Topics in Inorganic Chemistry*, S. Chand and Co., New Delhi, 2010.
4. J. D. Lee, *Concise Inorganic Chemistry*, 5th Edn., Oxford University Press, New Delhi, 2008.

Further reading

1. D. F. Shriver, P. W. Atkins, *Inorganic Chemistry*, 5rd Edn., Oxford University Press, New York, 2010.
2. M. C. Day, J. Selbin, *Theoretical Inorganic Chemistry*, East West Press, New Delhi, 2002.
3. J. E. Huheey, E. A. Keitler, R. L. Keitler, *Inorganic Chemistry – Principles of Structure and Reactivity,* 4th Edn., Pearson Education, New Delhi, 2013.

Module V: Acid Base Concepts (3 hrs)

[Prerequisites: Arrhenius definition, Bronsted-Lowry definition and conjugate acid-base pairs, lewis concept, ionization of acids and bases.]

Lux-Flood, Solvent system and Usanovich concepts.

Metal and nonmetal hydroxy compounds, acid anhydrides, amphoteric oxides and hydroxides.

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

References

1. W. U. Malik, G. D. Tuli, R. D. Madan, *Selected Topics in Inorganic Chemistry*, S. Chand and Co., New Delhi, 2010 (Reprint).
2. J. D. Lee, *Concise Inorganic Chemistry*, 5th Edn., Oxford University Press, New Delhi, 2008.
3. D. F. Shriver, P. W. Atkins, *Inorganic Chemistry*, 5rd Edn., Oxford University Press,New York, 2010.

Further reading

1. J. E. Huheey, E. A. Keitler, R. L. Keitler, *Inorganic Chemistry – Principles of Structure and Reactivity,* 4th Edn., Pearson Education, New Delhi, 2013.
2. M. C. Day, J. Selbin, *Theoretical Inorganic Chemistry*, East West Press, New Delhi, 2002.
3. O.W. Hand, H. L. Blewitt, *Acid Base Chemistry*, Macmillan USA, 1986.

Module VI: Nuclear Chemistry (5 hrs)

[Prerequisites: Nuclear stability – N/P ratio – Packing fraction – Mass defect – Binding energy - Nuclear fission - Atom bomb – Nuclear fusion – Hydrogen bomb.]

Nuclear forces - Exchange theory and nuclear fluid theory - Nuclear reactors. Decay series – group displacement law - Isotopes: Detection – Aston's mass spectrograph – Separation of isotopes by gaseous diffusion method and thermal diffusion method – Application of radioactive isotopes – ^{14}C dating – Rock dating – Isotopes as tracers – Study of reaction mechanism (ester hydrolysis) – Radio diagnosis and radiotherapy.

References

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

Further reading

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

Mark Distribution	
Module I	10 Marks
Module II	24 Marks
Module III	8 Marks
Module IV	15 Marks
Module V	8 Marks
Module VI	14 Marks

SEMESTER II

Course Code: CHE2B02

Core Course II: Theoretical and Inorganic Chemistry- II

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

CHE2B02	Theoretical and Inorganic Chemistry- II	L	T	P	C
		2	0	0	2
Objective(s)	Module I – To introduce the students to 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 – To enablethe students to understand the the basic postulates of quantum mechanics and how to solve the time-independent Schrödinger wave equation of different systems including H atom. Module III – To introduce the quantum mechanical treatment of chemical bonding in diatomic molecules using VB and MO theories. Module IV - To introduce the students to the quantum mechanical treatment of hybridisation and bonding in polyatomic systems.				
Course outcome (s)					
CO1	To understand 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 understand 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.				

[Pre-requisites: Early atom models – John Dalton's atomic theory, the discharge tube experiment and discovery of electron, the plum-pudding model, the gold foil experiment and the invention of the nucleus. The nuclear model. Failures of the nuclear model.]

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

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)

[Prerequisite: VSEPR theory: Postulates – applications.]

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) hybridization (derivation not required). Other examples of hybridization – Geometry of molecules like PCl_5, SF_6 and IF_7.

Reference

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

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

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

Further reading

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

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

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

SEMESTER III

Course Code: CHE3B03

Core Course III: PHYSICAL CHEMISTRY - I

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

CHE3B03	**PHYSICAL CHEMISTRY - I**	L	T	P	C
		3	0	0	3
Objective (s)	To introduce the concepts of chemical thermodynamics, equilibria and group theory.				
Course outcome (s)					
CO1	To understand the properties of gaseous state and how it links to thermodynamic systems.				
CO2	To understand the concepts of thermodynamics and it's relation to statistical thermodynamics.				
CO3	To apply symmetry operations to categorize different molecules.				

Module I: Gaseous State (8 hrs)

[Prerequisites: 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*, 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*, Vol. II and III, Macmillan Publishers, Noida, 2004.

Further reading

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

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

3. F. Daniels, R. A. Alberty, *Physical Chemistry*, 5th Edn., John Wiley and Sons, Canada, 1980.
4. P. Atkins, J. de Paula, *The Elements of Physical Chemistry* 7th Edn., Oxford University Press, Oxford, 2016.

Module II: Chemical Thermodynamics – I (16 hrs)

[Prerequisites: 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 thermal 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. Maxwell's relations.
Thermochemistry: Heat changes during physicochemical processes. Kirchoff's relations. Bond dissociation energies. Resonance energy from thermochemical data. Changes of thermodynamic properties with respect to different chemical changes.
Second law of thermodynamics - Need for the law - Kelvin, Planck and Clausius statements and equivalence of the two statements with entropic formulation. 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. Carnot's theorem - Carnot's cycle and its efficiency.

Module III: Chemical Thermodynamics – II (8 hrs)

[Prerequisites: Module II: Chemical Thermodynamics - I, idea of permutation and combination]
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*, Vol. II and III, Macmillan Publishers, Noida, 2004.

Further reading

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

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

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

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

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

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

7. J. Rajaram, J. C. Kuriacose, *Chemical Thermodynamics*, Pearson Education, New Delhi, 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 reaction quotient. Equilibrium constants and their quantitative dependence on temperature, pressure and thermodynamic derivation of relations between the various equilibrium constants Kp, Kc and Kx (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 Edn., Oxford University Press, 2006.

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

Further reading

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

2. K. L. Kapoor, *Physical Chemistry*, Vol. 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. P. W. Atkins, J. de Paula, *The Elements of Physical Chemistry*, 7th Edn., Oxford University Press, Oxford, 2016.

6. 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 – Schoenflies 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 for C_{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*, 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*, Vol. II and III, Macmillan Publishers, Noida, 2004.

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

Further reading

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

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

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

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

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

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

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: CHE4B04

Core Course IV: ORGANIC CHEMISTRY– I

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

CHE4B04	ORGANIC CHEMISTRY– I	L	T	P	C
		3	0	0	3
Objective (s)	To enable the students 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 analyse the mechanism of a chemical reaction.				
CO4	To analyse the stability of different aromatic systems.				

Module I: Reaction Mechanism: Basic Concepts (10 hrs)

[Prerequisites: Homolytic and heterolytic bond breaking – Curved arrow notation, drawing electron movements with arrows, half-headed and double headed arrows. Types of reagents: Electrophiles and nucleophiles.]

Electron Displacement Effects: Inductive effect: Definition – Characteristics - +I and –I groups. Applications: Comparison of acidity of (i) formic acid and acetic acid (ii) chlorobutanoic acids. Mesomeric effect: Definition – Characteristics - +M and –M groups. Applications: Comparison of basicity of aniline, *p*-nitroaniline and *p*-anisidine. Hyperconjugation: Definition – Characteristics. Examples: Propene, ethyl carbocation and ethyl free radical. Applications: relative stability of alkenes, comparison of stabilities of (i) 1-butene and 2-butene (ii) toluene, ethyl benzene and tert-butyl benzene. Electromeric effect: Definition – Characteristics - +E effect (addition of H^+ to ethene) and -E effect (addition of CN^- to acetaldehyde). Comparison of electron density in benzene, toluene, phenol, chlorobenzene and nitrobenzene. Steric effect: Definition, reason and examples.

Reaction intermediates: Carbocations, carbanions, free radicals and carbenes (hybridization, structure, formation and stability).

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

References

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

2. S. M. Mukherjee, S. P. Singh, *Reaction Mechanism In Organic Chemistry*, Macmillan, 1984.

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.

Further Reading

1. Jerry March, *Advanced Organic Chemistry*, 5th Edn., John Wiley & Sons, NewYork, 2004.
2. Reinhard Bruckner, *Advanced Organic Chemistry*, Elsevier, 2002.
4. J. Clayden, N. Greeves, S. Warren, P. Wothers, *Organic Chemistry*, 2nd Edn., Oxford University Press, New York, 2012.
5. V. K. Ahluwalia, *Green Chemistry*, Ane Books India, 2009.

Module II: Stereochemistry (13 hrs)

[Prerequisites: *Concept of isomerism*: Types of isomerism - constitutional isomerism (chain, position and functional) and stereoisomerism. *Stereoisomerism*: Classification into conformational isomerism and configurational isomerism. Elements of symmetry of molecules (Identity, proper axis of rotation, plane of symmetry, centre of symmetry and improper axis of rotation).]

Representation of organic molecules: Fischer, Flying wedge, Sawhorse and Newman projections. Inter conversion of different representations.

Conformational Isomerism: Conformations – Conformational analysis of ethane and *n*-butane including energy diagrams. Baeyer's strain theory. Conformations of cyclohexane (chair, half chair, boat and twist) - Axial and equatorial bonds - diaxial and flagpole interactions.

Configurational isomerism: Optical isomerism and Geometrical isomerism.

Optical Isomerism: Optical activity – Concept of chirality – Chirality in organic molecules: Enantiomers, Diastereomers and Meso compounds. Optical isomerism in glyceraldehyde, lactic acid and tartaric acid. Relative and absolute configuration - DL system, RS system of nomenclature for acyclic optical isomers with one and two asymmetric carbon atoms – sequence rules. Erythro and threo representations (basic idea only). Racemic mixture – Resolution methods – Enantiomeric excess. Asymmetric synthesis (partial and absolute).

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

References:

1. D. Nasipuri, *Stereochemistry of Organic Compounds: Principles and Applications*, 3rd Edn., New Age International Publishers, New Delhi, 2011.
2. P. S. Kalsi, *Stereochemistry, Conformation and Mechanisms*, New Age International Publishers, 2005.
3. R. T. Morrison, R. N. Boyd, *Organic Chemistry*, 7th Edn., Pearson Education, New Delhi, 2013.
4. I. L. Finar, *Organic Chemistry*, 5th Edn., Vol. I, Pearson Education, New Delhi, 2013.
5. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co., 2010.
6. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edn., Vikas Publishing House, New Delhi, 2004.

Further Reading

1. C. N. Pillai, *Organic Chemistry*, Universities Press, 2008.
2. P. Y. Bruice, *Essential Organic Chemistry*, 3rd Edn., Pearson Education, 2015.
3. J. Clayden, N. Greeves, S. Warren, P. Wothers, *Organic Chemistry*, 2nd Edn., Oxford University Press, New York, 2012.

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

[Prerequisites: Nomenclature of hydrocarbons and alkyl halides.]

Alkanes: Preparation from alkyl halides (Reduction of alkyl halides, Wurtz reaction and Corey-House synthesis), from carbonyl compounds (Clemmensen reduction, Wolf-kishner reduction and Kolbe electrolysis). Chemical reactions: Halogenation - Mechanism of free radical chlorination.

Alkenes: Preparation: dehalogenation of dihalides (stereochemistry expected) and dehydration of alcohols. Dehydrohalogenation of alkyl halides (Saytzeff's rule). Chemical reactions: Addition of halogens (electrophilic addition with mechanism), 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).

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 – Acidity of alkynes – test for terminal alkynes – Oxidation – (Ozonolysis and reaction with alkaline $KMnO_4$). Chemistry of the test for unsaturation: Bromine water and Baeyer's reagent.

Alkyl halides: Preparation – From alkenes and alcohols. Reactions – Types of aliphatic nucleophilic substitution reactions – $S_N1$and S_N2 mechanisms with stereochemical aspects and effects of substrate structure, solvent, nucleophile and leaving group. Elimination reactions: E1 & E2 mechanisms.

References

1. Peter Sykes, *A Guide book to Mechanism in Organic Chemistry*, 6th Edn., Pearson Education, New Delhi, 2013.
2. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edn., Vikas Publishing House, New Delhi, 2004.
3. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co., 2010.
4. R. T. Morrison, R. N. Boyd, *Organic Chemistry*, 7th Edn., Pearson Education, New Delhi, 2013.
5. I. L. Finar, *Organic Chemistry*, Vol. I, 5th Edn., Pearson Education, New Delhi, 2013.

Further Reading

1. Jerry March, *Advanced Organic Chemistry*, 5th Edn., John Wiley & Sons, NewYork, 2004.
2. J. Clayden, N. Greeves, S. Warren, P. Wothers, *Organic Chemistry*, 2nd Edn., Oxford University Press, New York, 2012.
3. V. K. Ahluwalia, *Green Chemistry*, Ane Books India, 2009.

Module IV: Aromaticity (3 hrs)

[Prerequisites: Structure of benzene – Huckel's $(4n+2)\pi$ electron rule.]

Applications of Huckel's rule to aromatic – anti-aromatic – non-aromatic compounds. Aromaticity of benzenoid (benzene, naphthalene and anthracene) nonbenzenoid (furan, thiophene, pyrrole, pyridine) and other cyclic systems – cyclopropene and cyclopropenyl ions, cyclopentadiene and cyclopentadienyl ions, cycloheptatriene and tropylium ion, cyclooctatetraene, azulene and annulenes.

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

Further Reading

1. P. S. Kalsi, *Organic Reactions and their Mechanisms*, New Age International Publishers, 2009.
2. S. H. Pine, *Organic Chemistry*, 5th Edn., McGraw Hill, 1987.
3. Jerry March, *Advanced Organic Chemistry*, 5th Edn., John Wiley & Sons, NewYork, 2004.
4. P. Y. Bruice, *Essential Organic Chemistry*, 3rd Edn., Pearson Education, 2015.
5. J. Clayden, N. Greeves, S. Warren, P. Wothers, *Organic Chemistry*, 2nd Edn., Oxford University Press, New York, 2012.

Module V: Aromatic Hydrocarbons and Aryl halides (6 hrs)

[Prerequisites: Module IV: Aromaticity. Electrophile and nucleophile, transition state, intermediate and activation energy.]

Nomenclature of benzene derivatives – Structure and stability of benzene (Kekule, Resonance and Molecular Orbital concepts). Aromatic Electrophilic substitution. Mechanism of nitration, halogenations, sulphonation, Friedel-Craft's alkylation and acylation. Orientation of aromatic substitution – Ring activating and deactivating groups with examples – ortho, para and meta directing groups. Birch reduction of benzene.

Aryl halides: Aromatic nucleophilic substitutions – bimolecular displacement mechanism, elimination-addition (benzyne intermediate) mechanism.

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.

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

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1. P. S. Kalsi, *Organic Reactions and their Mechanisms*, New Age International Publishers, 2009.
2. S. H. Pine, *Organic Chemistry*, 5th Edn., McGraw Hill, 1987.
3. Jerry March, *Advanced Organic Chemistry*, 5th Edn., John Wiley & Sons, NewYork, 2004.
4. P. Y. Bruice, *Essential Organic Chemistry*, 3rd Edn., Pearson Education, 2015.
5. J. Clayden, N. Greeves, S. Warren, P. Wothers, *Organic Chemistry*, 2nd Edn., Oxford University Press, New York, 2012.

Mark Distribution	
Module I	16 Marks
Module II	20 Marks
Module III	22 Marks
Module IV	6 Marks
Module V	15 Marks

SEMESTER IV

Course Code: CHE4B05(P)

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)

CHE4B05 (P)	INORGANIC CHEMISTRY PRACTICAL – I	L	T	P	C
		0	0	2	4
Objective (s)	To enable the students to gain 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 analyse the strength of different solutions.				

General Instructions

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

2. For weighing electronic balance may be used.

3. Double burette titration method may be used for acid base titrations in Module III. Single burette method can be followed for other titrations (Module IV- VII).

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

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

6. Practical examination will be conducted at the end of semester IV.

Module I: Introduction to Volumetric Analysis

1. Weighing using electronic balance.

2. Preparation of standard solutions.

Module II: 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 III: Neutralization Titrations

1. Strong acid – strong base titration.

2. Strong acid – weak base titration.

3. Weak acid – strong base titration.

4. Estimation of NH_3 by indirect method.

5. Titration of HCl + CH_3COOH mixture *Vs* NaOH using two different indicators to determine the composition.

6. Estimation of borax.

Module IV: Redox Titrations

a) Permanganometry

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

b) Dichrometry

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

c) Iodimetry and Iodometry

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

Module V: Precipitation Titration (using adsorption indicator)

1. Estimation of chloride in neutral medium.

Module VI: Complexometric Titrations

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

Module VII: Some Estimations of Practical Importance

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

Module VIII: 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. 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. G. D. Christian, *Analytical Chemistry*, 7th Edn., John Wiley and Sons, New York, 2013.
4. A. L. Underwood, *Quantitative Analysis*, 6th Edn., Prentice Hall of India Pvt. Ltd, New Delhi, 1999.
5. D. N. Bajpai, O. P. Pandey, S. Giri, *Practical Chemistry; For I, II & III B. Sc. Students*, S. Chand & Company Ltd., New Delhi, 2012.
6. W.G. Palmer, *Experimental Inorganic Chemistry*, Cambridge University Press, 1970.

SEMESTER V

Course Code: CHE5B06

Core Course VI: INORGANIC CHEMISTRY – III

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

CHE5B06	**INORGANIC CHEMISTRY – III**	L	T	P	C
		3	0	0	3
Objective (s)	To enable the students 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 quantitative analysis.				
CO2	To understand basic processes of metallurgy and to analyse the merits 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 (6 hrs)

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

Gravimetric analysis – Mechanism of precipitate formation. Factors affecting stability of precipitates. Co-precipitation and post precipitation. Effects of 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*, 6th Edn., Pearson Education, Noida, 2013.

Further reading

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

Module II: Metallurgy (10 hrs)

[Prerequisites: Occurrence of metals based on standard electrode potential – Concentration of ores – Calcination and roasting – Reduction to free metal.]

Electrometallurgy – Hydrometallurgy. Refining of metals: Electrolytic refining, ion exchange method, zone refining, vapour phase refining and oxidative refining – Ellingham diagrams for metal oxides – Extractive metallurgy of Al, Fe, Ni, Cu, 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 – Composition, properties and applications of industrially important stainless steel types: *Austenitic, Martensitic* and *Ferritic stainless steels*, Aerospace and automotive applications of stainless steel. Intramedullary rods (a brief study).

References

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

Further reading

1. A. Cottrel, *An introduction to metallurgy*, 2nd Edn., University press, 1990.
2. Jonathan Beddoes, J. Gordon Parr, *Introduction to stainless steels*, 3rd Edn., ASM International, 1999.

Module III: Interhalogen compounds (5 hrs)

[Prerequisites: Halogens, properties, electronic configuration, electronegativity, electron affinity.]

Electropositive character of iodine – General preparation and properties of interhalogen compounds (study of individual members not required) – Structure, 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*, Shoban Lal Nagin Chand and Co., Delhi, 1996.
2. D. F. Shriver, P. W. Atkins, *Inorganic Chemistry*, 3rd Edn., Oxford University Press, 2006.

Further reading

1. J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, *Inorganic Chemistry*, 4th Edn., Pearson. 2006.

2. F. A. Cotton, G. Wilkinson, C. Murillo, M. Bochman, *Advanced Inorganic Chemistry*, 6th Edn., John Wiley, New York, 1999.
3. F. A. Cotton, G. Wilkinson, P. L. Gaus, *Basic Inorganic Chemistry*, 3rd Edn., 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 of oxides, fluorides and oxy fluorides of xenon – Reaction of xenon fluorides with water – Uses of noble gases.

References

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

Further reading

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

Module V: Inorganic Polymers & Non-aqueous Solvents (8 hrs)

[Prerequisites: Catenation, Self ionization of water.]

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

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

References

1. B. R. Puri, L. R. Sharma, K. C. Kalia, *Principles of Inorganic Chemistry*, 31st Edn. Milestone Publishers, New Delhi, 2010.
2. S. Prakash, G. D. Tuli, S. K. Basu, R. D. Madan, Advanced Inorganic Chemistry,Vol. I, S Chand, 2006.
3. J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, *Inorganic Chemistry*, 4th Edn., Pearson, 2006.
4. Christian Reichardt, Thomas Welton, Solvents and solvent effect in organic chemistry, Wiley-VCH Verlag GmbH & Co., 2002.

Further reading

1. M. Clyde Day, J. Selbin, *Theoretical Inorganic Chemistry*, Reinhold Book Corp., 1962.
2. Sisler, Harry Hall, *Chemistry in non-aqueous solvents*, Reinhold, New York, 1961.

Module VI: Environmental Pollution (12 hrs)

[Prerequisites: What is Pollution? quality of drinking water.]

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

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

Thermal pollution, noise pollution and radioactive pollution (Sources, effects and consequences). Pollution due to light.

Hiroshima, Nagasaki and Chernobyl accidents (a brief study). Local environmental movements: Silent Valley, Plachimada, Narmada. Air pollution in Indian cities (Delhi, Agra and Kanpur).

References

1. S. S. Dara, *A Textbook of Environmental Chemistry and Pollution Control*, 8th Edn., S. Chand and Sons, New Delhi, 2008.
2. A. K. De, *Environmental Chemistry*, 6th Edn., New Age International (P) Ltd., New Delhi, 2006.
3. A. K. Ahluwalia, *Environmental Chemistry*, Ane Books India, New Delhi, 2008.

Further reading

1. M. L. Davis, D. A. Cornwell, *Introduction to Environmental Engineering*, 3rd Edn., McGraw Hill, New Delhi, 1998.
2. S. E. Manahan, *Environmental Chemistry*, 8th Edn., CRC Press, Florida, 2004.
3. G. M. Masters, *Introduction to Environmental Engineering and Science*, 3rd Edn., 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, *Waste Water treaement*, Ofxord & IBH Publ, Co. Pvt. Ltd., 1987.

Module VII: Solid Waste Management (4 hrs)

[Prerequisites: Aerobic and anaerobic degradation.]

House hold, municipal and industrial solid waste – Non-degradable, degradable and biodegradable waste – Hazardous waste – Pollution due to plastics. Solid waste management:

Recycling, digestion, dumping, incineration, land treatment and composting. Impacts of medical waste and *e-waste* and their disposal. Energy production from waste.

References

1. R. C. Brunner, *Hazardous Waste Incineration*, McGraw Hill Inc., 1989.
2. A. K. De, *Environmental Chemistry*, 6th Edn., New Age International (P) Ltd., New Delhi, 2006.

Mark Distribution	
Module I	8 Marks
Module II	15 Marks
Module III	10 Marks
Module IV	6 Marks
Module V	14 Marks
Module VI	18 Marks
Module VII	8 Marks

SEMESTER V

Course Code: CHE5B07

Core Course VII: ORGANIC CHEMISTRY – II

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

CHE5B07	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 preparations.				
Course outcome (s)					
CO1	To understand the difference between alcohols and phenols.				
CO2	To understand the importance of ethers and epoxides.				
CO3	To apply organometallic compounds in the 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.				

Module I: Alcohols and Phenols (14 hrs)

[Prerequisites: Monohydric alcohols – Nomenclature, hydrogen bonding.]

Methods of formation of alcohols by reduction of carbonyl compounds. Reaction of carbonyl compounds with Grignard reagent. From alkenes (hydration, hydroboration oxidation and oxymercuration-demercuration reactions). Reactions of alcohols: Acidic and basic nature of alcohols, formation of ester, reaction with hydrogen halides (Lucas test), oxidation (with PCC and $KMnO_4$) – pinacol-pinacolone rearrangement (mechanism expected). Victor Meyer's test. Phenols - Nomenclature, 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) and carboxylation (Kolbe Schmitt reaction). Riemer-Tiemann reaction (mechanism expected), Liebermann's nitroso reaction and Hauben-Hoesch reaction. Preparation of phenolphthalein and fluorescein and colour change of phenolphthalein with pH.

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.

Further reading

1. B. S. Bahl, *Advanced organic Chemistry*, 3rd Edn., S. Chand, 2002.
2. John McMurry, *Organic Chemistry*, 5th Edn., Thompson Asia Pvt. Ltd., 2000.
3. C. N. Pillai, *Organic Chemistry*, Universities Press, 2008.

Module II: Ethers and Epoxides (5 hrs)

[Prerequisites: Ethers - Nomenclature – Isomerism – Preparation by Williamson's synthesis.]

Reactions of ethers: Acidic cleavage and Claisen rearrangement (mechanism expected) – Zeisel's method of estimation of methoxy groups. Crown ethers: Nomenclature – importance in organic synthesis and phase transfer catalysis (PTC).

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

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.

Further reading

1. B. S. Bahl, *Advanced organic Chemistry*, 3rd Edn., S. Chand, 2002.
2. John McMurry, *Organic Chemistry*, 5th Edn., Thompson Asia Pvt Ltd., 2000.
3. C. N. Pillai, *Organic Chemistry*, Universities Press, 2008.

Module III: Organometallic Compounds (2 hrs)

Preparation and synthetic applications of Grignard reagent and organozinc 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.
5. B. S. Bahl, *Advanced organic Chemistry*, 3rd Edn., S. Chand, 2002.

Further reading

1. P. Y. Bruice, *Essential Organic Chemistry*, 3rd Edn., Pearson Education, 2015.
2. John McMurry, *Organic Chemistry*, 5th Edn., Thompson Asia Pvt Ltd., 2000.

Module IV: Aldehydes and Ketones (11 hrs)

[Prerequisites: Nomenclature – Isomerism. Preparation: From alcohols, cyanides, acid chlorides and Etard's reaction.]

Nucleophilic addition reactions – Carbon nucleophiles (addition of HCN, Wittig reaction), Oxygen nucleophiles (H_2O, alcohols,), Nitrogen nucleophiles (NH_3, hydroxyl amine, hydrazine, semicarbazide and DNP reagent) and Sulfur nucleophiles (sodium bisulfate). 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. Reactions involving α carbons of carbonyl compounds – Aldol condensation, Cannizzaro reaction Benzoin condensation and Perkin's reactions. Haloform reaction (mechanism expected). Synthetic utility of Wittig reaction, Reformatsky reaction and Beckmann rearrangement.

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.
5. B. S. Bahl, *Advanced organic Chemistry*, 3rd Edn., S. Chand, 2002.

Further reading

1. P. Y. Bruice, *Essential Organic Chemistry*, 3rd Edn., Pearson Education, 2015.
2. John McMurry, *Organic Chemistry*, 5th Edn., Thompson Asia Pvt. Ltd., 2000.
3. C. N. Pillai, *Organic Chemistry*, Universities Press, 2008.

Module V: Carboxylic Acids and Sulphonic Acids (14 hrs)

[Prerequisites: Carboxylic Acids: Nomenclature – Isomerism. Preparation.]

Carboxylic acids – 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 of carboxylic acid derivatives (acid chlorides, esters, amides and acid anhydrides). Fischer esterification (mechanism expected), HVZ reaction – Decarboxylation – Kolbe electrolysis (mechanism expected). Hydroxy acids – Citric acid – preparation by Reformatsky reaction and uses. Lactic acid, Malic acid and Tartaric acid (structure only). Methods of formation and chemical reactions of unsaturated monocarboxylic acids (cinnamic acid and crotonic acid). Ascend and descend in carboxylic acid series.

Sulphonic Acids: Preparation and properties of benzene sulphonic acid – Tosylation.

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

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.
5. B. S. Bahl, *Advanced organic Chemistry*, 3rd Edn., S. Chand, 2002.

Further reading

1. R. K. Bansal, *A Textbook of Organic Chemistry*, New Age International, 2010.
2. John McMurry, *Organic Chemistry*, 5th Edn., Thompson Asia Pvt. Ltd., 2000.
3. C. N. Pillai, *Organic Chemistry*, Universities Press, 2008.

Module VI: Nitrogen Compounds (14 hrs)

[Prerequisites: Nitro-aci tautomerism – Difference between alkyl nitrites and nitro alkanes. Diazotization and coupling.]

Nitro Compounds: Ketones from nitro compounds – Nef reaction (mechanism not required) – Reduction products of nitrobenzene in acidic, neutral and alkaline media.

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

Synthetic transformations of aryl diazonium salts, azo coupling. Preparation of methyl orange – Reason for its colour change with pH.

Carbonic Acid Derivatives: Preparation and properties of urea – Estimation of urea (hypobromite method and urease method) – preparation and basicity of guanidine.

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.
5. B. S. Bahl, *Advanced organic Chemistry*, 3rd Edn., S. Chand, 2002.

Further Reading

1. P. Y. Bruice, *Essential Organic Chemistry*, 3rd Edn., Pearson Education, 2015.
2. John McMurry, *Organic Chemistry*, 5th Edn., Thompson Asia Pvt Ltd, 2000.
3. C. N. Pillai, *Organic Chemistry*, Universities Press, 2008.
4. J. Clayden, N. Greeves, S. Warren, P. Wothers, *Organic Chemistry*, Oxford University Press, New York, 2012.

Module VII: Heterocyclic & Active Methylene Compounds (4 hrs)

Heterocyclic Compounds: Classification – Nomenclature – Preparation and properties of furan and pyridine. Indole – Fischer indole synthesis and resonance structures.

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

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.

Further reading

1. John McMurry, *Organic Chemistry*, 5th Edn., Thompson Asia Pvt Ltd, 2000.
2. C. N. Pillai, *Organic Chemistry*, Universities Press, 2008.

Mark Distribution	
Module I	16 Marks
Module II	8 Marks
Module III	4 Marks
Module IV	14 Marks
Module V	15 Marks
Module VI	16 Marks
Module VII	6 Marks

SEMESTER V

Course Code: CHE5B08

Core Course VIII: PHYSICAL CHEMISTRY – II

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

CHE5B08	PHYSICAL CHEMISTRY – II	L	T	P	C
		3	0	0	3
Objective (s)	To familiarise the students with the concepts 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 characterise different molecules using spectral methods.				
CO3	To understand various phase transitions and its applications.				

Module I: Kinetics (10 hrs)

[Prerequisites: Fundamentals of Kinetics – 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 – 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)

[Prerequisites: Physical and chemical adsorption, factors affecting adsorption.]

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

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*, 8th Edn., 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., Pearson Education, 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*, Vol. II and III, Macmillan Publishers, Noida, 2004.

Further reading

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

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

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

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

Module III: Phase Equilibria (10 hrs)

[Prerequisites: 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*, 8th Edn., 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.

Further reading

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

2. K. L. Kapoor, *Physical Chemistry*, Vol. 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. P. W. Atkins, J. de Paul,a *The Elements of Physical Chemistry*, 7th Edn., Oxford University Press, Oxford, 2016.

Module IV: Molecular Spectroscopy I (12 hrs)

[Prerequisites: 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)

[Prerequisites: Electromagnetic spectrum – energy range and frequency.]

Nuclear Magnetic Resonance (NMR) Spectroscopy: Proton NMR and ^{13}C NMR – Principle – Number and position of signals – Chemical shift – Different scales – Spin-spin coupling (qualitative idea). 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*, 8th Edn., 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.

Further reading

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

2. K. L. Kapoor, *Physical Chemistry*, Vol. 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, J. de Paula, *The Elements of Physical Chemistry*, 7th Edn., Oxford University Press, Oxford, 2016.

6. P. R. Singh, S. K. Dixit, *Molecular Spectroscopy: Principles and Chemical Applications*, S. Chand & Company, New Delhi 1980.

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

8. F. A. Cotton, *Chemical Applications of Group Theory*, 3rd Edn., John Wiley & Sons, New Delhi.

Module VI: Photochemistry (6 hrs)

[Prerequisites: Introduction – Difference between thermal and photochemical processes – Beer Lambert's law.]

Laws of photochemistry: Grothus-Draper law and Stark-Einstein's law of photochemical equivalence. Quantum yield and its explanation – Photophysical processes: Jablonski diagram – Fluorescence – Phosphorescence. Non-radiative processes: Internal conversion and inter system crossing. Photosensitization – Chemiluminescence – Photochemical reactions (hydrogen-chlorine and hydrogen-bromine).

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. 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*, Vol. 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.
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: CHE6B09

Core Course IX: INORGANIC CHEMISTRY – IV

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

CHE6B09	**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 introduce 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 (10 hrs)

[Prerequisites: laws of spectrophotometry - Beer-Lambert's law.]

Atomic Absorption Spectroscopy (AAS), Flame Emission Spectroscopy – Colorimetry – Spectrophotometry, Atomic Force Microscopy (AFM), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Thermogravimetry (TGA), Differential Scanning Calorimetry (DSC) and Cyclic Voltammetry (CV). [Principle and applications only.]

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.

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, Quantitative Chemical Analysis, 5th Edn., W. H. Free-man and Company, NewYork, 1999.

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

[Prerequisites: *Transition Metals:* General characteristics: Metallic character, oxidation states, size, density, melting point, boiling point. *Lanthanides:* Electronic configuration and general characteristics.]

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

Explanation of metallic properties of transition metals based on theories of Metallic Bonding: Free electron theory, valence bond theory and band theory (qualitative treatment only).

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

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

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*, Milestone Publishers, 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*, 6th Edn., John Wiley, New York. 1999.
2. D. F. Shriver, P. W. Atkins, *Inorganic Chemistry*, 3rd Edn., Oxford University Press, 2009.

Module III: Coordination Chemistry (16 hrs)

[Prerequisites: Coordinate bond, postulates of Werner's theory, ligand, coordination number, homoleptic and heteroleptic complex, isomerism in coordination compounds, difference between double salt and complex.]

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

[Prerequisites: Uniqueness of carbon, covalent bond, coordinate bond, bonding in carbon monoxide.]

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) – Bonding in metal carbonyls.

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

Catalysis: Zeigler Natta catalyst in the polymerization 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, 1991.

Module V: Bioinorganic Chemistry (8 hrs)

[Prerequisites: Metal ions in biological system – Trace and bulk metal ions.]

Haemoglobin and Myoglobin (elementary idea of structure and oxygen binding mechanism) – Chlorophyll and photosynthesis (mechanism not expected) – Sodium-potassium pump –

Biochemistry of Ca, Zn and Co – Toxicity of metal ions (Pb, Hg and As). Anticancer drugs: *Cis*-platin, oxaliplatin, carboplatin and auranofin – Structure and significance.

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.

Further reading

1. B. Douglas, D. Mc Daniel, J. Alexander, *Concepts and models of Inorganic Chemistry*, 3rd Edn., John Wiley, 1994.
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: CHE6B10

Core Course X: ORGANIC CHEMISTRY – III

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

CHE6B10	**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 provide a basic understanding of different spectral techniques and their application in simple molecules. To differentiate diverse pericyclic reactions.				
Course outcome (s)					
CO1	To elucidate the 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 (11 hrs)

[Prerequisites: Electromagnetic spectrum- wavelength, frequency and energy relation. Beer-Lambert's law - chromophore and auxochrome, functional groups.]

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. λ_{max} calculation for dienes and α,β-unsaturated carbonyl compounds.

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 (ethanol, acetone, acetophenone, acetaldehyde, acetic acid, propanoic acid and ethyl acetate).

Purification of organic compounds: Column, paper and thin layer chromatography. Gas Chromatography.

References

1. R. M. Silverstein, F. X. Webster, *Spectrometric Identification of Organic Compounds*, 6th Edn., John Wiley and Sons, New York, 2004.

2. Y. R. Sharma, *Elementary Organic Spectroscopy*, 5th Edn., S. Chand & Company Ltd., New Delhi, 2013.

3. D. L. Pavia, G. M. Lampman, G. S. Kriz, *Introduction to Spectroscopy*, 5th Edn., Thomson Brooks Cole, 2015.

4. Paula Y. Bruice, *Organic Chemistry*, 7rd Edn., Pearson Education, Asia, 2013.

Further reading

1. P. S. Kalsi, *Applications of Spectroscopic Techniques in Organic Chemistry*, 6th Edn., New Age International (P) Ltd., New Delhi, 2004.
2. William Kemp, *Organic Spectroscopy*, 2nd Edn., Macmillan, New York, 1987.
3. R. T. Morrison, R. N. Boyd, *Organic Chemistry*, 7th Edn., Pearson Education, New Delhi, 2013.
4. I. L. Finar, *Organic Chemistry*, 5th Edn., Vol. I, Pearson Education, New Delhi, 2013.

Module II: Carbohydrates (8 hrs)

[Prerequisites: Classification. Monosaccharides: Fischer projection – D, L configuration. Cyclic structure of ribose, deoxy ribose, glucose and fructose.]

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

References

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

Further reading

1. J. F. Robyt, *Essentials of Carbohydrate Chemistry*, Springer, 1998.
2. S. P. Bhutani, *Chemistry of Biomolecules*, Ane Books Pvt. Ltd., 2009.

Module III: Proteins and Nucleic acids (11 hrs)

[Prerequisites: Amino acids – Classification – Structure of amino acids – Zwitter ion formation – Isoelectric point.]

Amino acids: Synthesis (Strecker synthesis and amino malonate synthesis). Peptides and Proteins – Structure determination of peptides: Edmann degradation and Sanger's methods. Peptide synthesis: Solid phase synthesis. Denaturation of proteins. Enzymes – characteristics and examples. Tests for proteins: Chemistry of Xanthoprotein test, Biuret test and Ninhydrin test.

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

References

1. I. L. Finar, *Organic Chemistry*, Vol. I & II, Pearson Education.
2. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co., 2010.

3. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edn., Vikas Publishing House, New Delhi, 2004.
4. R. T. Morrison, R. N. Boyd, *Organic Chemistry*, 7th Edn., Pearson Education, New Delhi, 2013.

Further reading

1. O. P. Agarwal, *Chemistry of Organic Natural Products*, 30th Edn., Goel Publications, 2006.

Module IV: Biomolecules (5 hrs)

Lipids: Classification – Fats and oils – Hydrogenation – Analysis of fats and oils – Acid value, Saponification value and 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.

References

1. I. L. Finar, *Organic Chemistry*, Vol. I & II, Pearson Education.
2. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co., 2010.
3. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edn., Vikas Publishing House, New Delhi, 2004.

Further reading

1. John McMurry, *Organic Chemistry*, 5th Edn., Thompson Asia Pvt. Ltd., 2000.
2. C. N. Pillai, *Organic Chemistry*, Universities Press, 2008.
3. S. P. Bhutani, *Chemistry of Biomolecules*, Ane Books Pvt Ltd., 2009.
4. O. P. Agarwal, *Chemistry of Organic Natural Products*, 30th Edn., Goel Publications, 2006.
5. R. T. Morrison, R. N. Boyd, *Organic Chemistry*, 7th Edn., Pearson Education, New Delhi, 2013.

Module V: Natural products (5 hrs)

[Prerequisites: Heterocyclic systems - nitrogen heterocycles.]
Alkaloids: Extraction. Classification based on structure of heterocyclic ring. Physiological actions of nicotine, quinine, coniine.
Terpenes: Classification – Isoprene rule – Essential oils – Isolation of essential oils by steam distillation and Enfleurage process – Uses of lemongrass oil, eucalyptus oil – Isolation of terpenes from essential oils (elementary idea) – Source, structure and uses of citral, geraniol, limonene and menthol. Structure of natural rubber – Vulcanization and its advantages.
Note: Structural elucidation not expected in any case.

References

1. I. L. Finar, *Organic Chemistry*, Vol. I & II, Pearson Education.
2. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edn., Vikas Publishing House, New Delhi, 2004.

3. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co., 2010.
4. R. T. Morrison, R. N. Boyd, *Organic Chemistry*, 7th Edn., Pearson Education, New Delhi, 2013.

Further reading

1. S. P. Bhutani, *Chemistry of Biomolecules*, Ane Books Pvt. Ltd., 2009.
2. O. P. Agarwal, *Chemistry of Organic Natural Products*, 30th Edn., Goel Publications, 2006.

Module VI: Pericyclic Reactions (8 hrs)

[Prerequisites: Formation of molecular orbitals - bonding and antibonding MOs, nodes. Conjugated, cumulated and isolated double bonds.]

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. Supra-supra and supra-antara interactions. Sigmatropic reactions: [1,3], [1,5] and [3,3] rearrangements. FMO explanations and Woodward-Hoffmann selection rules for the above reactions. Cope and Claisen rearrangements (mechanism expected). Pericyclic reactions in human body – Vitamin D from cholesterol (elementary idea).

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. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co., 2010.
4. P. Y. Bruice, *Essential Organic Chemistry*, 3rd Edn., Pearson Education, 2015.
5. Jagdamba Singh, Jaya Singh, *Photochemistry and Pericyclic Reactions*, 3rd Edn., New Age Science Ltd., New Delhi, 2009.

Further Reading

1. R. Bruckner, *Advanced Organic Chemistry*, Elsevier, 2002.
2. Jerry March, *Advanced Organic Chemistry*, 5th Edn., John Wiley & Sons, NewYork, 2004.
3. S. H. Pine, *Organic Chemistry*, McGraw Hill, 2006.
4. J. Clayden, N. Greeves, S. Warren, P. Wothers, *Organic Chemistry*, 2nd Edn., Oxford University Press, New York, 2012.

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

SEMESTER VI

Course Code: CHE6B11

Core Course XI: PHYSICAL CHEMISTRY – III

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

CHE6B11	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 understand the basic concepts of electrochemistry.				
CO2	To understand the importance of colligative properties.				
CO3	To relate the properties of materials/solids to the geometrical properties and chemical compositions.				

Module I: Electrochemistry – I (12 hrs)

[Prerequisites: Fundamentals of Electrochemistry. Introduction (Faradays law, types of conductance) – Measurement of equivalent conductance – Variation of conductance with dilution – Kohlrausch's law – Arrhenius theory of electrolyte dissociation and its limitations.] Weak and strong electrolytes – Ostwald's dilution law, its uses and limitations – Debye-Huckel-Onsager's equation for strong electrolytes (elementary treatment only, derivation is not required) – Debye-Falkenhagen and Wein effects – Migration of ions and Transport number and its determination by Hittorf's and moving boundary methods. Applications of conductivity measurements: Determination of degree of dissociation, ionic product of water and solubility product of sparingly soluble salts (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)

[Prerequisites: Module I – Electrochemistry. Basics of thermodynamics. 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 – Relationship between free energy and electrical energy.

Gibbs Helmholtz equation to galvanic cells. Concentration cells: Concentration cells with and without transference – Liquid junction potential (LJP). 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 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. 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.

Further reading

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

2. K. L. Kapoor, *Physical Chemistry*, Vol. 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.

6. J. Bockris, A. K. N. Reddy, *Modern Electrochemistry*, Kluwer Academic/Plenum Publishers, New York, 2000.

Module III: Solutions (10 hrs)

[Prerequisites: 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 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. 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.

Further reading

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

2. K. L. Kapoor, *Physical Chemistry*, Vol. 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.

Module IV: Ionic Equilibria (3 hrs)

[Prerequisites: Introduction to acid base theories – pK_a, pK_b 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.

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. 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.

Further reading

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

2. K. L. Kapoor, *Physical Chemistry*, Vol. 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.

Module V: Solid State – I (10 hrs)

[Prerequisites: 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 Metals, 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*, 8th Edn., Oxford University Press, 2006.

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

4. Anthony R. West, *Solid State Chemistry and its Applications*, 2nd Edn., Wiley-Blackwell, 2014.

Further reading

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

2. K. L. Kapoor, *Physical Chemistry*, Vol. 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.

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

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
Course Code PCH6B01
Core Course XII: POLYMER CHEMISTRY - I
Total Hours: 48, Credits: 3, Hours/week: 3

PCH6 B01	**POLYMER CHEMISTRY - I**	L	T	P	C
		3	0	0	3
Objective(s)	To gain detailed knowledge about various mechanisms and technology adopted for polymerisation. To give a basic understanding of properties of polymers like glass transition temperature, molecular weight, reactions and degradation of polymers. To give detailed idea about different commercial and speciality polymers.				
Course outcome (s)					
CO1	To understand various classification of polymers				
CO2	To gain knowledge about various types of polymerisations methods and polymerisation techniques.				
CO3	To get basic idea about the important properties of polymer like average molecular weight, glass transition temperature and viscoelasticity				
CO4	To understand reactions and degradation exhibited by polymers				
CO5	To get deep idea about different commercial polymers and plastic recycling				

Module I: Introduction (6 hrs)

Polymers and macromolecules –Monomers, Homo, Hetero and Co-polymers

Classification - Natural and synthetic polymers - Organic and inorganic polymers - Linear, Branched and cross linked polymers –Plastics, elastomers, fibers and liquid resins; Thermoplastics and thermosetting plastics; Addition and condensation polymers

Tacticity in polymers- atactic, isotactic and syndiotactic polymers (Basic idea only); Dendrimers (Basic idea only)

Module II: Types of Polymerisation&Polymerisation Techniques (16 hrs)

Types of Polymerization: (9 hrs)

Chain polymerisation- free radical, ionic and Coordination polymerisation with mechanism Zegler Nattapolymerisation with mechanism and its advantages

Step Growth Polymerisation – Polycondensation with mechanism; Ring Opening and group transfer polymerization (mechanism not needed)

Polymerisation Techniques: (7 hrs)

Bulk, Solution, Suspension, Emulsion, Melt Condensation and Interfacial Polycondensation Techniques

Module III: Properties 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

G*lass transition temperature* –definition, factors affecting Tg,importance of Tg

Visco elasticity of polymers (Basic Concepts only)

Module IV: Reactions & Degradation of Polymers (6 hrs)

Reaction of polymers: Hydrolysis, addition, substitution and cyclisation reactions

Polymer degradation: Types of degradation –Thermal,mechanical, radiative and oxidative degradation

Module V: Commercial Polymers (10 hrs)

Preparation, Structure , properties and applications of- Polyolefins (HDPE, LDPE, PP and PS); Vinyl polymers (PVC and EVA); fluoro polymers (Teflon); Acrylic polymers (PAN and PMMA); Aliphatic polyamides (nylon6,6 and nylon 6); Aromatic polyamides (kevlar and nomex); Polyester (terylene); Polycarbonate (lexan); Polyurethanes; Resins- Glyptal and formaldehyde resins (UF, MF and PF); Synthetic rubbers (EPDM, BR, SBR, nitrile rubber, Neoprene, Butylrubber and silicone rubber); Conducting polymers- introduction, Dopping, Polyaniline and Polypyrrol (conduction mechanism not required)

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. George Odian, *Principles of Polymerization*, 4th Edn., Wiley, 2004
4. B. K. Sharma, *Polymer Chemistry*, Goel Publishing House, Meerut, 1989.
5. M. G. Arora, M. Singh, M. S. Yadav, *Polymer Chemistry*, 2nd Revised Edition, Anmol Publications Private Ltd., New Delhi, 1989.

Further reading

1. K. J. Saunders, *Organic Polymer Chemistry*, 2nd Edn., Chapman and Hall, London, 1988.
2. Gowri Sankar Misra, *Introductory Polymer Chemistry*, New Age International, New Delhi, 1993.

Mark Distribution	
Module I	13 Marks
Module II	22 Marks
Module III	16 Marks
Module IV	12 Marks
Module V	16 Marks

SEMESTER VI
Course Code - PCH6B02(E1)
Core Course XIII: Elective (E1)
POLYMER PROCESSING &TECHNOLOGY
Total Hours: 48, Credits: 2, Hours/ week: 3

PCH6 B02 (E1)	**POLYMER PROCESSING & TECHNOLOGY**	L	T	P	C
		3	0	0	2
Objective (s)	To gain detailed knowledge about different natural polymers and their modified form. To give a basic understanding of plastic and rubber processing technologies. To give basic idea about characterisation of polymers.				
Course outcome (s)					
CO1	To get deep knowledge about different natural polymer like natural rubber and cellulose and their modified forms				
CO2	To understand concept of compounding and commonly adopted plastic processing techniques.				
CO3	To understand various rubber processing techniques.				
CO4	To acquire basic idea about important properties and standard organisations that is used to characterise polymers.				

Module I: Natural Polymers (16hrs)

Natural rubber –Latex collection and treatment (Concentration & Preservation), Composition and structure; Preparation of Ribbed Smoked Sheets; Technically specified rubber (TSR); superior processing rubbers; Latex processing –dipping, moulding and casting-Latex spreading; foam rubber; Modified forms of natural rubber-epoxidised NR, rubber hydrochloride, cyclized rubber; skim rubber, pale crepe rubber and brown crepe rubber

Cellulose-Cellulose based polymer products –Cotton –Rayon-Cellulose acetate –Cellulose nitrate

Module II: Plastic Processing (12hrs)

Plastic compounding- Compounding ingredients (no detailed study)-plasticizers, extenders, fillers, antioxidants, accelerators, colorants; Plastic processing Techniques-Calendaring, Die Casting, Rotational Casting, Film Casting, Compression Molding, Injection moldings, Blow Moulding, Extrusion Moulding, Transfer moulding, Thermo foaming and Laminating process.

Module III: Rubber processing (10hrs)

Compounding and Compounding ingredients, Curing System, Anti degradents, plasticisers and fillers, colorants, blowing agents, Mastication, mixing, Milling, Internal mixers, extrusion Calendaring and vulcanisation

Module IV: Characterisation of Polymers (10 hrs)

Stress strain properties , tensil strength ,Elongation at break ,modulus, Universal Testing Machine, impact test ,hardness, creep, stress relaxation, dynamic fatigue, plastimeters, Schorch cure time, optimum cure time , melt flow index, Heat distortion temperature, Vicat softening temperature.

Standard Organisations like ASTM, BIS, BS, DIN and ISO for testing of polymer (No detailed study)

References

1. F. W. Billmeyer F.W., *Text book of polymer science*, Jr. John Wiley and Sons, 1994.
2. V. R. Gowariker, N. V. Viswanathan, Jayader Sreedhar, *Polymer Science*, Wiley Eastern Ltd., NewDelhi.
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, Anmol Publications Private Ltd., New Delhi, 1989.
5. Maurice Morton, *Rubber Technology*, van Nostrand, Reinhold, New York.
6. P. Ghosh, *Polymer Science & Technology*, 2nd Edn., Tata McGraw Hill, New Delhi.

Mark Distribution	
Module I	27 Marks
Module II	20 Marks
Module III	16 Marks
Module IV	16 Marks

SEMESTER VI
Course Code - PCH6B02(E2)
Core Course XIII: Elective (E2)
POLYMER BLENDS AND COMPOSITES
Total Hours: 48, Credits: 2, Hours/ week: 3

PCH6 B02 (E2)	**POLYMER BLENDS AND COMPOSITES**	L	T	P	C
		3	0	0	2
Objective (s)	To gain detailed knowledge about different polymer blends and their modified form. To give a basic understanding of polymer composites.				
Course outcome (s)					
CO1	To get deep knowledge about different polymer blends.				
CO2	To understand composition and applications of different polymer blends.				
CO3	To understand various types of polymer composites.				

Module I. Polymer Blends (PB) (13 hrs)

Introduction, definition-homologous, miscible, immiscible, partially miscible, compatible & incompatible polymer blends. Polymer alloys. Interpenetrating polymer network (IPN), Engineering plastic blends, impact modified PB, Thermoplastic-polymer liquid crystalline blends & electrically conducting blends. (Elementary idea only with examples)

Module II. IPN in Polymer blends & alloys (13 Hrs)

Classification of IPN - full, sequential, simultaneous, thermoplastic, Semi I, Semi II & pseudo IPN. Synthesis of IPN-sequential, filled sequential, anionically polymerized sequential IPN, latex interpenetrating elastomeric network (LEN), latex interpenetrating polymer network (LIPN), simultaneous IPN (SINS), grafted SINS, thermoplastic IPNs (elementary idea only)

Module III. Polymer Composites (14Hrs)

Introduction, definition, classification-particulate, fibre (short & long), laminates, nanocomposites & biocomposites. Role of fibre and matrix in improving composite properties. Reinforcing techniques-Hand layup technique, filament winding technique, spray up technique & pultrusion.

Moduleb IV. Commercially important Polymer blends (8 Hrs)

Composition and applications of SYNAPRENE 1958, APPARENE 198, BLENDS OF PVC &Nirile rubber(NBR/PVC blends), EDPM/PP blends, EDPM Rubber & NBR-PP Blend.

References

1. R.P. Singh, C. K. Das & S. K. Mustafi, Polymer Blends &Alloys –an Overview, Asian Books Pvt.
Ltd. 2002 (Ist Edn).
2. Joel R Fried, Polymer Science & Technology, (2 nd Edn), Prentice-Hall of India, New Delhi.
3. Billmeyer F.W., Text book of polymer science, Jr. John Wiley and Sons, 1994.
4. Maurice Morton, Rubber Technology- van Nostrand, Reinhold, New York.
5. Gowariker V.R., Viswanathan N.V. & Jayader Sreedhar, Polymer Science, Wiley Eastern Ltd., New Delhi.

SEMESTER VI

Course Code: CHE6B14(P)

Core Course XIV: PHYSICAL CHEMISTRY PRACTICAL

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

CHE6B14(P)	PHYSICAL CHEMISTRY PRACTICAL	L	T	P	C
		0	0	5	4
Objective (s)	To familiarise the students with the relation between physical properties and chemical composition used for analysis. To provide students an idea of designing experimental methods to analyse 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 an experimental method to determine the physical properties.				
CO3	To understand the principles of Refractometry, Potentiometry and Conductometry.				

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 semester V. Practical examination will be conducted at the end of semester VI.

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 (c) *versus* time of flow x density of the solution (td)].
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 (K_f) of solid solvent using a solute of known molecular mass.
2. Determination of molecular mass of the solute using a solvent of known cryoscopic constant (K_f).

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

Module III: Transition Temperature

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

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

Module IV: Phase Equilibria

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

Module V: Spectroscopy

1. Determination of composition of glycerine-water mixture by refractive index method.
2. Determination of refractive indices of KCl solutions of different concentration and concentrations of unknown KCl solution.
3. 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. Conductometric titration of strong acid x strong base.
2. Potentiometric titration of strong acid x strong base.

Module VII: pH metry

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

Module VIII: Kinetics

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

References

1. A. Findlay, *Findlay's Practical Physical Chemistry*, 9th Edn., John Wiley and Sons, New York, 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: CHE6B15(P)

Core Course XV: ORGANIC CHEMISTRY PRACTICAL

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

CHE6B15(P)	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.

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 VII: Chromatography

Paper chromatographic separation of mixture of two amino acids.

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: CHE6B16(P)

Core Course XVI: INORGANIC CHEMISTRY PRACTCAL-II

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

CHE6B16(P)	**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: CHE6B17(P)

Core Course XVII: INORGANIC CHEMISTRY PRACTCAL-III

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

CHE6B17(P)	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: CHE6B18(Pr)

Core Course XVIII: PROJECT WORK

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

CHE6B18(Pr)	**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 colleges shall send only the marks obtained for internal examination to the university. The internal assessment shall be based on a predetermined transparent system involving written 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:* CHE1B01, CHE2B02, CHE3B03, CHE4B04, CHE5B06, CHE6B10, CHE6B11, PCH6B01 and elective course; *Seminar:* CHE5B07, CHE5B08 and CHE6B09.

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*	*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 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*
Volumetry	*Preparation*		*Analysis*	*Preparation*		*Mixture*
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 Marks*
3 Hours	**Gravimetry and Colorimetry**		65
	Procedure of colorimetry	4	
	Procedure of gravimetry	8	
	Result	35	
	Calculation	2	
	Record	8	
	Viva-Voce	8	
	Industrial Visit		
	Report	8	15
	Viva-Voce	7	

Guidelines

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

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

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

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

Table 5: Inorganic Chemistry Practical – III

Duration	*Pattern*	*Marks*	*Total Marks*
3 Hours	Question on qualitative analysis	4	80
	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

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	CHE5D01	Open Course 1: Environmental Chemistry	3	48	75
	CHE5D02	Open Course 2: Chemistry in Daily Life			
	CHE5D03	Open Course 3: Food Science and Medicinal Chemistry			

SEMESTER V

Course Code: CHE5D01

Open Course 1: ENVIRONMENTAL CHEMISTRY

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

Course outcomes

At the end of the course, students will be able to:

CO 1: Recall the technical/scientific terms involved in pollution.

CO 2: Understand the causes and effects of air pollution.

CO 3: Understand the sources, types and effects of water pollution.

CO 4: Describe water quality parameters.

CO 5: Know soil, noise, thermal and radioactive pollutions and their effects.

CO 6: Study various pollution control measures.

CO 7: 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: CHE5D02

Open Course 2: CHEMISTRY IN DAILY LIFE

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

Course outcomes

At the end of the course, students will be able to:

CO 1: Understand the basics of polymer chemistry.

CO 2: Explain the functions of biomolecules, vitamins, enzymes, hormones and nucleic acid.

CO 3: Describe food additives and food habits.

CO 4: Explain the uses of pesticides and fertilizers and their impacts on the environment.

CO 5: Understand advantages and disadvantages of cleansing agents and cosmetics.

CO 6: Recognize the common classes of drugs in pharmaceutical industry and their application.

CO 7: 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: CHE5D03

Open Course 3: FOOD SCIENCE AND MEDICINAL CHEMISTRY

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

Course outcomes

At the end of the course, students will be able to:

CO 1: Understand food adulteration and preservation methods.

CO 2: Understand food additives.

CO 3: Compare modern food with natural food.

CO 4: Describe the harmful effects of alcohol and modern food habits.

CO 5: Exhibit a broad and coherent body of knowledge on the biomolecules, vitamins, enzymes, hormones and nucleic acids.

CO 6: Recognize the uses of Indian medicinal plants and plant extracts.

CO 7: Recall the chemical, generic and trade names of drugs and their uses.

CO 8: Describe the treatment methods used in medical field.

CO 9: 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 colleges shall send only the marks obtained for internal examination to the university.

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. University 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

FIRST SEMESTER B.Sc DEGREE EXAMINATION
CBCSSUG - CHEMISTRY
CHE1B01 - Core Course I
THEORETICAL AND INORGANIC CHEMISTRY - I

Time: Two Hours **Maximum: 60 Marks**

Section A (Short answers)

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

1. Differentiate between scientific theory and law.
2. Write note on S phrase and R phrase?
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. Distinguish between hard and soft acids and bases.
11. Write note on radioactive tracer.
12. Draw the structure of boric acid. **[Ceiling of marks: 20]**

Section B (Paragraph)

(Answer questions up to 30 marks. 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. Explain the principles of Aston's mass spectrograph.
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
CHE2B02 - Core Course II
THEORETICAL AND INORGANIC CHEMISTRY - II

Time: Two Hours **Maximum: 60 Marks**

Section A (Short answers)

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

1. Predict the hybridization and geometry of SF_4 and IF_7.

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 questions up to 30 marks. 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
CHE3B03 - Core Course III
PHYSICAL CHEMISTRY – I

Time: Two Hours **Maximum: 60 Marks**

Section A (Short answers)

(Answer questions up to 20 marks. 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 questions up to 30 marks. 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
CHE4B04 - Core Course IV
ORGANIC CHEMISTRY – I

Time: Two Hours **Maximum: 60**

Marks

Section A (Short answers)

(Answer questions up to 20 marks. 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. Write equation to show the Birch reduction of benzene.
12. Write the mechanism of nitration of benzene. **[Ceiling of marks: 20]**

Section B (Paragraph)

(Answer questions up to 30 marks. 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.
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. Explain the postulates of Baeyer's strain theory. **[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) Write the SN1and SN2 mechanisms of aliphatic nucleophilic substitution reactions with stereochemical aspects. **[1 X 10 = 10]**

FOURTH SEMESTER B.Sc DEGREE EXAMINATION
CBCSSUG - CHEMISTRY
CHE4B05(P) - Core Course V
INORGANIC CHEMISTRY PRACTICAL - I

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

Section A
Answer the following questions in 10 minutes

1. Calculate the mass of 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
CHE5B06 -Core Course VI
INORGANIC CHEMISTRY – III

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

Section A (Short answers)

(Answer questions up to 20 marks. 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 are the 4 major types of medical waste? **[Ceiling of marks: 20]**

Section B (Paragraph)

(Answer questions up to 30 marks. 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. How we can prevent thermal and radioactive pollution?
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
CHE5B07 -Core Course VII
ORGANIC CHEMISTRY – II

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

Section A (Short answers)
(Answer questions up to 20 marks. 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. How will you explain the basicity of guanidine? **[Ceiling of marks: 20]**

Section B (Paragraph)
(Answer questions up to 30 marks. 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. a) How is methyl orange prepared? How will you explain its colour change with pH? b) How is urea estimated by the urease method? **[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
CHE5B08 - Core Course VIII
PHYSICAL CHEMISTRY – II

Time: Two Hours **Maximum: 60 Marks**

Section A (Short answers)

(Answer questions up to 20 marks. 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 questions up to 30 marks. 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
CHE6B09 - Core Course IX
INORGANIC CHEMISTRY – IV

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

Section A (Short answers)
(Answer questions up to 20 marks. 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 questions up to 30 marks. 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
CHE6B10 - Core Course X
ORGANIC CHEMISTRY - III

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

Section A (Short answers)
(Answer questions up to 20 marks. 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 nonreducig 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 structure of nitrogenous base 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 questions up to 30 marks. Each question carries 5 marks)

13. How will you distinguish ethyl acetate and propanoic acid by IR and ^{1}H NMR spectroscopy?
14. Write note on column and paper chromatography.
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
CHE6B11 - Core Course XI
PHYSICAL CHEMISTRY – III

Time: Two Hours **Maximum: 60 Marks**

Section A (Short answers)

(Answer questions up to 20 marks. 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 questions up to 30 marks. 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│ AgI in 0.045 M KI‖0.045 M $AgNO_3$ │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
PCH6B01 - Core Course XII
POLYMER CHEMISTRY-I

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

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

1. What is meant by tacticity of polymers?
2. What is 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 6,6.
10. What is meant by viscoelasticity of polymers?
11. How silicones are prepared?
12. What is meant by resins? Give an example. **[Ceiling of marks: 20]**

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

13. Distinguish between plastics, fibers and elastomers with example.
14. Write a short note on emulsion 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. Write a note on the conductivity of polyaniline.
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 the following: a) Hydrolysis and substitution reactions of polymers (5 marks), b) Molecular weight distribution (2 ½), c) Degree of polymerization (2 ½) **[1 X 10 = 10]**

SIXTH SEMESTER B. Sc. DEGREE EXAMINATION

(CBCSSUG) - CHEMISTRY

PCH6B02(E1) - Core Course XIII

POLYMER PROCESSING & TECHNOLOGY

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

Section A (Short answers)

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

1. How is rayon prepared?
2. What are the benefits of adding fillers to polymers?
3. Distinguish between Schorch time and optimum cure time.
4. Write a note on curing.
5. What is meant by tensile strength and hardness?
6. What are plasticizers? Give two examples.
7. What is skim rubber?
8. Define Heat distortion temperature.
9. What is meant by mastication?
10. What is meant by latex compounding?
11. Name any four standard organizations for testing of polymers.
12. What are flame retardants? Give example. **[Ceiling of marks: 20]**

Section B (Paragraph)

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

13. Explain blow molding with neat diagram.
14. Write a note on creep and stress relaxation.
15. Explain thermofoaming
16. Distinguish between die casting and rotational casting
17. Explain blow moulding with diagram.
18. Write a note on antioxidants and accelerators.
19. How will you test elastic properties? **[Ceiling of marks: 30]**

Section C (Essay)

(Answer any one. Each question carries 10 marks)

20. Explain Calendaring, Compression Molding and Injection moldings techniques of plastic processing.
21. Write a note on cellulose derivatives. **[1 X 10 = 10]**

SIXTH SEMESTER B. Sc. DEGREE EXAMINATION
(CBCSSUG) - CHEMISTRY
PCH6B02(E2) - Core Course XIII
POLYMER BLENDS AND COMPOSITES

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

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

1. What are condensation polymers? Give examples
2. What is tacticity?
3. What is poly dispersity index?
4. What is degree of polymerization?
5. Give any two preparations of vinyl polymers?
6. What is Teflon? Give any two applications.
7. Give any two properties of nylon-6 and lexan
8. What is vulcanization?
9. What is visco elasticity?
10. What are the factors affecting T_g?
11. What is thermoforming?
12. What are conducting polymers? Give examples. **[Ceiling of marks: 20]**

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

13. Briefly explain injection molding
14. Briefly explain number average and weight average molecular weight of polymers
15. Explain the mechanism of free radical polymerization.
16. Explain the mechanism of Zeigler-Natta polymerization.
17. Explain the different classifications of polymers.
18. What is meant by recycling of plastics? What are plastic identification codes?
19. Explain bulk and emulsion polymerization. **[Ceiling of marks: 30]**

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

20. Explain
a. Polymer degradation
b. Calendaring and Compression molding

21. Explain the preparation, properties and applications of
a. PVC
b. PMMA
c. Nylon66 **[1 X 10 = 10]**

SIXTH SEMESTER B. Sc. DEGREE EXAMINATION
CBCSSUG - CHEMISTRY
CHE6B14(P) - 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
CHE6B15(P) - 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 ---------- (1x8 = 8 Marks)

Section B
Answer the following question in 10 minutes

9. Write the principle and procedure for the conversion of benzamide into benzoic acid. (8 Marks)

Section C

10. Convert the whole of the given acetanilide in to *p*-nitroacetanilide. Exhibit the crude and crystallised samples for inspection. (12 Marks)
11. Analyse qualitatively and systematically the given organic compound by micro method with a view to identify the following. (a) Detect the elements present in it. (b) Find out whether the compound is aliphatic or aromatic. (c) Find out whether the compound is saturated or unsaturated. (d) Detect the elements present in it. (e) Identify and confirm the functional groups. (f) Suggest a suitable derivative. Give its method of preparation. Prepare the derivative suggested by the examiner and exhibit. (g) Write the systematic procedure of analysis including chemistry of identification tests, confirmation tests and derivative preparation. (36 Marks)

Section D

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

SIXTH SEMESTER B. Sc. DEGREE EXAMINATION
CBCSSUG - CHEMISTRY
CHE6B16(P) - 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
CHE6B17(P) - 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)

FIFTH SEMESTER B. Sc. DEGREE EXAMINATION
CBCSSUG - CHEMISTRY
CHE5D01 - Open Course 1
ENVIRONMENTAL CHEMISTRY

Time: 2 Hours **Maximum marks: 60**

Section A (Short answers)

(Answer questions up to 20 marks. 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 questions up to 30 marks. 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
CHE5D02 - Open Course 2
CHEMISTRY IN DAILY LIFE

Time: 2 Hours **Maximum marks: 60**

Section A (Short answers)

(Answer questions up to 20 marks. 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 questions up to 30 marks. 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
CHE5D03 - Open Course 3
FOOD SCIENCE AND MEDICINAL CHEMISTRY

Time: 2 Hours **Maximum marks: 60**

Section A (Short answers)

(Answer questions up to 20 marks. 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 questions up to 30 marks. 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]**