FAROOK COLLEGE (AUTONOMOUS)

Farook College PO, Kozhikode-673632

U.G Programme in Chemistry

Under

Choice Based Credit Semester System

SYLLABUS

Core, Complementary & Open Courses

(2022 Admission Onwards)

Prepared By:

Board of Studies in Chemistry

Farook College (Autonomous)

CERTIFICATE

I hereby certify that the documents attached are the bona fide copies of the syllabus of Core Courses offered to B.Sc. Chemistry programme and Complementary and Open Courses offered by the Department of Chemistry to be effective from 2022 admission onwards.

Date: Principal

Place: Farook College

Table of Contents

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 organised from Monday to Friday with five contact periods of one hour duration on each day. A sequence of 18 such weeks (16 instructional weeks and two weeks for examination) constitutes a semester.

Course means a segment of subject matter to be covered in a semester. The undergraduate programme includes 5 types of courses, *viz.*, common courses, core courses, complementary courses, open course and audit course. **Common courses** include English and additional language courses. Every undergraduate student shall undergo 10 common courses (English courses and 4 additional language courses) for completing the programme. **Core courses** comprise compulsory course in a subject related to a particular degree programme offered by the parent department. There are 18 core courses including a project work. **Complementary courses** cover two disciplines that are related to the core subject and are distributed in the first four semesters. There shall be one **open course** in the 5th 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 (22 for common (English) courses + 16 for common languages other than English) credits shall be from common courses, 55 credits for core courses (including 2 credits each for project work and Elective), 24 credits for complementary courses (12 credits each) and 3 credits for the open course. Audit courses shall have 4 credits per course and a total of 16 credits in the entire programme.

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

Each course shall have a unique alphanumeric **code 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, BCH5B06 represents a core course of serial number 06 offered in 5th semester in B.Sc. Chemistry Programme.

UNDERGRADUATE PROGRAMME IN CHEMISTRY

Preamble

Science education is central to the development of any society. This can be achieved only by revamping the undergraduate programme to make it effective and meaningful. The development of scientific temper in society necessitates proper education and guidance. In order to achieve this, one must update the developments in the field of science. An effective science education can be imparted at the undergraduate level only by revamping the present curriculum.

To achieve this goal, the curriculum should be restructured by emphasising various aspects such as the creativity of students, knowledge of current developments in the discipline, awareness of environmental impacts due to the development of science and technology, and the skills essential for handling equipments and instruments in laboratories and industries.

Chemistry, being an experimental science, demands testing theories through practical laboratory experiences for a thorough understanding of the subject. Nowadays, chemistry laboratories in academic institutions use large amounts of chemicals. The awareness and implementation of eco-friendly experiments becomes a global necessity. It is essential to ensure that laboratory chemicals are used at a minimal level without affecting the skill and understanding aimed through laboratory sessions. This creates an environmental awareness among the students and pollution free atmosphere in the campus.

During the preparation of the syllabus, the existing syllabus, the syllabi of XI^{th} & XII^{th} standards, UGC model curriculum and the syllabi of other universities have been referred. Care has been taken to ensure that the syllabus is compatible with the syllabi of other universities at the same level. Sufficient emphasis is given in the syllabus for training in laboratory skills and instrumentation.

The units of the syllabus are well defined. The number of contact hours required for each unit is given which excludes prerequisites. 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 external evaluation**. A list of references and further readings are provided at the end of each unit.

Aims

This curriculum has been prepared with the objective of giving sound knowledge and understanding of chemistry to undergraduate students. The goal of the syllabus is to make the study of chemistry stimulating, relevant and interesting. It has been prepared with a view to equip students with the potential to contribute to academic and industrial environments.

This curriculum will expose students to various fields in chemistry and develop interest in related disciplines. Chemistry, being a border science to biology, physics and engineering, has a key role to play in the understanding of these disciplines. The updated syllabus is based on an interdisciplinary approach to understand the application of the subject in daily life.

Broad Objectives

To enable the students

- To understand basic facts and concepts in chemistry.
- To apply the principles of chemistry.
- To appreciate the achievements in chemistry and to know the role of chemistry in nature and in

society.

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

Programme Structure

Semester	Common course		Core course	Complementary course		Open course	Total
	English	Additional Language		Mathematics	Physics		
I	3 + 3	4	2	3	2	-	**17**
II	4 + 4	4	2	3	2	-	**19**
III	4	4	3	3	2	-	**16**
IV	4	4	$3 + 4^{*}$	3	$2 + 4^{*}$	-	**24**
V	-	-	3 + 3 + 3	-	-	3	**12**
VI	-	-	$3 + 3 + 3 + 3 + 2^{\#} + 4^{*} + 4^{*} + 4^{*} + 4^{*} + 2^{**}$	-	-	-	**32**
Total	**22**	**16**	**55**	**12**	**12**	**3**	**120**

*Practical **Project $^{\#}$Elective

Credit and Mark Distribution in Each Semesters

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	550
2	Additional Language	400
3	Core course: Chemistry	1475
4	Complementary course: Mathematics	300
5	Complementary course: Physics	400
6	Open Course	75
	Total Marks	**3200**

Ten point Indirect Grading System

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

BSc Program Outcomes

Upon completion of undergraduate programme, the students will be able to:

- Understand the basic concepts, fundamental principles, and scientific theories associated with various scientific phenomena and the relevance of those concepts in everyday life.
- Demonstrate and apply fundamental knowledge in concepts of Biological/Physical Sciences and their application in research, industry.
- Explore inter-disciplinary areas in the field of basic and applied sciences.
- Conceive the methodology of sciences starting from the observation, evidence-based knowledge acquisition, deduction, logical inferences, induction leading to knowledge production.
- Develop scientific temper and transform the scientific knowledge for the betterment of individuals and society as a whole.
- To understand and analyze the problems in the local and global sphere and use the basic knowledge in science to solve real-life situations.
- Acquire the skills in handling scientific instruments, performing laboratory experiments, taking measurements, and analyzing the data scientifically.
- The student will be able to critically evaluate and discuss scientific literature and key methodologies with regard to validity, reliability, and applicability, within the biological and physical sciences.
- Capability to solve problems by using research-based knowledge and research methods.
- Realize that subjects in other faculties such as humanities, performing arts, social sciences, etc. greatly and effectively influence the evolution of new scientific ideas.
- Critically weigh and evaluate the potential and impact of scientific innovations on the environment and find a sustainable solution to issues pertaining to the environment, public health, and agriculture.
- Apart from Acquiring subject-specific skills students will develop laboratory skills, computational skills, qualitative and quantitative data handling skills that enable them to apply their knowledge in science to real-life situations.
- Acquire Practical, technical, and professional skills to qualify for a broad range of positions in research, industry, consultancy, and education or for further education in a doctoral program.

BSc Chemistry Program Specific Outcomes

Upon completion of BSc Chemistry programme, the students will be able to:

- Acquire a comprehensive knowledge and understanding of the major areas of inorganic, organic, theoretical and physical chemistry including a wide range of other disciplinary subjects such as analytical, bio- and industrial chemistry
- Interpret chemical information verbally, mathematically and graphically
- Develop a sense of inquiry and problem solving ability to pursue higher studies and succeed in competitive examinations.
- Apply the concepts and techniques in Mathematics and Physics as tools to learn Chemistry.
- Demonstrate writing, speaking, reading and listening competence in two languages.
- Achieve laboratory skills needed to design safe, eco-friendly and novel chemical experiments to succeed in graduate and professional school, chemical industry and research.
- Use computers for chemical simulations and data analysis.
- Illustrate environmental issues and human rights for generating a novel society.

Credit and Mark Distribution in Each Semester

Total Credits: 120

Semester	Course	Credit	Internal	External	Total Mark
I	Common course: English	3	15	60	75
	Common course: English	3	15	60	75
	Common course: Additional Language	4	20	80	100
	Core Course I: Theoretical and Inorganic	2	15	60	75
	Complementary course: Mathematics	3	15	60	75
	Complementary course: Physics	2	15	60	75
	Total	**17**			**475**
II	Common course: English	4	20	80	100
	Common course: English	4	20	80	100
	Common course: Additional Language	4	20	80	100
	Core Course II: Theoretical and Inorganic	2	15	60	75
	Complementary course: Mathematics	3	15	60	75
	Complementary course: Physics	2	15	60	75
	Total	**19**			**525**
III	Common course: English	4	20	80	100
	Common course: Additional Language	4	20	80	100
	Core Course III: Physical Chemistry-I	3	15	60	75
	Complementary course: Mathematics	3	15	60	75
	Complementary course: Physics	2	15	60	75
	Total	**16**			**425**
IV	Common course: English	4	20	80	100
	Common course: Additional Language	4	20	80	100
	Core Course IV: Organic Chemistry-I	3	15	60	75
	Core Course V: Inorganic Chemistry	4	20	80	100
	Complementary course: Mathematics	3	15	60	75
	Complementary course: Physics	2	15	60	75
	Complementary course: Physics Practical	4	20	80	100
	Total	**24**			**625**
V	Core Course VI: Inorganic Chemistry-III	3	15	60	75
	Core Course VII: Organic Chemistry-II	3	15	60	75
	Core Course VIII: Physical Chemistry-II	3	15	60	75
	Open course	3	15	60	75
	Total	**12**			**300**
VI	Core Course IX: Inorganic Chemistry-IV	3	15	60	75
	Core Course X: Organic Chemistry-III	3	15	60	75
	Core Course XI: Physical Chemistry-III	3	15	60	75
	Core Course XII: Advanced and Applied	3	15	60	75
	Core Course XIII: Elective	2	15	60	75
	Core Course XIV: Physical Chemistry	4	20	80	100
	Core Course XV: Organic Chemistry	4	20	80	100
	Core Course XVI: Inorganic Chemistry	4	20	80	100
	Core Course XVII: Inorganic Chemistry	4	20	80	100
	Core Course XVIII: Project Work	2			75
	Total	**32**			**850**
English		22			550
Additional Language		16			400
Mathematics		12			300
Physics		12			400
Chemistry		55			1475
Open Course		3			75
Total		**120**			**3200**

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	BCH1B01	Core Course I: Theoretical and Inorganic Chemistry- I		2	32	2	75
	-	Core Course V : Inorganic Chemistry Practical-I		2	32	-*	-
II	BCH2B02	Core Course II: Theoretical and Inorganic Chemistry- II		2	32	2	75
	-	Core Course V : Inorganic Chemistry Practical-I		2	32	-*	-
III	BCH3B03	Core Course III: Physical Chemistry-I		3	48	3	75
	-	Core Course V : Inorganic Chemistry Practical-I		2	32	-*	-
IV	BCH4B04	Core Course IV: Organic Chemistry-I		3	48	3	75
	BCH4B05L	Core Course V : Inorganic Chemistry Practical-I		2	32	4	100
V	BCH5B06	Core Course VI: Inorganic Chemistry-III		3	48	3	75
	BCH5B07	Core Course VII: Organic Chemistry-II		4	64	3	75
	BCH5B08	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	BCH6B09	Core Course IX: Inorganic Chemistry-IV		3	48	3	75
	BCH6B10	Core Course X: Organic Chemistry-III		3	48	3	75
	BCH6B11	Core Course XI: Physical Chemistry-III		3	48	3	75
	BCH6B12	Core Course XII: Advanced and Applied Chemistry		3	48	3	75
	BCH6E01	Core Course XIII: Elective***	1. Industrial Chemistry	3	48	2	75
	BCH6E02		2. Polymer Chemistry				
	BCH6E03		3. Medicinal and Environmental Chemistry				
	BCH6B13L	Core Course XIV: Physical Chemistry Practical		-	-	4**	100
	BCH6B14L	Core Course XV: Organic Chemistry Practical		-	-	4**	100
	BCH6B15L	Core Course XVI: Inorganic Chemistry Practical-II #		5	80	4	100
	BCH6B16L	Core Course XVII: Inorganic Chemistry Practical-III		5	80	4	100
	BCH6B17P	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: BCH1B01

Core Course I: THEORETICAL AND INORGANIC CHEMISTRY- I

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

BCH1B01	**Theoretical and Inorganic Chemistry-I**	*	**	***	#
Objectives(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 familiarize different electronegativity scales.			
	CO4	To analyse the characteristics of representative elements.			
	CO5	To distinguish between different acid base concepts.			
	CO6	To understand the basic concepts of nuclear chemistry			

*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 ofchemistry, branches of chemistry, interdisciplinary areas involving Chemistry.]

What is science? Scientific statements - scientific methods - observation - posing a question - formulation of hypothesis - experiment - theory - law. Falsification of hypothesis - inductive and deductive reasoning- 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 analysisof 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.

Intellectual Property Rights: Principles, Parent Law and Practices, Types of IPR.

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.h 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. Acidsand bases, Organic and Inorganic chemicals]

Laboratory Hygiene and Safety: Awareness of Material Safety Data Sheet (MSDS). Storage and handling of chemicals. R & S Phrases (elementary idea only) – Safe laboratory practices –Lab safety signs. Personal Protective Equipment (PPE). 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.

Basic idea on biohazards and biosafety issues.

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

Atomic mass - Molecular mass - mole concept – molar volume. Oxidation and reduction – oxidation number and valency – variable valency - equivalent mass. Methods of expressing concentration: Weight percentage, molality, molarity, normality, mole fraction, mill moles, ppm and ppb. Numerical Problems related to basic concepts.

Volumetric Analysis: Standard solutions- Primary and secondary standards, quantitative dilution – problems. Acid base titrations- titration curves – pH indicators. Redox titrations – titration curve –titrations involving MnO_4^- and $Cr_2O_7^{2-}$ I_2 and liberated I_2 - redox indicators. Complexometric titrations – EDTA titrations - titration curves – metal ion indicators. Precipitation Titrations-Adsorption indicators. Double burette method of titration.

References

1. B. R. Puri, L. R. Sharma, K. C. Kalia, *Principles of Inorganic Chemistry*, 31st Ed., Milestone Publishers and Distributors, New Delhi, 2013.
2. Satya Prakash, *Advanced Inorganic Chemistry*, Vol. 1, 5th Ed., 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 Ed., 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 Ed., Brooks/Cole, Thomson Learning, Inc., USA, 2004.
3. R. H. Hill, D. Finster, Laboratory Safety for Chemistry Students, 1st Ed., 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 inproperties: Atomic and ionic radii.]

Ionization enthalpy - Electron affinity (electron gain enthalpy) – Electronegativity: Pauling's, Mulliken's, Allred Rachow's and Mulliken-Jaffé's electronegativity 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.]*

Diagonal relationship and Inert pair effect. Ionic compounds: Lattice energy of ionic compounds – Born-Lande equation (derivationnot expected) - Solvation enthalpy and solubility of ionic compounds - Born-Haber cycle and itsapplications - Properties of ionic compounds.

Polarity in covalent compounds - Percentage of ionic character - Dipole moment and molecular structure.

Comparison of Lewis acidity of boron halides - Preparation, properties, structure and uses of Diborane, Boric acid, Borazine and Boron nitride

Structures of oxides and oxy acids of N and P, Structure and acidic strength of oxy and peroxy acids of sulphur, oxy acids of chlorine.

References

1. B. R. Puri, L. R. Sharma, K. C. Kalia, *Principles of Inorganic Chemistry*, 31st Ed., Milestone Publishers and Distributors, New Delhi, 2013.
2. Satya Prakash, *Advanced Inorganic Chemistry*, Vol. 1, 5th Ed., 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 Ed., Oxford University Press, New Delhi, 2008.

Further reading

1. D. F. Shriver, P. W. Atkins, Inorganic Chemistry, 5rd Ed., 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 Ed., 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.]

Arrhenius Concept, Bronsted-Lowry's concept, relative strength of acids, Pauling's rules, Lewis concept, group characteristics of Lewis acids, Lux-Flood concept, Usanovich concepts.

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 Ed., Oxford University Press, New Delhi, 2008.
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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.]

Disintegration Laws and Radioactive equilibrium- Nuclear stability and nuclear binding energy- Nuclear forces -meson exchange theory- Nuclear models (Liquid Drop and Shell Model): Concept of nuclear quantum number, magic numbers- Nuclear Reactions: Artificial radioactivity, transmutation of elements, fission, fusion and spallation. Separation and uses of isotopes.

Radio chemical methods: principles of determination of age of rocks and minerals, radio carbon dating, hazards of radiation and safety measures.

References

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

Further reading

1. S. Glasstone, *Source Book on Atomic Energy*, 3rd Ed., East-West Press Pvt. Ltd., NewDelhi, 1967.
2. J. B. Rajam, L. D. Broglie, *Atomic Physics*, 7th Ed., 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	10 Marks

SEMESTER II

Course Code: BCH2B02

Core Course II: THEORETICAL AND INORGANIC CHEMISTRY- II

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

BCH2B02	**Theoretical and Inorganic Chemistry-II**		L*	T**	P***	C#
			2	0	0	2
Objectives(s)	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. To enable the students to understand the basic postulates of quantum mechanics and how to solve the time-independent Schrödinger wave equation of different systems including H atom. To introduce the quantum mechanical treatment of chemical bonding in diatomic molecules using VB and MO theories. 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.				

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

[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.]

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 (6 hrs)

The Schrodinger wave equation, Postulates of Quantum mechanics, well behaved functions. Probabilistic interpretation of the wave function, linear and Hermitian operators, Laplacian and Hamiltonian operators, eigen functions and eigen values of an operator, Expectation values in Quantum mechanics, Particle in a one-dimensional box

Module III: Schrödinger treatment of one electron atom (4 hrs)

Application of Schrödinger wave equation to hydrogen atom. The wave equation in spherical polar coordinates. 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).

Spin orbitals (elementary idea only). Pauli's exclusion principle

Module IV: 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 V: Bonding in polyatomic molecules (6 hrs)

[Prerequisite: VSEPR theory: Postulates and 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.

References

1. D. A. McQuarrie, J. D. Simon, *Physical Chemistry – A Molecular Approach*, Viva, 2001.
2. A. K. Chandra, *Introductory Quantum Chemistry*, 4th Ed., Tata McGraw Hill Publishing Company, Noida, 1994.
3. R. K. Prasad, *Quantum Chemistry*, 3rd Ed., New Age International, 2006.
4. 4. P. W. Atkins, R. S. Friedman, Molecular Quantum Mechanics, 4th Ed., Oxford University Press, 2005

Further reading

1. F.L. Pilar, Elementary Quantum Chemistry, McGraw-Hill, 1968.
2. M.W. Hanna, Quantum Mechanics in Chemistry, 2nd Edition, W.A. Benjamin Inc., 1969.
3. Horia Metiu, Physical Chemistry – Quantum Mechanics, Taylor & Francis, 2006.
4. A.K. Chandra, Introduction to Quantum Chemistry, 4th Edition, Tata McGraw-Hill, 1994.

Mark Distribution	
Module I	15 Marks
Module II	15

	Marks
Module III	10 Marks
Module IV	24 Marks
Module V	15 Marks

SEMESTER III

Course Code: BCH3B03

Core Course III: PHYSICAL CHEMISTRY - I

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

BCH3B03	**PHYSICAL CHEMISTRY - I**		L*	T**	P***	C#
			3	0	0	3
Objectives(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				
	CO3	To appreciate the relation between thermodynamicsand statistical thermodynamics.				
	CO4	To understand the properties o fchemical equillibrium				
	CO5	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 behaviour - 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 Ed., Vishal Publishing Company, New Delhi, 2013.
2. P. W. Atkins, J. de Paula, Atkin’s Physical Chemistry, 8th Ed., Oxford University Press, 2006.
3. D. A. McQuarrie, J. D. Simon, Physical Chemistry: A Molecular Approach, University Science Books: Sausalito, CA, 1997.
4. K. L. Kapoor, Physical Chemistry, Vol. II and III, Macmillan Publishers, Noida, 2004.

Further reading

1. G. M. Barrow, Physical Chemistry, 5th Ed., Tata McGraw Hill Education, New Delhi, 2006.
2. S. Glasstone, D.H. Lewis, Elements of Physical Chemistry, 2nd Ed., Macmillan &

Company, UK, 1962.
3. F. Daniels, R. A. Alberty, Physical Chemistry, 5th Ed., John Wiley and Sons, Canada, 1980.
4. P. Atkins, J. de Paula, The Elements of Physical Chemistry 7th Ed., 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.

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

Third law of thermodynamics - Nernst heat theorem - Statement of third law. Residual entropy and absolute entropy

Module III: Chemical Thermodynamics – II (6 hrs)

[Prerequisites: Module II: Chemical Thermodynamics - I, idea of permutation and combination]

Fundamental concepts of Statistical Thermodynamics - Probability - Partition function - ensembles - Boltzmann distribution derivation - Relation between entropy and probability - Stirling's approximation.

References

1. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical Chemistry, 46th Ed., Vishal Publishing Company, New Delhi, 2013.
2. P. W. Atkins, J. de Paula, Atkin’s Physical Chemistry, 8th Ed., Oxford University Press,

2006.
3. D. A. McQuarrie, J. D. Simon, Physical Chemistry: A Molecular Approach, University Science Books: Sausalito, CA; 1997.
4. K. L. Kapoor, *Physical Chemistry*, Vol. II and III, Macmillan Publishers, Noida, 2004.

Further reading

1. G. M. Barrow, Physical Chemistry, 5th Ed., Tata McGraw Hill Education, New Delhi, 2006.
2. S. Glasstone, D. H. Lewis, Elements of Physical Chemistry, 2nd Ed., Macmillan & Company, UK, 1962.
3. F. Daniels, R. A. Alberty, Physical Chemistry, 5th Ed., John Wiley and Sons, Canada, 1980.
4. P.W. Atkins, J. de Paula, The Elements of Physical Chemistry, 7th Ed., 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 Ed., Vishal Publishing Company, New Delhi, 2013.
2. P. W. Atkins, J. de Paula, Atkin's Physical Chemistry, 8th Ed., Oxford University Press, 2006.
3. D. A. McQuarrie, J. D. Simon, *Physical Chemistry: A Molecular Approach*, University Science Books: Sausalito, CA; 1997.

Further reading

1. G. M. Barrow, Physical Chemistry, 5th Ed., 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 Ed., Macmillan & Company, UK, 1962.
4. F. Daniels, R. A. Alberty, Physical Chemistry, 5th Ed., John Wiley and Sons, Canada, 1980.
5. P. W. Atkins, J. de Paula, The Elements of Physical Chemistry, 7th Ed., 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 Ed., Vishal Publishing Company, New Delhi, 2013.
2. P. W. Atkins, J. de Paula, Atkin's Physical Chemistry, 8th Ed., Oxford University Press 2006.
3. D. A. McQuarrie, J. D. Simon, Physical Chemistry: A Molecular Approach, University Science Books: Sausalito, CA; 1997.
4. 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 Ed., Tata McGraw Hill Education, New Delhi, 2006.
2. S. Glasstone, D. H. Lewis, Elements of Physical Chemistry, 2nd Ed., Macmillan & Company, UK, 1962.
3. F. Daniels, R. A. Alberty, Physical Chemistry, 5th Ed., John Wiley and Sons, Canada, 1980.
4. P. W. Atkins, J. de Paula, The Elements of Physical Chemistry, 7th Ed., 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 Ed., John Wiley & Sons, New York, 1990.

Mark Distribution	
Module I	14 Marks
Module II	27 Marks
Module III	12 Marks
Module IV	12 Marks
Module V	14 Marks

SEMESTER IV

Course Code: BCH4B04

Core Course IV: ORGANIC CHEMISTRY– I

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

BCH4B04	**ORGANIC CHEMISTRY– I**		L*	T**	P***	C#
			3	0	0	3
Objectives(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.				
	CO5	To understand reactions of aromatic hydrocarbon				

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- hybridisation, 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 Ed., Pearson Education, New Delhi, 2013.
2. S. M. Mukherjee, S. P. Singh, Reaction Mechanism In Organic Chemistry, Macmillan, 1984.

3. P. S. Kalsi, Organic Reactions, Stereochemistry and Mechanisms, 4th Ed., New Age International Publishers, New Delhi, 2006.
4. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, A Textbook of Organic Chemistry, 2nd Ed., Vikas Publishing House, New Delhi, 2004.
5. M. K. Jain, S. C. Sharma, Modern Organic Chemistry, 3rd Ed., Vishal Publishing Company Co., 2010.
6. R. T. Morrison, R. N. Boyd, Organic Chemistry, 7th Ed., Pearson Education, New Delhi, 2013.
7. I. L. Finar, Organic *Chemistry*, Vol. I, 5th Ed., Pearson Education, New Delhi, 2013.

Further Reading

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

Module II: Reaction Mechanism -II (10 hrs)

[Prerequisites: Types of organic reactions- structure of benzene-resonance]

Chemistry of reactive intemediates: Carbocations, carbanions, free radicals and carbenes-hybridization, nitrenes, benzynes, structure, formation and stability and reactions. Solvent classification –basic idea about dipole moment and dielectric constant. Nucleophilic and electrphilic substititution S_NI, S_N2, S_NAr and S_E (aromatic and aliphalic). Elimination reactions E1, E2 and E1cb. (Mechanisms with stereochemical aspects and effects of substrate structure, solvent, nucleophile and leaving group). Addition reactions-electrophilic addition reactions - addition of hydrogen halides (Markownikov and Anti-Markownikov addition with mechanism) and addition of Halogens, addition of water and hydroboration reaction.

References

1. Peter Sykes, *A Guide book to Mechanism in Organic Chemistry*, 6th Ed., Pearson Education, New Delhi, 2013.
2. S. M. Mukherjee, S. P. Singh, Reaction Mechanism In Organic Chemistry, Macmillan, 1984.
3. P. S. Kalsi, Organic Reactions, Stereochemistry and Mechanisms, 4th Ed., New Age International Publishers, New Delhi, 2006.
4. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, A Textbook of Organic Chemistry, 2nd Ed., Vikas Publishing House, New Delhi, 2004.
5. M. K. Jain, S. C. Sharma, Modern Organic Chemistry, 3rd Ed., Vishal Publishing Company Co., 2010.
6. R. T. Morrison, R. N. Boyd, Organic Chemistry, 7th Ed., Pearson Education, New Delhi, 2013.
7. I. L. Finar, Organic *Chemistry*, Vol. I, 5th Ed., Pearson Education, New Delhi, 2013.

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8. Jerry March, *Advanced Organic Chemistry*, 5th Ed., John Wiley & Sons, NewYork, 2004.
9. Reinhard Bruckner, *Advanced Organic Chemistry*, Elsevier, 2002.

10. J. Clayden, N. Greeves, S. Warren, P. Wothers, *Organic Chemistry*, 2nd Ed., Oxford University Press, New York, 2012.
11. V. K. Ahluwalia, *Green Chemistry*, Ane Books India, 2009.

Module III: Stereochemistry (16 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, propane, *n*-butane (including energy diagrams) and substituted ethane. 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), Optical isomerism in compounds without stereo centres -allenes and biphenyls

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 Ed., 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 Ed., Pearson Education, New Delhi, 2013.
4. I. L. Finar, *Organic Chemistry*, 5th Ed., Vol. I, Pearson Education, New Delhi, 2013.
5. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Ed., Vishal Publishing Company Co., 2010.
6. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Ed., 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 Ed., Pearson Education, 2015.
3. J. Clayden, N. Greeves, S. Warren, P. Wothers, *Organic Chemistry*, 2nd Ed., Oxford

University Press, New York, 2012.

Module IV: Aliphatic Hydrocarbons (8 hrs)

[Prerequisites: Nomenclature of hydrocarbons]

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.

Module V: Aromatic Hydrocarbons and Aromaticity (6 hrs)

[Prerequisites: Structure of benzene – Huckel's (4n+2)π electron rule Aromaticity,Aromatic reactions]

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.

Monocyclcic, bicyclic and tricyclic aromatic hydrocarbons - Nomenclature of benzene derivatives – Structure and stability of benzene (Kekule, Resonance and Molecular Orbital concepts). Orientation of aromatic substitution – Ring activating and deactivating groups with examples – *ortho, para* and *meta* directing groups. Birch reduction of benzene.

References:

1. R. T. Morrison, R. N. Boyd, *Organic Chemistry*, 7th Ed., Pearson Education, New Delhi, 2013.
2. I. L. Finar, *Organic Chemistry*, Vol. I, 5th Ed., Pearson Education, New Delhi, 2013.
3. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Ed., Vishal Publishing Company Co., 2010.
4. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Ed., Vikas Publishing House, New Delhi, 2004.
5. Peter Sykes, *A Guide book to Mechanism in Organic Chemistry*, 6th Ed., 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 Ed., McGraw Hill, 1987.
3. Jerry March, Advanced Organic Chemistry, 5th Ed., John Wiley & Sons, NewYork, 2004.
4. P. Y. Bruice, Essential Organic Chemistry, 3rd Ed., Pearson Education, 2015.
5. J. Clayden, N. Greeves, S. Warren, P. Wothers, Organic Chemistry, 2nd Ed., Oxford University Press, New York, 2012.
6. V. K. Ahluwalia, *Green Chemistry*, Ane Books India, 2009.

Mark Distribution	
Module I	14 Marks
Module II	18 Marks
Module III	22 Marks
Module IV	15 Marks
Module V	10 Marks

SEMESTER IV

Course Code: BCH4B05L

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)

PART-A

			L*	T**	P***	C#
BCH4B05L	**INORGANIC CHEMISTRY PRACTICAL– I**		3	0	2	4
Objectives(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 quantitative analysis				
	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.				
	CO5	To enable the students to develop skills preparation of inorganic complexes.				

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, 2 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 Ed., Pearson Education, Noida, 2013.
2. D. A. Skoog, D. M. West, F.J. Holler, S. R. Crouch, Fundamentals of Analytical Chemistry, 8th Ed., Brooks/Cole, Thomson Learning, USA, 2004.
3. G. D. Christian, Analytical Chemistry, 7th Ed., John Wiley and Sons, New York, 2013.

4. A. L. Underwood, Quantitative Analysis, 6th Ed., 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.

PART-B

Semester 1 (8 hours)

Organic Chemistry Experiments

1. To determine the R_f value of the amino acids present in a given mixture by paper chromatography.
   Group-A : Glutamic acid, Lysine, Histidine, Argenine, Serine, Glycine, Aspartic acid
   Group-B: Lucine, Phenyl alanine, Isoleucine, Tryptophan, Methionine, Valine, Tyrosine.
2. To determine the R_f value of the components present in a given binary mixture by thin layer chromatography: Benzophenone, Anisole, Benzoic acid, Hydroquinone, ,Chlorophyll a and b.
3. Separation of o-and p-nitroaniline by using thin layer chromatography and calculate their R_f values.
4. Identification of caffeine present in tea extract by thin layer chromatography.

Semester 2 (8 hours)

Inorganic chemistry experiments (8 Hours)

A. Preparation of Coordination Complexes

1. Tris(acetylacetonato)manganate III
2. cis-and trans- potassium dioxalatodiaquachromate
3. Preparation of ionization isomers of chromium(III) chloride hexahydrate

B. Stabilization of unusual oxidation states

1. Preparation of copper(I) chloride
2. Preparation of hexaamminecobalt(III) chloride

Semester 3 (8 hours)

Molecular Modeling Studie- I

1. Creating H_2O, CH_4, NH_3, C_6H_6, C_2H_4, H_2O, HF dimer and HF trimer by using Molecular Editor and Visualization software Avogadro
2. Modeling of H_2O, CH_4, NH_3, C_6H_6, C_2H_4, H_2O, HF dimer and HF trimers and save the coordinates as .xyz, .sdf, and.mol.
3. Download different protein structures in PDB format (PDB IDs: 1HSG, 6VWW, 1R42, and 6W9C) from the Protein Data Bank.
4. Visualisation of proteins (PDB IDs: 1HSG, 6VWW, 1R42, and 6W9C) with using PyMOL or RasMol softwares and prepare for docking.

Semester 4 (16 hours)

Molecular Docking Studies- II

1. Perform the molecular docking of the ligands indinavir, lopinavir and ritonavir against HIV protease target (PDB ID 1HSG) using autodock vina software. Predict which ligand has great binding affinity to HIV protease.

2. Find the best Acetylcholinesterase inhibitor among the following compounds using vina molecular docking. (Given PDB ID of target protein -1EVE)
   a) Galantamine b) Donepezil c) Rivastgmine
3. Find the best **anti inflammatory** compound among Aspirin, Ibuprofen and Mefnamic acid using molecular docking calculations. Target PDB ID is 1cx2.

SEMESTER V

Course Code: BCH5B06

Core Course VI: INORGANIC CHEMISTRY – III

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

BCH5B06	**INORGANIC CHEMISTRY– III**		L*	T**	P***	C#
			3	0	0	3
Objectives(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, inter-halogen compounds and inorganic polymers.					
Course outcome(s)	**CO1**	To understand the principles behind qualitative 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 understand different environment 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 for anions, and its advantages.

Gravimetric analysis – Principles of gravimetric Estimation. Mechanism of precipitate formation. Factors affecting stability ofprecipitates. Co-precipitation and post precipitation. Effects of digestion, washing, drying andignition of precipitates. Use of calcium chloride and silica gel in desiccators.

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 Ed., Pearson Education, Noida, 2013.

Further reading

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

Module II: Metallurgy (9 hrs)

[Prerequisites: Occurrence of metals based on standard electrode potential – Concentration ofores – 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, Bessimer Converter– classification of steel – Composition and uses of alloy steels

References

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

Further reading

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

Module III: Interhalogen compounds (5 hrs)

[Prerequisites: Halogens, properties, electronic configuration, electronegativity, electronaffinity.]

General preparation and properties of interhalogen compounds (study of individual members not required) – Electropositive character of iodine – 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 Ed., Oxford University Press, 2006.

Further reading

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

Module IV: Noble Gases (5 hrs)

[Prerequisites: Why the name noble gas? electronic configuration.]

Occurrence and uses Separation of noble gases by charcoal adsorption method - rationalization of inertness of noble gases - preparation, properties, stucture and reactivities of fluorides (XeF_n) and oxofluorides (XeO_mF_n) of xenon - Xenon-oxygen compounds - Fluorides of Krypton –Clathrates.

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 Ed., Oxford University Press,2006.
3. M. N. Greenwood, A. Earnshaw, *Chemistry of the elements*, 2nd Ed., Butterworth, 1997.

Further reading

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

2. F. A. Cotton, G. Wilkinson, C. Murillo, M. Bochman, *Advanced Inorganic Chemistry*, 6th Ed., John Wiley, New York, 1999.
3. F. A. Cotton, G. Wilkinson, P. L. Gaus, *Basic Inorganic Chemistry*, 3rd Ed., John Wiley, New York, 2008.

Module V: Inorganic Polymers (6 hrs)

[Prerequisites: Catenation]

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

References

1. B. R. Puri, L. R. Sharma, K. C. Kalia, *Principles of Inorganic Chemistry*, 31st Ed. 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 Ed., Pearson, 2006.

Further reading

1. M. Clyde Day, J. Selbin, *Theoretical Inorganic Chemistry*, Reinhold Book Corp.,1962.

Module VI: Environmental chemistry (12 hrs)

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

Air pollution: Causes, effects and control measures. Acid rain, smog, greenhouse effect, Global warming, ozone depletion – causes and consequences.

Water pollution: Causes- organic, inorganic and macroscopic contaminants, effects of pesticides, insecticides and detergents on water pollution. Marine pollution, eutrophication, biomagnification, water quality parameters-DO, BOD, 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).

Soil pollution: Causes and effects: Agrochemicals, industrial wastes, petroleum wastes, electronic wastes, landfill and dumping. Genetically modified plants.

Solid waste management - 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 medicalwaste and e-waste and their disposal. Energy production from waste.

References

1. S. S. Dara, *A Textbook of Environmental Chemistry and Pollution Control*, 8th Ed., S. Chand and Sons, New Delhi, 2008.

2. A. K. De, *Environmental Chemistry*, 6th Ed., New Age International (P) Ltd., NewDelhi, 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 Ed., McGraw Hill, New Delhi, 1998.
2. S. E. Manahan, *Environmental Chemistry*, 8th Ed., CRC Press, Florida, 2004.
3. G. M. Masters, *Introduction to Environmental Engineering and Science*, 3rd Ed., 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: Social Issues and the Environment (5 hrs)

Urban problems related to energy. Water conservation, rainwater harvesting, water shed management. Resettlement and rehabilitation of people: its problems and concerns. Environmental ethics: Issues and possible solutions. Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation, Public awareness.

References

1. Heywood, V.H & Watson, R.T. 1995. Global Biodiversity Assessment, Cambridge University Press 1140pb (Ref)
2. Jadhav.H & Bhosale.V.M. 1995. Environmental Protection and Laws. Himalaya Pub. House, Delhi 284p (Ref)
3. Mekinney, M.L & Schock.R.M. 1996 Environmental Science Systems & Solutions. Web enhanced edition 639p (Ref)
4. Miller T.G. Jr., Environmental Science, Wadsworth Publishing Co. (TB)

Mark Distribution	
Module I	9 Marks
Module II	12 Marks
Module III	8 Marks
Module IV	8 Marks
Module V	10 Marks
Module VI	20 Marks
Module VII	8 Marks

SEMESTER V

Course Code: BCH5B07

Core Course VII: ORGANIC CHEMISTRY – II

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

BCH5B07	**ORGANIC CHEMISTRY– II**		L*	T**	P***	C#
			3	0	0	3
Objectives(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 (12 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.

Module II: Ethers and Epoxides (4 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.

Module III: Halogen compounds and Organometallic Compounds (6 hrs)

Preparation and reactions of alkyl and aryl halides.

Reactions of Grignard and organolithium reagents with epoxides. Preparation and synthetic applications of Grignard reagent and organozinc compounds.

Module IV: Carbonyl compounds and active methylene groups (8 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. Haloform reaction (mechanism expected).

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

Module V: Carboxylic Acids and Sulphonic Acids (12 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, lactic acid, malic acid and tartaric (structure only). Dicarboxylic acids and blancs rule. 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.

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.

Module VII: Organic reactions mechanism and synthetic application (8 hrs)

Pinacol-pinacolone rearrangement, Riemer-Tiemann reaction, Claisen rearrangement, Benzoin condensation, Perkin's reactions, Wittig reaction, Beckmann rearrangement, Reformatsky reaction (citric acid preparation). Hofmann's bromamide reaction, Schmidt, Curtius and Lossen rearrangement. Mcmurry reaction, Favorski, benzilic acid rearrangement, Baeyer-Villeger reaction.

References

1. R. T. Morrison, R. N. Boyd, Organic Chemistry, 7th Ed., Pearson Education, New Delhi, 2013.
2. I. L. Finar, Organic Chemistry, Vol. I, 5th Ed., Pearson Education, New Delhi, 2013.
3. M. K. Jain, S. C. Sharma, Modern Organic Chemistry, 3rd Ed., Vishal Publishing Company Co., 2010.
4. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, A Textbook of Organic Chemistry, 2nd Ed., Vikas Publishing House, New Delhi, 2004.
5. B. S. Bahl, *Advanced organic Chemistry*, 3rd Ed., S. Chand, 2002.

Further Reading

1. J. Clayden, N. Greeves, S. Warren, P. Wothers, *Organic Chemistry*, Oxford University Press, New York, 2012.
2. P. Y. Bruice, *Essential Organic Chemistry*, 3rd Ed., Pearson Education, 2015.
3. John McMurry, *Organic Chemistry*, 5th Ed., Thompson Asia Pvt Ltd, 2000.
4. C. N. Pillai, *Organic Chemistry*, Universities Press, 2008.
5. R. K. Bansal, *A Textbook of Organic Chemistry*, New Age International, 2010.

Mark Distribution	
Module I	14 Marks
Module II	6 Marks
Module III	8 Marks
Module IV	12 Marks
Module V	13 Marks
Module VI	14 Marks
Module VII	12 Marks

SEMESTER V

Course Code: BCH5B08

Core Course VIII: PHYSICAL CHEMISTRY – II

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

BCH5B08	**PHYSICAL CHEMISTRY– II**		L*	T**	P***	C#
			3	0	0	3
Objectives(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 understand different types of adsorption and isotherms				
	CO3	To understand different types of catalysis				
	CO4	To characterise different molecules using spectral methods.				
	CO5	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. 1. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical Chemistry, 46th Ed., Vishal Publishing Company, New Delhi, 2013.
2. 2. P. W. Atkins, J. de Paula, Atkin's Physical Chemistry, 8th Ed., Oxford University Press, 2006.
3. 3. Donald A. McQuarrie, John D. Simon, Physical Chemistry: A Molecular Approach, University Science Books: Sausalito, CA; 1997.
4. 4. K. Laidler, Chemical Kinetics, 3rd Ed., Pearson Education, New Delhi, 2004.
5. 5. P. L. Soni, O. P. Dharmarha, U. N. Dash, Textbook of Physical Chemistry, 23rd Ed., Sultan Chand & Sons, New Delhi, 2011.
6. 6. K. L. Kapoor, Physical Chemistry, Vol. II and III, Macmillan Publishers, Noida, 2004.

Further reading

1. 1. Gordon M. Barrow, Physical Chemistry, 5th Ed., Tata McGraw Hill Education, New Delhi, 2006.
2. 2. S. Glasstone, D. H. Lewis, Elements of Physical Chemistry, 2nd Ed., Macmillan & Company, UK, 1962.
3. 3. F. Daniels, R. A. Alberty, Physical Chemistry, 5th Ed., John Wiley and Sons, Canada, 1980.
4. P. W. Atkins, J. de Paula, The Elements of Physical Chemistry, 7th Ed., 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. 1. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical Chemistry, 46th Ed., Vishal Publishing Company, New Delhi, 2013.
2. 2. P. W. Atkins, J. de Paula, Atkin's Physical Chemistry, 8th Ed., Oxford University Press, 2006.

3. 3. Donald A. McQuarrie, John D. Simon, Physical Chemistry: A Molecular Approach, University Science Books: Sausalito, CA; 1997.
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1. 1. Gordon M. Barrow, Physical Chemistry, 5th Ed., Tata McGraw Hill Education, New Delhi, 2006.
2. 2. K. L. Kapoor, Physical Chemistry, Vol. II and III, Macmillan Publishers, Noida, 2004.
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4. 4. F. Daniels, R. A. Alberty, Physical Chemistry, 5th Ed., John Wiley and Sons, Canada, 1980.
5. 5. P. W. Atkins, J. de Paul,a The Elements of Physical Chemistry, 7th Ed., 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. 1. B. R. Puri, L. R. Sharma, M. S. Pathania, *Principles of Physical Chemistry*, 46th Ed., Vishal Publishing Company, New Delhi, 2013.
2. 2. P. W. Atkins, J. de Paula, *Atkin's Physical Chemistry*, 8th Ed., Oxford University Press 2006.
3. 3. Donald A. McQuarrie, John D. Simon, *Physical Chemistry: A Molecular Approach*, University Science Books: Sausalito, CA; 1997.
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5. 5. G. M. Barrow, *Introduction to Molecular Spectroscopy*, McGraw Hill, London, 1962.

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1. 1. G. M. Barrow, *Physical Chemistry*, 5th Ed., Tata McGraw Hill Education, New Delhi, 2006.
2. 2. K. L. Kapoor, *Physical Chemistry*, Vol. II and III, Macmillan Publishers, Noida, 2004.
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6. 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 Ed., 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. 1. B. R. Puri, L. R. Sharma, M. S. Pathania, *Principles of Physical Chemistry*, 46th Ed., Vishal Publishing Company, New Delhi, 2013.
2. 2. P. W. Atkins, J. de Paula, *Atkin's Physical Chemistry*, 8th Ed., Oxford University Press, 2006.
3. 3. Donald A. McQuarrie, John D. Simon, *Physical Chemistry: A Molecular Approach*, University Science Books: Sausalito, CA; 1997.
4. 4. K. K. Rohatgi-Mukherjee, *Fundamentals of Photochemistry*, New Age International, 1978.

Further reading

1. 1. G. M. Barrow, Physical Chemistry, 5th Ed., Tata McGraw Hill Education, New Delhi, 2006.
2. 2. K. L. Kapoor, Physical Chemistry, Vol. II and III, Macmillan Publishers, Noida, 2004.
3. 3. S. Glasstone, D. H. Lewis, Elements of Physical Chemistry, 2nd Ed., Macmillan & Company, UK, 1962.
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5. 5. Peter Atkins, Julio de Paula, The Elements of Physical Chemistry, 7th Ed., Oxford University Press, Oxford, 2016.
6. 6. K. Laidler, Chemical Kinetics, 3rd Ed., 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: BCH6B09

Core Course IX: INORGANIC CHEMISTRY – IV

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

BCH6B09	**INORGANIC CHEMISTRY– IV**		L*	T**	P***	C#
			3	0	0	3
Objectives(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 understand the basic reactions in Non aqueous solvents				
	CO3	To distinguish between lanthanides and actinides.				
	CO4	To appreciate the importance of Crystal field theory.				
	CO5	To distinguish geometries of coordination compounds.				
	CO6	To understand the importance of metals in living systems.				

Module I: Instrumental Methods of Analysis (6 hrs)

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

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

References

1. D. A. Skoog, F. James Holler, S. R. Crouch, *Principles of Instrumental Analysis*, 6thEd., 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 Ed., 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 Ed.,Saunders College Publishing, Fort Worth, 1992.
2. D. C. Harris, Quantitative Chemical Analysis, 5th Ed., W. H. Free-man and Company,NewYork, 1999.

Module II: Non-aqueous Solvents (3 hrs)

[Prerequisites: Self-ionization of water.]

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

References

1. Christian Reichardt, Thomas Welton, Solvents and solvent effect in organic chemistry,Wiley-VCH Verlag GmbH & Co., 2002.

Further reading

1. Sisler, Harry Hall, *Chemistry in non-aqueous solvents*, Reinhold, New York, 1961.

Module III: 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 generalcharacteristics.]*

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 MetallicBonding: Free electron theory, valence bond theory and band theory (qualitative treatment only).

Lanthanides: Occurrence of lanthanides– 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 Ed., Wiley India Pvt. Ltd., 2008.
2. B. R. Puri, L. R. Sharma, K. C. Kalia, *Principles of Inorganic Chemistry*, MilestonePublishers, New Delhi, 2010.
3. J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, *Inorganic Chemistry*, Pearson,2006.

Further reading

1. F. A. Cotton, G. Wilkinson, *Advanced Inorganic Chemistry*, 6th Ed., John Wiley, NewYork. 1999.
2. D. F. Shriver, P. W. Atkins, *Inorganic Chemistry*, 3rd Ed., Oxford University Press,2009.

Module IV: Coordination Chemistry (16 hrs)

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

Isomerism in coordination compounds –Structural isomerism and stereo isomerism . Chelates, chelate effect-Stability of complexes: Inert and labile complexes – Factors influencing stability.

Review of Werner's theory and Sidgwick's concept of coordination – EAN rule- Bonding theories: Valence bond theory - Geometries of coordination numbers IV and VI – Inner orbital and outer orbital complexes- 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. – Jahn Teller Effect– Jahn –Teller distortion in Cu(II) complexes. Spectrochemical series - Explanation of geometry, magnetism and spectral properties - Merits and demerits of Crystal field theory. Term symbols - Calculation of magnetic moments – spin only formula. Application of complexes in qualitative and quantitative analysis.

References

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

Further reading

1. F. A. Cotton, G. Wilkinson, *Advanced Inorganic Chemistry,* 6th Ed., 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 Ed., Pearson Education, New Delhi, 2013.
3. D. F. Shriver, P. Atkins, *Inorganic Chemistry*, 5th Ed., Oxford University Press, NewYork, 2010.
4. F. Basolo, R. C. Johnson, *Coordination Chemistry*, 2nd Ed., Science Reviews, Wilmington, 1986.
5. G. L. Meissler, D. A. Tarr, *Inorganic Chemistry*, 3rd Ed., Pearson Education, 2004.

Module V: Organometallic Compounds (8 hrs)

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

Definition – Classification based on the nature of metal-carbon bond and on the basis of hapticity. Naming of organometallic compounds. The 18- electron rule and stability – Ferrocene: Preparation, properties and bonding (VBT only). Metal-alkene complexes –Zeise's salt.

Catalytic properties of organometallic compounds - Zeigler Natta catalyst in the polymerization of alkene and Wilkinson catalyst in the hydrogenation of alkene (mechanism not expected).

Metal Carbonyl-Bonding in metal carbonyls. Preparation and properties of mononuclear carbonyls - Structures of Mo $(CO)_6$, $Fe(CO)_5$ and $Ni(CO)_4$. Structure of Mn_2CO_{10} and $Co_3(CO)_{12}$.

References

1. P. Powell, Principles of Organometallic Compounds, 2nd Ed., Chapman and Hall,London, 1988.
2. B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, 31st Ed.,Milestone Publishers, New Delhi 2010.
3. G. L. Meissler, D. A. Tarr, Inorganic Chemistry, 3rd Ed., 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 VI: Bioinorganic Chemistry (7 hrs)

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

Essential and trace elements in biological systems –Evolution of bioinorganic chemistry as a branch. Biological functions and toxicity of metals – Fe, Cu, Zn, Cr, Mn, Ni, Co, Cd, Hg and Pb. Structure and functions of haemoglobin and myoglobin, and Cobalamines. Metalloenzymes of zinc-carbonic anhydrase, carboxy peptidase, alcohol dehydrogenase. Cytochrome (structural feature). Na/K pump. Chlorophyll and photosynthesis (mechanism not expected)

Treatment of metal toxicity by chelation therapy - Anti cancer drugs – cis platin and carboplatin– Structure and significance.

References

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

Further reading

1. B. Douglas, D. Mc Daniel, J. Alexander, *Concepts and models of Inorganic Chemistry*,3rd Ed., 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	10 Marks
Module II	8Marks
Module III	12 Marks
Module IV	24 Marks
Module V	12 Marks
Module VI	14 Marks

SEMESTER VI

Course Code: BCH6B10

Core Course X: ORGANIC CHEMISTRY – III

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

BCH6B10	**ORGANIC CHEMISTRY– III**		L*	T**	P***	C#
			3	0	0	3
Objectives(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 use of alkaloids and terpenes.				
	CO5	To distinguish different pericyclic reactions.				

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

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

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

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 – Chemical and magnetic equivalence 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, Isomers of dichlorobenzene and xylenes.

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).

References

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

2. 2. Y. R. Sharma, *Elementary Organic Spectroscopy*, 5th Ed., S. Chand & Company Ltd., New Delhi, 2013.
3. 3. D. L. Pavia, G. M. Lampman, G. S. Kriz, *Introduction to Spectroscopy*, 5th Ed., Thomson Brooks Cole, 2015.
4. 4. Paula Y. Bruice, *Organic Chemistry*, 7rd Ed., Pearson Education, Asia, 2013.

Further reading

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

Module II: Bioorganic compounds - 1 (8 hrs)

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

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

Further reading

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

Module III: Bioorganic compounds - 2 (15 hrs)

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

Proteins: Amino acids: Synthesis (Strecker synthesis and amino malonate synthesis). Peptides and Proteins – Structure determination of peptides: Edmann degradation and Sanger's methods. Amino and carboxy protecting groups in peptide synthesis, 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.

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: Fat soluble and water soluble vitamins – Vitamin A, B, C, D, E, K - 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 Ed., Vishal Publishing Company Co., 2010.
3. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, A Textbook of Organic Chemistry, 2nd Ed., Vikas Publishing House, New Delhi, 2004.
4. R. T. Morrison, R. N. Boyd, Organic Chemistry, 7th Ed., Pearson Education, New Delhi, 2013.

Further reading

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

Module IV: Heterocyclic compounds and Natural products (7 hrs)

[Prerequisites: Structure of heterocyclic systems.]

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

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. 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 Ed., Vikas Publishing House, New Delhi, 2004.
3. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Ed., Vishal Publishing Company Co., 2010.
4. R. T. Morrison, R. N. Boyd, *Organic Chemistry*, 7th Ed., Pearson Education, New Delhi, 2013.
5. P. Y. Bruice, *Essential Organic Chemistry*, 3rd Ed., Pearson Education, 2015.

Further reading

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

Module V: 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).

Structural problems on pericyclic reactions.

References

1. Peter Sykes, *A Guide book to Mechanism in Organic Chemistry*, 6th Ed., Pearson Education, New Delhi, 2013.
2. P. S. Kalsi, *Organic Reactions, Stereochemistry and Mechanisms*, 4th Ed., New Age International Publishers, New Delhi, 2006.
3. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Ed., Vishal Publishing Company Co., 2010.
4. P. Y. Bruice, *Essential Organic Chemistry*, 3rd Ed., Pearson Education, 2015.
5. Jagdamba Singh, Jaya Singh, *Photochemistry and Pericyclic Reactions*, 3rd Ed., New Age Science Ltd., New Delhi, 2009.

Further Reading

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

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

SEMESTER VI

Course Code: BCH6B11

Core Course XI: PHYSICAL CHEMISTRY – III

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

BCH6B11	**PHYSICAL CHEMISTRY– III**		L*	T**	P***	C#
			3	0	0	3
Objectives(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 understand the concept of buffer solutions.				
	CO4	To relate the properties of materials/solids to the geometrical properties and chemical compositions.				
	CO5	To understand the different types of defects in solids				

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.]

Ionic mobility – relation with ion conductivity, influence of temperature on ion conductivity, ion conductivity and viscosity – Walden's rule, influence of dielectric constant of solvent on ion conductivity. Abnormal ion conductivity of hydrogen and hydroxyl ions.

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. 1. B. R. Puri, L. R. Sharma, M. S. Pathania, *Principles of Physical Chemistry*, 46th Ed., Vishal Publishing Company, New Delhi, 2013.
2. 2. P. W. Atkins, J. de Paula, *Atkin's Physical Chemistry,* 8th Ed., Oxford University Press, 2006.
3. 3. Donald A. McQuarrie, John D. Simon, *Physical Chemistry: A Molecular Approach* University Science Books: Sausalito, CA; 1997.
4. 4. S. Glasstone, *An Introduction to Electrochemistry*, East-West Press Pvt. Ltd., New Delhi, 2007.

Further reading

1. 1. G. M. Barrow, Physical Chemistry, 5th Ed., Tata McGraw Hill Education, New Delhi, 2006.
2. 2. K. L. Kapoor, Physical Chemistry, Vol. II and III, Macmillan Publishers, Noida, 2004.
3. 3. S. Glasstone, D. H. Lewis, Elements of Physical Chemistry, 2nd Ed., Macmillan & Company, UK, 1962.
4. 4. F. Daniels, R. A. Alberty, Physical Chemistry, 5th Ed., John Wiley and Sons, Canada, 1980.
5. 5. Peter Atkins, Julio de Paula, The Elements of Physical Chemistry, 7th Ed., Oxford University Press, Oxford, 2016.
6. 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. 1. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical Chemistry, 46th Ed., Vishal Publishing Company, New Delhi, 2013.
2. 2. P. W. Atkins, J. de Paula, Atkin's Physical Chemistry, 8th Ed., Oxford University Press, 2006.
3. 3. Donald A. McQuarrie, John D. Simon, Physical Chemistry: A Molecular Approach, University Science Books: Sausalito, CA; 1997.
4. 4. P. L. Soni, O. P. Dharmarha, U. N. Dash, Textbook of Physical Chemistry, 23rd Ed., Sultan Chand & Sons, New Delhi, 2011.

Further reading

1. G. M. Barrow, Physical Chemistry, 5th Ed., Tata McGraw Hill Education, New Delhi, 2006.
2. 2. K. L. Kapoor, Physical Chemistry, Vol. II and III, Macmillan Publishers, Noida, 2004.
3. 3. S. Glasstone, D. H. Lewis, Elements of Physical Chemistry, 2nd Ed., Macmillan & Company, UK, 1962.
4. F. Daniels, R. A. Alberty, Physical Chemistry, 5th Ed., John Wiley and Sons, Canada, 1980.

Module IV: Ionic Equilibria (3 hrs)

[Prerequisites: Introduction to acid base theories – pKa, pKb and pH – Buffer solutions.]

Hard and soft acids and bases, HSAB principle and its applications

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 Kw - Solubility product and common ion effect and applications.

References

1. 1. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical Chemistry, 46th Ed., Vishal Publishing Company, New Delhi, 2013.
2. 2. P. W. Atkins, J. de Paula, Atkin's Physical Chemistry, 8th Ed., Oxford University Press, 2006.
3. 3. Donald A. McQuarrie, John D. Simon, Physical Chemistry: A Molecular Approach, University Science Books: Sausalito, CA; 1997.
4. 4. P. L. Soni, O. P. Dharmarha, U. N. Dash, Textbook of Physical Chemistry, 23rd Ed., Sultan Chand & Sons, New Delhi, 2011.

Further reading

1. 1. G. M. Barrow, Physical Chemistry, 5th Ed., Tata McGraw Hill Education, New Delhi, 2006.
2. 2. K. L. Kapoor, Physical Chemistry, Vol. II and III, Macmillan Publishers, Noida, 2004.
3. 3. S. Glasstone, D. H. Lewis, Elements of Physical Chemistry, 2nd Ed., Macmillan & Company, UK, 1962.
4. 4. F. Daniels, R. A. Alberty, Physical Chemistry, 5th Ed., John Wiley and Sons, Canada, 1980.
5. 5. Peter Atkins, Julio de Paula, The Elements of Physical Chemistry, 7th Ed., 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 9naCl 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. 1. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical Chemistry, 46th Ed., Vishal Publishing Company, New Delhi, 2013.
2. 2. P. W. Atkins, J. de Paula, Atkin's Physical Chemistry, 8th Ed., Oxford University Press, 2006.
3. 3. Donald A. McQuarrie, John D. Simon, Physical Chemistry: A Molecular Approach, University Science Books: Sausalito, 1997.
4. 4. Anthony R. West, Solid State Chemistry and its Applications, 2nd Ed., Wiley-Blackwell, 2014.

Further reading

1. 1. Gordon M. Barrow, Physical Chemistry, 5th Ed., Tata McGraw Hill Education, New Delhi, 2006.
2. 2. K. L. Kapoor, Physical Chemistry, Vol. II and III, Macmillan Publishers, Noida, 2004.
3. 3. S. Glasstone, D. H. Lewis, Elements of Physical Chemistry, 2nd Ed., Macmillan & Company, UK, 1962.
4. 4. F. Daniels, R. A. Alberty, Physical Chemistry, 5th Ed., John Wiley and Sons, Canada, 1980.
5. 5. Peter Atkins, Julio de Paula, The Elements of Physical Chemistry, 7th Ed., Oxford University Press, Oxford, 2016.
6. 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: BCH6B12

Core Course XII: ADVANCED AND APPLIED CHEMISTRY

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

BCH6B12	**ADVANCED AND APPLIED CHEMISTRY**		L*	T**	P***	C#
			3	0	0	3
Objectives(s)	To initiate the students to the role and opportunities of chemistry as a discipline in modern civilization.					
Course outcome(s)	**CO1**	To understand nanomaterials and their importance.				
	CO2	To appreciate the importance of green approach in chemistry.				
	CO3	To understand the uses and importance of computational calculations in molecular design.				
	CO4	To understand the role of chemistry in human happiness index and life expectancy.				
	CO5					

Module I: Chemistry of Nanomaterials (8 hrs)

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

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

Applications of nanomaterials in nanoelectronics, nanosensors, nanocatalysts, nanofilteration, diagnostic and therapeutic applications.

References

1. 1. M. A. Shah, Tokeer Ahmad, *Principles of Nanoscience and Nanotechnology*, Narosa Publishing House, New Delhi, 2010.
2. 2. T. Pradeep, *A Textbook of Nanoscience and Nanotechnology*, McGrawhill, New Delhi, 2012.
3. 3. P. N. Prasad, *Nanophotonics*, John Wiley & Sons, 2004.
4. 4. P. W. Atkins, J. de Paula, *Atkin's Physical Chemistry*, 8th Ed., Oxford University Press, 2006.

Further reading

1. 1. V. S. Muralidharan, A. Subramania, *Nano Science and Technology*, CRC Press, London.
2. 2. V. R. Raghavan, *Materials Science and Engineering*, Prentice Hall (India) Ltd, 2001.
3. 3. Jonathan W. Steed, David R. Turner, Karl J. Wallace, *Core Concepts in Supramolecular Chemistry and Nanochemistry*, John Wiley & Sons Ltd., 2007.

Module II: Green Chemistry (4 hrs)

Birth of green chemistry – need of green chemistry approach – Twelve principles of green chemistry with explanations - Atom economy and microwave assisted reactions – Green solvents – Green synthesis of ibuprofen. Microwave and ultrasound assisted green synthesis: Diels-Alder reaction and Cannizzaro reaction- Introduction to microscale experiments.

References

1. V. K. Ahluwaliya, *Green Chemistry*, Narosa Publishing House, New Delhi, 2011.
2. P. S. Kalsi, J. P. Kalsi, *Bioorganic, Bioinorganic and Supramolecular Chemistry*, 1st Ed., New Age International Publishers (P) Ltd., New Delhi, 2007.
3. W. Bannwarth, B. Hinzen, *Combinatorial Chemistry – From Theory to Application*, 2nd Ed., Wiley-VCH, 2006.
4. Jonathan W. Steed, David R. Turner, Karl J. Wallace, *Core Concepts in Supramolecular Chemistry and Nanochemistry*, John Wiley & Sons Ltd., 2007.

Further reading

1. Paul T. Anastas, T. C. Williamson, Green Chemistry – Designing Chemistry for the Environment, 2nd Ed., 1998.
2. Andrew P. Dicks, Green Organic Chemistry in Lecture and Laboratory, CRC Press, University of Toronto, Ontario, Canada, 2011.
3. Helena Dodziuk, Introduction to Supramolecular Chemistry, Springer, New York, 2002.

Module III: Molecular Recognition and Supramolecular Chemistry (6 hrs)

The concepts of molecular recognition, host, guest and receptor systems. Supramolecular chemistry, Forces involved in molecular recognition. Hydrogen bonding, ionic bonding, pi stacking, van der Waals and hydrophobic interactions. Molecular recognition in DNA and protein structures

Module IV: Introduction to Computational Chemistry (8 hours)

Computational chemistry as a tool and its scope. Classification of computational chemistry methods – Empirical force field models and their use in chemical and biochemical studies- Electronic Structure methods (basic idea of ab initio and semi empirical methods), Potential energy surfaces and the exploration tools available for the location of local and global minima and transition states. Geometry optimization. Software's used in computational chemistry calculations.

Reference

1. 1. I. N. Levine, Quantum Chemistry, 6th Ed., Pearson Education Inc., 2009.
2. 2. Frank Jensen, *Introduction to Computational Chemistry*, John Wiley & Sons Ltd., 1999.
3. 3. C. J. Cramer, *Essentials of Computational Chemistry: Theories and models*, John Wiley & Sons, 2002.
4. 4. P. W. Atkins, *Molecular Quantum Mechanics*, Oxford University Press, New York, 2005.
5. 5. R. K. Prasad, *Quantum Chemistry*, Oscar Publications, New Delhi, 2000.

Further reading

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

Module V: Medicinal Chemistry (8 hours)

Health and Biochemical Analysis: Biochemical analysis of urine and serum. Blood: Composition, grouping and Rh factor - Blood transfusion

Drugs (chemical, generic and trade names with examples). Terminology: Prodrug, pharmacy, pharmacology, pharmacodynamics and pharmacokinetics (elementary idea only). Antipyretics, analgesics, antacids, antihistamines, antibiotics, antiseptics, disinfectants (definition and examples, structures not expected) – Preparation of paracetamol and aspirin.

Causes, symptoms and drugs used for the treatment of air-borne diseases (anthrax, chickenpox, influenza, measles and tuberculosis), water and food borne diseases (cholera, dysentery, typhoid fever and hepatitis A), bronchial asthma, kidney stone, diabetes

Medical applications of nanomaterials. Radio diagnosis: Benefits and risks. Biodegradable polymers used in surgical sutures and capsule covers.

References

1. G. Thomas, Fundamentals of Medicinal Chemistry, John Wiley & Sons, London, 2003.
2. Arthur C. Guyton, John E. Hall, Textbook of Medical Physiology, 12th Ed., Saunders, US, 2010.
3. D. J. Abraham, Burger's Medicinal Chemistry and Drug Discovery, Vol.1-6, Wiley , Interscience, Hoboken, NJ, 2003

Further reading

1. S. C. Rastogi, Biochemistry, 2nd Ed., Tata McGraw Hill Publishing Co., New Delhi, 2007.
2. Gurdeep R. Chatwal, Synthetic Drugs, Himalaya Publishing House, Bombay, 1995

Module VI: Industrial Catalysis (8 hours)

Adsorption and catalysis – adsorption and reaction rate – strength of adsorption bond and catalysis, kinetics of heterogeneous catalysis

Preparative methods for heterogeneous catalysts, Determination of surface area and pore structure of catalysts,

Basic concepts in phase transfer catalysis – phase transfer catalyzed reactions

Enzymes – an introduction to enzymes – enzymes as proteins – classification and nomenclature of enzymes

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

References

1. E. Stocchi, Industrial Chemistry, Vol. I, Ellis Horwood Ltd., UK, 1990.
2. J.A. Kent, Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi, 1997.
3. B. K. Sharma, Engineering Chemistry, Goel Publishing House, Meerut, 1997.

Module VII: Food chemistry (6 hrs)

Food adulterants: Common food adulterants in various food materials and their identification: Milk, vegetable oils, tea, coffee powder and chilli powder.

Food additives: Food preservatives, artificial sweeteners and antioxidants (definition and examples, structures not required) – Structure of BHT, BHA and Ajinomoto – Common permitted and non-permitted food colours (structures not required) – Natural pigments in fruits and vegetables (carotenoids, chlorophylls and flavonoids). Artificial ripening of fruits. Composition of chocolate, milk powder and soft drinks.

References

1. B. Sivasankar, Food processing and preservation, Prentice – Hall of India Pvt. Ltd. New Delhi, 2002.
2. K. Singh, Chemistry in Daily Life, Prentice Hall of India, New Delhi, 2008.
3. Srinivasan Damodaran, Kirk L. Parkin, Owen R. Fennema, Food Chemistry, 4th Ed., CRC Press, New York, 2007.

Further reading

1. Encyclopedia of Food Chemistry, Elsevier, 2018
2. B. Srilakshmi, Food Science, 5th Ed., New Age Publishers, New Delhi, 2010

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

SEMESTER VI

Course Code: BCH6E01

Core Course XIII: Elective 1. INDUSTRIAL CHEMISTRY

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

BCH6E01	**INDUSTRIAL CHEMISTRY**		L*	T**	P***	C#
			3	0	0	2
Objectives(s)	To familiarise the students with the role and opportunities of chemistry as a discipline in modern civilization. To create awareness among the students about different chemical industries.					
Course outcome(s)	**CO1**	To understand the requirements of an industry				
	CO2	To understand the importance of petrochemicals.				
	CO3	To appreciate the importance and to familiarise the opportunities of pharmaceutical, leather and sugar industries.				
	CO4	To analyse the role of catalysts in industrial processes.				
	CO5	To understand the use of Textiles, Paints and Pigments in industry				

Module I: Introduction (4 hrs)

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

References

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

Further reading

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

Module II: Petrochemical Industry (12 hrs)

Introduction. Natural gas – CNG, LNG and LPG. Coal: Classification based on carbon content – carbonisation of coal – composition and uses of various fractions. Crude Oil: Constitution and distillation – composition and uses of different distillates – ignition point, flash point and octane number – cracking. Catalysts used in Petroleum Industries: Structure, selectivity and applications.Synthetic Petrol: Manufacture by Bergius and Fischer-Tropsch processes.Manufacture of petrochemicals: Ethylene glycol, glycerine, acetone, phenol, vinyl acetate, toluene, linear alkyl benzenes and their sulphonates.

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

References

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

Further reading

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

Module III: Pharmaceutical Industry (8 hrs)

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

References

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

Further reading

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

Module IV: Industrial Catalysis (6 hrs)

Types of catalysts: Homo catalysis and hetero catalysis – Applications of phase transfer catalysis and nano particle catalysts – Zeigler Natta catalyst and Wilkinson catalyst (mechanism not expected). Applications of raney nickel, platinum, palladium, ruthenium and TiO_2 based catalysts.

References

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

Pub., New Delhi, 1997.

Further reading

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

Module V: Leather and Sugar Industries (8 hrs)

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

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

References

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

Further reading

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

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

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

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

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

References

1. 1. Sara J. Kadolph, Anna L. Langford, *Textiles*, 10th Ed., Pearson/Prentice-Hall, New Delhi, 2007.
2. 2. A. A. Vidya, *Production of Synthetic Fibers*, Prentice-Hall of India, New-Delhi, 1988.

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

SEMESTER VI

Course Code: BCH6E02

Core Course XIII: Elective 2. POLYMER CHEMISTRY

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

BCH6E02	**POLYMER CHEMISTRY**		L*	T**	P***	C#
			3	0	0	2
Objectives(s)	To gain detailed knowledge about the classification of polymers and various mechanisms and technology adopted for polymerisation. To give a basic understanding of the properties of polymers like glass transition temperature, molecular weight and degradation of polymers. To give a detailed idea about different commercial polymers.					
Course outcome(s)	**CO1**	To understand what are macromolecules, their classification				
	CO2	To understand the important characteristics of polymers such as average molecular weight, glass transition temperature, viscoelasticity and degradation.				
	CO3	Able to appreciate the chemistry of different types of polymerisation.				
	CO4	To characterise different commercial polymers and to understand the significance of recycling.				
	CO5	To understand plastic pollution and recycling				
	CO6	Aquire the knowledge of different types polymerisation processes, processing techniques, additives and different type of commercial polymers				

Module I: Introduction (6 hrs)

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

Module II: Types of Polymerisation (9 hrs)

Chain and step growth polymerizations – Free radical, ionic and coordination polymerizations with mechanism – Zeigler-Natta polymerization (mechanism expected) and its advantages – Ring-opening & group transfer polymerization (Mechanism not needed).

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

Glass Transition Temperature (Tg): Definition- Factors affecting Tg - Importance of Tg. Molecular Weight of Polymers: Number average, weight average and viscosity average molecular weights – Poly Dispersity Index and its significance - Molecular weights and degree of polymerisation. Polymer solubility (basic concept only), Viscoelasticity of polymers (basic concept only) - Vulcanisation and cyclisation reactions.

Module IV: Polymerisation Techniques (12 hrs)

Polymerisation Techniques: Bulk, solution, suspension, emulsion, melt condensation and interfacial polycondensation polymerisations. Polymer Processing: Calendering, rotational moulding, compression, injection moulding, blow moulding and thermoforming, Solution, suspension and casting process of plastics

Module V: Polymer Processing (6)

Additives for Plastics and Rubbers- Fillers, Coupling Agents, Plasticisers, Flow promoters, Anti-ageing additives, Falme retarders, Colouring agents, Blowing agents and cross linking agents, (Elemenatry ideas)

Module VI: Commercial Polymers (12 hrs)

Preparation, structure, properties and uses of polyethylene (LDPE and HDPE), polypropylene, polystyrene, PVC, PVP, teflon, PAN, PMMA, synthetic rubbers (BR, SBR, nitrile rubber, neoprene, butyl rubber and silicone rubber), terylene, glyptal, lexan, kevlar, nomex, polyurethanes, melmac, phenol-formaldehyde resin and urea-formaldehyde resin – Plastic identification codes, Recycling of plastics. Polymers in medical field - High temperature and fire-resistant polymers - Conducting polymers - Carbon fibers (basic idea only).

References

1. F.W. Billmeyer Jr., Textbook of Polymer Science, John Wiley & Sons, New Delhi, 2007
2. V. R. Gowarikar, Polymer Chemistry, New Age International Pvt. Ltd., New Delhi, 2010.
3. B. K. Sharma, Polymer Chemistry, Goel Publishing House, Meerut, 1989.
4. M. G. Arora, M. Singh, M. S. Yadav, Polymer Chemistry, 2nd Revised Ed., Anmolpublications Private Ltd., New Delhi, 1989.
5. K. J. Saunders, Organic Polymer Chemistry, 2nd Ed., Chapman and Hall, London, 1988.
6. Malcolm P. Stevens, Polymer Chemistry: An Introduction, 3rd Ed., Oxford University Press, USA, 1998.
7. Gowri Sankar Misra, Introductory Polymer Chemistry, New Age International, New Delhi, 1993.
8. M. S. Bhatnagar, Polymer Chemistry, S Chand and Company Pvt. Ltd., New Delhi, 2014

Further reading

1. R. B. Seymour, C. E. Carraher, Polymer Chemistry: An Introduction, Marcel Dekker, Inc. New York, 1981.
2. G. Odian, Principles of Polymerization, 4th Ed., Wiley, 2004.
3. P. Ghosh, Polymer Science & Technology, Tata McGraw-Hill Education, 1991.
4. R. W. Lenz, Organic Chemistry of Synthetic High Polymers, Interscience Publishers, New York, 1967.
5. M.P.Stevens, *Polymer Chemistry: An Introduction*, 3rd Ed.,Oxford University Press, 2005

Mark Distribution	
Module I	4 Marks
Module II	16 Marks
Module III	16 Marks
Module IV	18 Marks
Module V	6 Marks
Module VI	18 Marks

SEMESTER VI

Course Code: BCH6E03

Core Course XIII: Elective 3. MEDICINAL AND ENVIRONMENTAL CHEMISTRY

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

BCH6E03	**MEDICINAL AND ENVIRONMENTAL CHEMISTRY**		L*	T**	P***	C#
			3	0	0	2
Objectives(s)	To introduce the students to the importance of chemistry in medicinal field and to get ideas about various diseases. To help the students to get information about various toxic substances in environment and their control.					
Course outcome(s)	**CO1**	To understand the importance of drugs in human health.				
	CO2	To understand the facts about common diseases and treatment.				
	CO3	To identify the presence of toxic substances in atmosphere.				
	CO4	To understand air pollution control measures and monitoring techniques				
	CO5	To apply chemistry in treatment of water and sewage.				

Module I: Health and Biochemical Analysis (6 hrs)

Definition of health - WHO standard - Sterilization of surgical instruments - Biochemical analysis of urine and serum. Blood: Composition, grouping and Rh factor - Blood transfusion.

Module II: Drugs (4 hrs)

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

Module III: Common Diseases and Treatment (10 hrs)

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

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

Module IV: Environmental Toxicology (6 hrs)

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

Module V: Control and Monitoring of Air Pollutants (12 hrs)

Air Pollution Control Measures: Gravitational settling chamber, fabric filter, wet scrubber, catalytic converters, stacks and chimneys, cyclone collectors, Cottrell electrostatic precipitator, extraction ventilator, zoning and green belt.

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

Module VI: Water Treatment Processes (10 hrs)

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

References

1. G. Thomas, *Fundamentals of Medicinal Chemistry*, John Wiley & Sons, London, 2003.
2. Arthur C. Guyton, John E. Hall, Textbook of Medical Physiology, 12th Ed., Saunders, US, 2010.
3. D. J. Abraham, *Burger's Medicinal Chemistry and Drug Discovery*, Vol.1-6, Wiley Interscience, Hoboken, NJ, 2003.
4. B. L. Oser, *Hawk's Physiological Chemistry*, Tata McGraw-Hill Publishing Co. Ltd., New Delhi,.
5. S. C. Rastogi, *Biochemistry*, 2nd Ed., Tata McGraw Hill Publishing Co., New Delhi, 2007.
6. Gurdeep R. Chatwal, *Synthetic Drugs*, Himalaya Publishing House, Bombay, 1995.
7. Jayashree Ghosh, *A Textbook of Pharmaceutical Chemistry*, 3rd Ed., S. Chand and Company Ltd., New Delhi, 1999.
8. Rasheeduz Zafar, *Medicinal Plants of India*, 1st Ed., CBS Publishers & Distributors Pvt. Ltd., New Delhi, 2009.
9. A. K. De, *Environmental Chemistry*, 6th Ed., New Age International (P) Ltd., New Delhi, 2006.
10. M. L. Davis, D. A. Cornwell, *Introduction to Environmental Engineering*, 3rd Ed., McGraw Hill, New Delhi, 1998.
11. S. E. Manahan, *Environmental Chemistry*, 8th Ed., CRC Press, Florida, 2004.
12. G. M. Masters, *Introduction to Environmental Engineering and Science*, 3rd Ed., Prentice-Hall

Inc., New Delhi, 2007.
13. A. K. Ahluwalia, *Environmental Chemistry*, Ane Books India, New Delhi, 2008.
14. B. K. Sharma, H. Kaur, *Environmental Chemistry*, Goel Publishing House, Meerut, 1996.

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

SEMESTER VI

Course Code: BCH6B13L

Core Course XIV: PHYSICAL CHEMISTRY PRACTICAL

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

PART-A

BCH6B13L	**PHYSICAL CHEMISTRY PRACTICAL**		L*	T**	P***	C#
			0	0	5	4
Objectives(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 colligative property.				
	CO4	To understand the principles of Viscosity, Spectroscopy, Refractometry, Potentiometry and Conductometry; and to apply the skill to determine unknown concentration				
	CO5	To understand the kinetics of hydrolysis reaction				

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 glycerin-water system and determination of percentage of glycerin 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 (Kf) of solid solvent using a solute of known molecular mass.
2. Determination of molecular mass of the solute using a solvent of known cryoscopic constant (Kf).

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

Module III: Transition Temperature

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

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

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 their 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 Ed., 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 Ed., Brooks/Cole, Thomson Learning, Inc., USA, 2004.
7. P. S. Sindhu, Practicals in Physical Chemistry - A Modern Approach, Macmillan India Ltd., 2006.

PART-B

(I) Computational Chemistry Experiments with Gaussian 16 program.

1. Single point energy calculations of simple molecules like H_2O and NH_3 at the B3LYP /3-21G level of theory
2. Effect of basis set on the computation of H-O-H bond angle in H_2O and NH_3 using the B3LYP method (3-21G, 6-31G, 6-31+G, 6-31+G* basis sets can be used).
3. Geometry optimization of molecules like H_2O, NH_3, HCHO & C_2H_4 at the B3LYP/6-31G* level of theory
4. Computation of dipole and quadrupole moments of HCHO & C_2H_4 at the B3LYP /6-31G level of theory.
5. Comparison of stability of cis- and trans- isomers of difluoroethylene at the B3LYP /6-31G* level of theory.
6. Computation of the energy of HOMO and LUMO of H_2O and NH_3 at the B3LYP /6-31G* level of theory.
7. Comparison of stability of cis-planar and trans-planar conformers of H_2O_2 at the B3LYP /6-31G* level of theory.

(II) Physical chemistry experiments

1. Determination of Activity Coefficient of Silver ions by Potentiometric measurements.
   (a) with transference (b) without transference.
2. Determination of dissociation constant of weak acid.
3. Determination of concentration of an optically active substance by Polarimetric measurements (Glucose/Fructose/Sucrose).
4. Determination of equivalent conductance of strong electrolytes at several concentrations and verification of Onsager equation.
5. Determination of equivalent conductance of weak electrolytes at infinite dilution by using Kohlrausch's law.

SEMESTER VI

Course Code: BCH6B14L

Core Course XV: ORGANIC CHEMISTRY PRACTICAL

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

PART-A

BCH6B14L	**ORGANIC CHEMISTRY PRACTICAL**		L*	T**	P***	C#
			0	0	5	4
Objectives(s)	To empower the students to prepare different compounds without compromising yield. To understand 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. Semi-micro 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.

PART-B

Organic chemistry experiments (8 Hours)

Preparation of drug/intermediates

1. Aspirin
2. Benzimidazole
3. Benzotriazole
4. Sulphanilamide
5. 1,2,3,4-tetrahydrocarbazole

References

1. B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatchell, Vogel's Textbook of Practical Organic Chemistry, 5th Ed., Pearson Education, Noida, 2014.
2. F. G. Mann, B. C. Saunders, Practical Organic Chemistry, 4th Ed., Pearson Education,

Noida, 2011.
3. Arthur I. Vogel, Elementary Practical Organic Chemistry- Small Scale Preparations, 2nd Ed., Pearson Education, Noida, 2013.
4. V. K. Ahluwalia, S. Dhingra, Comprehensive Practical Organic Chemistry, Universities Press, Hyderabad, 2004.

SEMESTER VI

Course Code: BCH6B15L

Core Course XVI: INORGANIC CHEMISTRY PRACTICAL-II

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

BCH6B15L	**INORGANIC CHEMISTRY PRACTICAL-II**		L*	T**	P***	C#
			0	0	5	4
Objectives(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				
	CO3	To enable the student to apply the principles of gravimetry in quantitative analysis				
	CO4	To understand the principles behind colourimetry				
	CO5	To enable the student to apply the principles of colourimetry 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 $K_2Cr_2O_7$ and 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 Ed., 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 Ed., Brooks/Cole, Thomson Learning, USA, 2004.

SEMESTER VI

Course Code: BCH6B16L

Core Course XVII: INORGANIC CHEMISTRY PRACTICAL-III

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

BCH6B16L	INORGANIC CHEMISTRY PRACTICAL-III		L*	T**	P***	C#
			0	0	5	4
Objectives(s)	To develop skill in qualitative analysis of inorganic compounds.					
Course outcome(s)	**CO1**	To enable the students to develop skills in inorganic qualitative analysis.				
	CO2	To understand the reactions of common cations and anions				
	CO3	To understand interfering radicals and their elimination				
	CO4	To understand the principles behind inorganic mixture analysis and to apply it in qualitative analysis.				
	CO5	To analyse systematically mixtures containing two cations and two anions.				

General Instructions

1. Semi-micro 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

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.

Systematic analysis of mixtures containing two cations and two anions from the above list. Na_2CO_3 extract procedure may be adopted.

References

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

SEMESTER VI

Course Code: BCH6B17P

Core Course XVIII: PROJECT WORK

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

BCH6B17P	**PROJECT WORK**		L*	T**	P***	C#
			0	0	2	2
Objectives(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 understand to record scientific observations systematically				
	CO4	To analyse scientific problems systematically.				
	CO5	To understand scientific report writing				

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 Corse 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 internal assessment shall be based on a predetermined transparent system involving written test, class room participation, 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 (20%)	**3**
2	Test papers I (40%)	**6**
3	Assignment (20%)	**3**
4	Seminar/ Viva (20%)	**3**
	Total	**15**

**Viva:* BCH1B01, BCH2B02, BCH3B03, BCH4B04, BCH5B06, BCH6B10, BCH6B11, BCH6B12 and elective course; *Seminar:* BCH5B07, BCH5B08 and BCH6B09.

Test Paper

Table 2: 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 85% = 5, 55 to 65% = 4, 45 to 55% = 3, 35 to 45% = 2, below 35% = 1, Absent = 0.

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.

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

Inorganic Chemistry Practical-I		*Physical Chemistry Practical*	*Organic Chemistry Practical*		*Inorganic Chemistry Practical –II*	*Inorganic Chemistry Practical –III*
Volumetry	*Preparation*		*Analysis*	*Preparation*	Gravimetry / Colourimetry	*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)				

Number of Experiments (Marks in brackets)

2. EXTERNAL EVALUATION

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

PATTERN OF QUESTION PAPERS

Table 1: Inorganic Chemistry Practical – I

Duration	*Pattern*	*Marks*	*Total Marks*
3 Hours	Question on volumetric analysis	8	80
	Procedure 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 standardisation; 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 standardisation 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 recrystallised 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 Mixture***
Volumetry	Preparation		*Analysis*	*Preparation*		
19-20 (6)	6 (2)	14 (8)			10-11 (8)	10 (8)
18 (5)	5 (1)	13 (7)			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	Organisation of report and conclusion (30%)	4.5
4	Viva-voce (30%)	4.5
	Total Marks	**15**

Table 2: External Evaluation

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

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

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

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

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

SYLLABUS FOR COMPLEMENTARY COURSES

CHEMISTRY COMPLEMENTARY COURSE STRUCTURE

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

Semester	*Code No*	*Course Title*	*Hrs/ Week*	*Total Hrs*	*Credit*	*Marks*
I	BCH1C01	Complementary Course I: **General Chemistry**	2	32	2	75
	-	Complementary Course V: **Chemistry Practical**	2	32	-*	-*
II	BCH2C02	Complementary Course II: **Physical Chemistry**	2	32	2	75
	-	Complementary Course V: **Chemistry Practical**	2	32	-*	-*
III	BCH3C03	Complementary Course III: **Organic Chemistry**	3	48	2	75
	-	Complementary Course V: **Chemistry Practical**	2	32	-*	-*
IV	BCH4C04	Complementary Course IV: **Physical and Applied Chemistry**	3	48	2	75
	BCH4C05L	Complementary Course V: **Chemistry Practical**	2	32	4	100
Total					12	400

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

SEMESTER I

Course Code: BCH1C01

Complementary Course I: GENERAL CHEMISTRY

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

BCH1C01	**GENERAL CHEMISTRY**	L*	T**	P***	C#
		2	0	0	2
Objectives(s)	To provide the students a thorough knowledge about the chemistry of quantitative and qualitative analysis and the theories of chemical bonding. It will also impart the ideas about atomic nucleus and the importance of metals in biological systems.				
Course outcome(s)	**CO1**	To understand and to apply the theories of quantitative and qualitative analysis.			
	CO2	To understand the theories of chemical bonding.			
	CO3	To appreciate the uses of radioactive isotopes.			
	CO4	To understand the importance of metals in biological systems.			

Module I: Analytical Chemistry (10 hrs)

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

Theory of volumetric analysis – Acid-base, redox and complexometric titrations – Acid-base, redox and complexometric indicators. Double burette method of titration: Principle and advantages. Principles in the separation of cations in qualitative analysis - Applications of common ion effect and solubility product - Microanalysis and its advantages.

Accuracy & Precision (mention only).

References

1. 1. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, Vogel's Textbook of Quantitative Chemical Analysis, 6th Ed., Pearson Education, Noida, 2013.
2. G.Svehla, Vogel's Qualitative Inorganic Analysis, 7th Ed., Prentice Hall, New Delhi, 1996

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

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

Chemical Bonding: Introduction – Type of bonds. Ionic bond: Factors favouring the formation of ionic bonds - Lattice energy of ionic compounds and its application. Covalent bond: Lewis theory – Coordinate bond. VSEPR theory: Shapes of $BeCl_2$, BF_3, $SnCl_2$, CH_4, NH_3, H_2O, NH_4^+, SO_4^{2-}, PCl_5, SF_4, ClF_3, XeF_2, SF_6, IF_5, XeF_4, IF_7 and XeF_6. Valence Bond theory - Hybridisation involving s, p and d orbitals: sp (acetylene), sp^2 (ethylene), sp^3 (CH_4),

sp^3d (PCl_5), sp^3d^2 (SF_6). Molecular Orbital theory: LCAO – Electronic configuration of H_2, B_2, C_2, N_2, O_2 and CO – Calculation of bond order – determination of HOMO and LUMO – Explanation of bond length and bond strength. Intermolecular forces - Hydrogen bonding in H_2O - Dipole-dipole interactions.

References

1. C. N. R. Rao, *Understanding Chemistry*, Universities Press India Ltd., Hyderabad, 1999.
2. RK. Prasad, *Quantum Chemistry*, 4th Ed., New Age International Ltd., New Delhi, 2012
3. 3. Manas Chanda, *Atomic Structure and Chemical Bonding*, 4th Ed., Tata McGraw Hill Publishing Company, Noida, 2007.
4. 4. R. Puri, L. R. Sharma K. C. Kalia, *Principles of Inorganic Chemistry*, 31st Ed., Milestone Publishers and Distributors, New Delhi, 2013.

Module III: Nuclear Chemistry (6 hrs)

Natural radioactivity – Modes of decay – Group displacement law.

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

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

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

References

1. 1. H. J. Arnikar, *Essentials of Nuclear Chemistry*, 4th Ed., New Age International (P) Ltd., New Delhi, 2005.
2. 2. R. Gopalan, *Elements of Nuclear Chemistry*, Vikas Publ. House, 2000.

Module IV: Bioinorganic Chemistry (6 hrs)

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

References

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

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

SEMESTER II

Course Code: BCH2C02

Complementary Course II: PHYSICAL CHEMISTRY

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

BCH2C02	**PHYSICAL CHEMISTRY**		L*	T**	P***	C#
			2	0	0	2
Objectives(s)	To provide the students a thorough knowledge about different terminologies in thermodynamics and the continuity between different states of matter. To impart an idea about the basic principles of electrochemistry.					
Course outcome(s)	**CO1**	To understand the importance of free energy in defining spontaneity.				
	CO2	To realise the theories of different states of matter and their implication.				
	CO3	To understand the basic principles of electrochemistry.				
	CO4	To understand Buffer solutions.				

Module I: Thermodynamics (6 hrs)

Definition of thermodynamic terms - System – Surroundings - Types of systems.

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

References

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

Module II: Gaseous and Solid States (10 hrs)

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

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

References

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

Module III: Liquid State and Solutions (6 hrs)

Liquid State: Introduction - Vapour pressure, surface tension and viscosity – Explanation of these properties on the basis of intermolecular attraction.

Solutions: Kinds of solutions - Solubility of gases in liquids – Henry's law and its applications - Colligative properties - Osmotic pressure - Laws of osmotic pressure - Reverse osmosis and its applications - Determination of molecular mass using colligative properties.

References

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

Module IV: Electrochemistry (10 hrs)

Specific conductance, equivalent conductance and molar conductance - Variation of conductance with dilution - Kohlrausch's law - Degree of ionization of weak electrolytes - Application of conductance measurements – Conductometric titrations.

Galvanic cells - Cell and electrode potentials - IUPAC sign convention – Reference electrodes – Standard Hydrogen electrode – Calomel electrode - Standard electrode potential - Nernst equation - H_2-O_2 fuel cell.

Ostwald's dilution law – Buffer solutions – Buffer action [acetic acid/sodium acetate & NH_4OH/NH_4Cl], applications of buffers.

References

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

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

IV	Marks

SEMESTER III

Course Code: BCH3C03

Complementary Course III: ORGANIC CHEMISTRY

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

BCH3C03	**ORGANIC CHEMISTRY**		L*	T**	P***	C#
			3	0	0	2
Objectives(s)	To provide the students a thorough knowledge about basic theory and concepts of organic chemistry.					
Course outcome(s)	**CO1**	To understand the basic concepts involved in reaction intermediates.				
	CO2	To realise the importance of optical activity and chirality.				
	CO3	To appreciate the importance of functional groups and aromatic stability.				
	CO4	To understand the basic structure and importance of carbohydrates, nucleic acids, alkaloids and terpenes.				

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

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

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

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

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

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

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

References

1. 1. Peter Sykes, A Guide book to Mechanism in Organic Chemistry, 6th Ed., Pearson Education, New Delhi, 2013.
2. 2. P. S. Kalsi, Organic Reactions, Stereochemistry and Mechanisms, 4th Ed., New Age International Publishers, New Delhi, 2006.
3. 3. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, A Textbook of Organic Chemistry, 2nd Ed., Vikas Publishing House, New Delhi, 2004.

4. 4. M. K. Jain, S. C. Sharma, Modern Organic Chemistry, 3rd Ed., Vishal Publishing Company Co., 2010.
5. 5. R. T. Morrison, R. N. Boyd, Organic Chemistry, 7th Ed., Pearson Education, New Delhi, 2013.
6. 6. I. L. Finar, *Organic Chemistry*, Vol. I, 5th Ed., Pearson Education, New Delhi, 2013.

Module II: Stereochemistry (6 hrs)

Conformations: Conformations of ethane, cyclohexane and methylcyclohexane – Explanation of stability.

Geometrical Isomerism: Definition – Condition – Geometrical isomerism in but-2-ene and but-2-ene-1,4-dioic acid – Methods of distinguishing geometrical isomers using melting point and dipole moment.

Optical Isomerism: Optical activity – Chirality – Enantiomers – Meso compounds – Diastereoisomers – Optical isomerism in lactic acid and tartaric acid.

References

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

Module III: Aromatic Hydrocarbons (5 hrs)

Nomenclature and isomerism in substituted benzene. Structure and stability of benzene: Kekule, resonance and molecular orbital description.

Mechanism of aromatic electrophilic substitution: Halogenation, nitration, sulphonation and Friedel-Craft's reactions – orientation effect of substituents.

Aromaticity and Huckel's rule: Application to benzenoid (benzene, naphthalene and anthracene) and nonbenzenoid (pyrrole, pyridine and indol) aromatic compounds.

References

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

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

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

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

Phenols: Preparation from chlorobenzene – Comparison of acidity of phenol, *p*-nitrophenol and *p*-methoxyphenol – Preparation and uses of phenolphthalein.

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

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

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

Amines: Preparation from nitro compounds – Hofmann's bromamide reaction – Hofmann's carbylamines reaction. Basicity: Comparison of basicity of ammonia, methyl amine and aniline.

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

References

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

Module VI: Biomolecules (8 hrs)

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

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

Enzymes: Characteristics and examples.

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

References

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

3. 3. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Ed., Vishal Publishing Company Co., 2010.
4. 4. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Ed., Vikas Publishing House, New Delhi, 2004.

Moldule VII: Alkaloids and Terpenes (3 hrs)

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

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

Note: Structural elucidation not expected in any case.

References

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

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

SEMESTER IV

Course Code: BCH4C04

Complementary Course IV: PHYSICAL AND APPLIED CHEMISTRY

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

BCH4C04	PHYSICAL AND APPLIED CHEMISTRY	L*	T**	P***	C#
		3	0	0	2
Objectives(s)	To provide the students a thorough knowledge about colloidal chemistry, nanochemistry and the importance of chemistry in daily life. It also provides a basic idea related to separation and spectral techniques. It also imparts the idea of green processes with special emphasis on environment.				
Course outcome(s)	**CO1**	To understand the basic concepts behind colloidal state and nanochemistry.			
	CO2	To understand the importance of green chemistry			
	CO3	To appreciate different separation methods and spectral techniques.			
	CO4	To understand the extent of chemistry in daily life.			

Module I: Colloidal Chemistry (6 hrs)

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

References

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

Module II: New Vistas in Chemistry (6 hrs)

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

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

References

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

Module III: Chromatography (6 hrs)

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

References

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

Module IV: Spectroscopy (10 hrs)

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

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

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

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

References

1. 1. P. S. Kalsi, *Applications of Spectroscopic Techniques in Organic Chemistry*, 6th Ed., New Age International (P) Ltd., New Delhi, 2004.
2. 2. C. N. Banwell, E. M. Mc Cash, *Fundamentals* of *Molecular Spectroscopy*, 4th Ed., McGraw–Hill publishing Company Limited, New Delhi, 2002.

Module V: Polymers (4 hrs)

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

References

1. V. R. Gowarikar, *Polymer Chemistry*, New Age International Pvt. Ltd., New Delhi, 2010

2. 2. Fred. W. Billmeyer, *Textbook of Polymer Science*, 3rd Ed., Wiley India, Delhi, 2008.

Module VI: Environmental Pollution (6 hrs)

Definition – Types of pollution.

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

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

Soil pollution – Pollution due to plastics. Thermal pollution and radioactive pollution: Sources, effects and control measures.

References

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

Module VII: Chemistry in Daily Life (10 hrs)

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

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

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

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

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

References

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

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

Module VI	10 Marks
Module VII	17 Marks

SEMESTER IV

Course Code: BCH4C05L

Complementary Course V: CHEMISTRY PRACTICAL

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

BCH4C05L	**CHEMISTRY PRACTICAL**		L*	T**	P***	C#
			2	0	2	4
Objectives(s)	To develop proficiency in quantitative and qualitative analysis and expertise in organic preparation and determination of physical constants.					
Course outcome(s)	**CO1**	To understand the reactions of common cations				
	CO2	To understand the basic concepts of inter group separation and cation solution analysis				
	CO3	To understand various volumetric estimation techniques				
	CO4	To enable the students to develop analytical and preparation skills.				

General Instructions

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

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

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

Module II: Volumetric Analysis

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

Permanganometry:

a. Estimation of oxalic acid.
b. Estimation of Fe^{2+}/$FeSO_4.7H_2O$/Mohr's salt.

Dichrometry:

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

Iodimetry and Iodometry:

a. Estimation of iodine.
b. Estimation of copper.
c. Estimation of chromium.

5. Complexometric Titrations
    a. Estimation of zinc.
    b. Estimation of magnesium.
    c. Determination of hardness of water.

Module III: Gravimetric Analysis

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

Module IV: Inorganic Qualitative Analysis

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

Module V: Determination of Physical Constants

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

Module VI: Organic Preparations

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

References

1. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Ed., Pearson Education, Noida, 2013.
2. D. A. Skoog, D. M. West, F. J. Holler, S. R. Crouch, *Fundamentals of Analytical Chemistry*, 8th Ed., Brooks/Cole, Thomson Learning, USA, 2004.
3. V. K. Ahluwalia, Sunita Dhingra, Adarsh Gulati, *College Practical Chemistry*, Universities Press (India) Pvt. Ltd., Hyderabad, 2008 (Reprint).
4. G. Svehla, *Vogel's Qualitative Inorganic Analysis*, 7th Ed., Prentice Hall, New Delhi, 1996.
5. V. V. Ramanujam, *Inorganic Semi Micro Qualitative Analysis*, 3rd Ed., The National Publishing Company, Chennai, 1974.
6. W. G. Palmer, *Experimental Inorganic Chemistry*, Cambridge University Press, 1970.

EVALUATION SCHEME FOR COMPLEMENTARY COURSES

Complementary Course Theory: Evaluation Scheme

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

1. INTERNAL EVALUATION

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

Table 1: Components of Evaluation

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

Test Paper

Table 2: 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, Absent = 0 mark.

2. EXTERNAL EVALUATION

External evaluation carries 80% marks (60 mark). University examinations for two hours duration will be conducted at the end of each semester.

Table 1: Pattern of Question Papers

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

Complementary Course Practical: Evaluation Scheme

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

1. INTERNAL EVALUATION

20% of the total marks are for internal evaluation.

Table 1: Components of Evaluation

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

Table 2: Number of Experiments and Marks for Practical Records

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

2. EXTERNAL EVALUATION

External evaluation carries 80% marks. Practical examination will be conducted at the end of 4^{th} semester.

Table 1: Pattern of Question Paper

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

Guidelines

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

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

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

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

Table 2: Evaluation of Records

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

SYLLABUS FOR OPEN COURSES

OPEN COURSE STRUCTURE

(FOR STUDENTS OTHER THAN B.Sc. CHEMISTRY) Total Credits: 3
(Internal 20%; External 80%)

Semester	*Code No*	*Course Title*	*Hrs/ Week*	*Total Hrs*	*Marks*
V	BCH5D01	Open Course 1: Environmental Chemistry	3	48	75
	BCH5D02	Open Course 2: Chemistry in Daily Life			
	BCH5D03	Open Course 3: Food Science and Medicinal Chemistry			

SEMESTER V

Course Code: BCH5D01

Open Course 1: ENVIRONMENTAL CHEMISTRY

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

BCH5D01	ENVIRONMENTAL CHEMISTRY		L*	T**	P***	C#
			3	0	0	2
Objectives(s)	To introduce various types of pollutions To understand water quality and water quality parameters To appreciate the importance chemistry in agriculture, food industry, cosmetics, and cleaning.					
Course outcome(s)	**CO1**	Recall the technical/scientific terms involved in pollution.				
	CO2	Understand the causes and effects of air pollution				
	CO3	Understand the sources, types and effects of water pollution.				
	CO4	Describe water quality parameters.				
	CO5	Know soil, noise, thermal and radioactive pollutions and their effects.				
	CO6	Study various pollution control measures.				
	CO7	Understand the basics of green chemistry.				

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

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

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

References

1. 1. A. K. De, *Environmental Chemistry*, 7th Ed., New Age International, 2012.
2. 2. A. K. Ahluwalia, *Environmental Chemistry*, The Energy and Resources Institute, 2017.
3. 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. 1. S. K. Banergy, *Environmental Chemistry*, 2nd Ed., Prentice-Hall of India Pvt. Ltd.,

New Delhi, 2005.
2. 2. V. N. Bashkin, *Environmental Chemistry: Asian Lessons*, Springer Science & Business Media, 2003.
3. 3. S. E. Manahan, *Environmental Chemistry*, 8th Ed., CRC Press, Florida, 2004.
4. 4. A. K. Ahluwalia, *Environmental Chemistry*, The Energy and Resources Institute, 2017.
5. 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. 1. S. K. Banergy, *Environmental Chemistry*, 2nd Ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 2005.
2. 2. J. M. H. Selendy, *Water and Sanitation-Related Diseases and the Changing Environment*, John Wiley & Sons, 2011.
3. 3. P. K. Goel, *Water Pollution: Causes, Effects and Control*, New Age International, 2006.
4. 4. V. N. Bashkin, *Environmental Chemistry: Asian Lessons*, Springer Science & Business Media, 2003.
5. 5. S. E. Manahan, *Environmental Chemistry*, 8th Ed., CRC Press, Florida, 2004.
6. 6. A. K. Ahluwalia, *Environmental Chemistry*, The Energy and Resources Institute, 2017.
7. 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. 1. S. E. Manahan, *Environmental Chemistry*, 8th Ed., CRC Press, Florida, 2004.
2. 2. A. K. Ahluwalia, *Environmental Chemistry*, The Energy and Resources Institute, 2017.
3. 3. A. K. De, *Environmental Chemistry*, 6th Ed., New Age International.
4. 4. Balram Pani, *Textbook of Environmental Chemistry*, I. K. International Pvt. Ltd., 2010.
5. 5. Anindita Basak, *Environmental Studies*, Pearson Education India, 2009.
6. 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. KB Schnelle, CA 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. SC Ameta, R Ameta, *Green Chemistry*: *Fundamentals & 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: BCH5D02

Open Course 2: CHEMISTRY IN DAILY LIFE

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

BCH5D02	**CHEMISTRY IN DAILY LIFE**		L*	T**	P***	C#
			3	0	0	2
Objectives(s)	To introduce various applications of chemistry in daily life To understand different types of polymers To understand different biomolecules. To appreciate the importance chemistry in agriculture, food industry, cosmetics, and cleaning.					
Course outcome(s)	**CO1**	Understand the basics of polymer chemistry.				
	CO2	Explain the functions of biomolecules, vitamins, enzymes, hormones and nucleic acid.				
	CO3	Describe food additives and food habits.				
	CO4	Explain the uses of pesticides and fertilizers and their impacts on the environment.				
	CO5	Understand advantages and disadvantages of cleansing agents and cosmetics.				
	CO6	Recognize the common classes of drugs in pharmaceutical industry and their application.				
	CO7	Understand the basic concepts and processes in petroleum industry.				

Module I: Polymers (8 hrs)

Classification of polymers: Origin, structure, synthesis, molecular forces. Commercially important polymers: Application of polyethylene, polystyrene, polyhaloolefines, Nylon 6,

Nylon 66, Melamine, Terylene, Bakelite, natural and synthetic rubber, vulcanization, Advantages of vulcanized rubber, natural silk and artificial silk, inorganic polymer: (Examples Only) - Plastic identification codes – Applications of biodegradable polymers (PGA, PLA and PHBV) – Importance of plastic recycling.

References

1. 1. B. K. Sharma, *Industrial Chemistry*, 11th Ed., Goel publishing House, Meerut, 2000.
2. 2. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Ed., Vikas Publishing House (Pvt.) Ltd., New Delhi, 2004.
3. V. R. Gowarikar, *Polymer Chemistry*, New Age International Pvt. Ltd., New Delhi, 2010.
4. 4. B. K. Sharma, *Polymer Chemistry*, Goel Publishing House, Meerut, 1989.
5. 5. M. G. Arora, M. Singh, M. S. Yadav, *Polymer Chemistry*, 2nd Revised Ed., 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 Ed., 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 Ed., 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. 1. Lillian Hoagland Meyer, *Food Chemistry*, 1st Ed., CBS Publishers & Distributors, New Delhi, 2004.
2. 2. B. A. Fox, A. G. Cameron, E. Arnold, *Food Science*, Nutrition and Health, 6th Ed.,

Edward Arnold, London, 1995.
3. 3. A. Siddiqui, N. Anusha, *Deleterious Effects of Food Habits in Present Era*, J. Aller. Ther. 3:114, 2012.
4. 4. H. S. Ramaswamy, M. Marcotte, *Food Processing: Principles and Applications*, CRC Press, 2005.
5. 5. A. F. Smith, *Encyclopedia of Junk Food and Fast Food*, Greenwood Publishing Group, 2006.
6. 6. T. A. M. Sagati, The Chemistry of Food Additives and Preservatives, John Wiley & Sons, 2012.
7. 7. S. N. Mahindru, *Food Additives*, APH Publishing, 2009.
8. 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. 1. H. S. Rathore, L. M. L. Nollet, *Pesticides: Evaluation of Environmental Pollution*, CRC Press, USA, 2012.
2. 2. Murray Park, *The Fertilizer Industry*, Elsevier, 2001.
3. 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. 1. B. K. Sharma, *Industrial Chemistry*, Krishna Prakashan Media, 1991.
2. 2. M. S. R. Winter, *A Consumer's Dictionary of Cosmetic Ingredients*, 7th Ed., Three Rivers Press, New York, 2009.

Module VI: Pharmaceuticals and Vaccines (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).

History of Vaccines & Vaccinology, over view of bacterial and viral vaccines and their importance to public health. Epidemiology and pathophysiology of vaccine preventable diseases with special emphasis on Diphtheria, Tetanus and Pertussis, vaccine preventable infectious diseases, Overview of national and international regulatory requirements/ guidance for production

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 Ed., 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. 1. B. K. B. Rao, *Modern Petroleum Refining Processes*, 4th Ed., Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 2002.
2. 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: BCH5D03

Open Course 3: FOOD SCIENCE AND MEDICINAL CHEMISTRY

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

BCH5D03	**FOOD SCIENCE AND MEDICINAL CHEMISTRY**		L*	T**	P***	C#
			3	0	0	2
Objectives(s)	To understand different food adulterants and preservation techniques To understand different types of drugs and their use in disease treatment. To understand first aids and the safety steps to be taken for common illnesses.					
Course outcome(s)	**CO1**	Understand food adulteration and preservation methods.				
	CO2	Understand food additives.				
	CO3	Compare modern food with natural food.				
	CO4	Describe the harmful effects of alcohol and modern food habits.				
	CO5	Exhibit a broad and coherent body of knowledge on the biomolecules, vitamins, enzymes, hormones and nucleic acids.				
	CO6	Recognize the uses of Indian medicinal plants and plant extracts.				
	CO7	Recall the chemical, generic and trade names of drugs and their uses.				
	CO8	Describe the treatment methods used in medical field.				
	CO9	Illustrate first aids and the safety steps to be taken for common illnesses.				

Module I: Food Adulteration and Preservation (6 hrs)

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

Methods of preservation*:* Need for preservation - Classification - Freezing, smoking, use of sugar, pickling, artificial food additives, canning and bottling, high pressure, burial in the ground, controlled use of microorganism 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 Ed., 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. 1. B. Siva Sankar, *Food Processing and Preservation*, Prentice–Hall of India Pvt. Ltd., New Delhi, 2002.
2. 2. Lillian Hoagland Meyer, *Food Chemistry*, 1st Ed., CBS Publishers & Distributors, New Delhi, 2004.
3. 3. B. A. Fox, A. G. Cameron, E. Arnold, *Food Science, Nutrition and Health*, 6th Ed., 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. 1. B. Siva Sankar, Food Processing and Preservation, Prentice–Hall of India Pvt. Ltd., New Delhi, 2002.
2. 2. Srilakshmi, Food Science, 5th Ed., New Age Publishers, New Delhi, 2010.
3. 3. Lillian Hoagland Meyer, Food Chemistry, 1st Ed., CBS Publishers & Distributors, New Delhi, 2004.
4. 4. B. A. Fox, A. G. Cameron, E. Arnold, Food Science, Nutrition and Health, 6th Ed., 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. 1. S. C. Rastogi, *Biochemistry*, 2nd Ed., Tata McGraw Hill Publishing Co., New Delhi, 2007.
2. 2. M. V. Kulkarni, *Biochemistry*, Pragati Books Pvt. Ltd., 2008.
3. 3. U. Satyanarayana, U. Chakrapani, *Biochemistry*, Elsevier Health Sciences, 2014.

4. 4. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Ed., 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. 1. Guyton and Hall, *Textbook of Medical Physiology*, 12th Ed., Saunders, US, 2010.
2. 2. B. L. Oser, *Hawk's Physiological Chemistry*, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 1979.
3. 3. S. C. Rastogi, *Biochemistry*, 2nd Ed., Tata McGraw Hill Publishing Co., New Delhi, 2007.
4. 4. Rasheeduz Zafar, *Medicinal Plants of India*, 1st Ed., CBS Publishers & Distributors Pvt. Ltd., New Delhi, 2009.
5. 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. 1. Gurdeep R. Chatwal, *Synthetic Drugs*, Himalaya Publishing House, Bombay, 1995.
2. 2. Jayashree Ghosh, *A Textbook of Pharmaceutical Chemistry*, 3rd Ed., S. Chand and Company Ltd., New Delhi, 1999.
3. 3. A. H. Beckett, J. B Stenlake, *Practical Pharmaceutical Chemistry*, 4th Ed., 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. 1. Jayashree Ghosh, *A Textbook of Pharmaceutical Chemistry*, 3rd Ed., S. Chand and Company Ltd., New Delhi, 1999.
2. 2. A. H. Beckett, J. B Stenlake, *Practical Pharmaceutical Chemistry*, 4th Ed., CBS Publishers and Distributors, New Delhi, 2000.
3. 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

EVALUATION SCHEME 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 in each course are for internal evaluation. The internal assessment shall be based on a predetermined transparent system involving written test, class room participation, assignment and seminar/viva in respect of theory courses.

Table 1: Components of Evaluation

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

Test Paper

Table 2: 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 45% = 2, below 35% = 1, Absent = 0 mark.

2. EXTERNAL EVALUATION

External evaluation carries 80% marks (60 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**

MODEL QUESTION PAPER FOR CORE COURSES

FIRST SEMESTER B.Sc DEGREE EXAMINATION

CBCSSUG - CHEMISTRY

BCH1B01 - 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

BCH2B02 - 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

BCH3B03 - 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.
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
BCH4B04 - 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? Use it to discuss aromaticity of azulene and annulenes.
14. a) Write any three methods of resolution racemic mixtures. b) Distinguish between absolute and partial asymmetric synthesis
15. What is hyperconjugation? Write the order of stability of propene, 1-butene and 2-butene. Explain why?
16. Write a short note on hybridisation, structure, formation and stability of carbenes.
17. a) What is Corey – House synthesis? b) Write the mechanism of free radical chlorination of methane.
18. What is ozonolysis? One mole of alkene, C_6H_{12} on ozonolysis yields 1mole each of propanal and propanone. Find structure of the parent alkene and write equation for 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 Friedel-Craft's alkylation and acylation reactions. Write the mechanism of each reaction. b) Explain benzyne mechanism 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

BCH4B05L - 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

BCH5B06 -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

BCH5B07 -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

BCH5B08 - 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°C. What will be the half life at 550°C? **[1 X 10 = 10]**

SIXTH SEMESTER BSc. DEGREE EXAMINATION

CBCSSUG - CHEMISTRY

BCH6B09 - 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

BCH6B10 - 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

BCH6B11 - 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

BCH6B12 - Core Course XII

ADVANCED AND APPLIED CHEMISTRY

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

Section A (Short answers)

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

1. Explain the term global minimum in computational chemistry.

2. Describe the change melting point when the particle size of a material approaches nanoscale rang.

3. What are the advantages of microwave assisted organic synthesis?

4. Explain any two principles of green chemistry.

5. Draw the structure of endosulphan and DDT.

6. Explain the uses of nanomaterials.

7. Describe the term prodrugs with example.

8. What are BHA and BHT? Mention their important applications.

9. Name two software used in computational chemistry.

10. What is talc? What is its composition?

11. Name one nitrogenous fertilizer and one potash fertilizer.

12. Explain the importance of combinatorial synthesis. **[Ceiling of marks: 20]**

Section B (Paragraph)

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

13. Distinguish between the bottom up and top down methods of nanoscale synthesis.

14. Explain different host-guest interactions in supramolecules.

15. Explain with example the difference between percentage yield and atom economy.

16. Distinguish between molecular mechanics method and electronic structure method in computational chemistry.

17. Explain the term PHBV and PGA. Discuss its significance and applications.

18. Write a short note on the role of water in setting of cement.

19. Explain the theories behind color of dyeing compounds. **[Ceiling of marks: 30]**

Section C (Essay)

(Answer any one. Each question carries 10 marks)

20. a) Describe a method for the purification of collide. b) Explain the advantages of Zeigler Natta polymerization.

21) Write a short note on

a) zeta potential, b) artificial ripening, c) Travancore Cochin Chemicals, d) Flash point of a liquid fuel. **[1 X 10 = 10]**

SIXTH SEMESTER B. Sc. DEGREE EXAMINATION

(CBCSSUG) - CHEMISTRY

BCH6E01 - Core Course XIII

INDUSTRIAL CHEMISTRY

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

Section A (Short answers)

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

1. Describe the term pilot plant?
2. How we can convert wash to rectified spirit?
3. How coal is classified based on carbon content?
4. Differentiate between paraffin base and asphalt base.
5. What are the different routes of drug administration?
6. Explain the term prodrug with example?
7. What is Zeigler Natta catalyst? Mention its important application.
8. Mention the applications of ruthenium based catalysts.
9. What is a nanoparticle catalyst? Give examples.
10. Explain the term denatured spirit and mention it's applications.
11. What are chromatic and achromatic colours?
12. Describe the components of paint. **[Ceiling of marks: 20]**

Section B (Paragraph)

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

13. What are the important features of environmental management systems?
14. Discuss the various steps involved in the manufacture of leather.
15. What are anti-knocking compounds? Discuss their mechanism of action.
16. Discuss the composition and uses white lead, ultramarine and guignet's green.
17. Discuss the causes, symptoms and treatment of lung cancer.
18. What is meant by phase transfer catalysis? What are its important applications?
19. Discuss briefly the medical applications of nanomaterials.

[Ceiling of marks: 30]

Section C (Essay)

(Answer any one. Each question carries 10 marks)

20. Write notes on (a) oil based paints (b) luminescent paints (c) fire retardant paints.

21. (a) What is synthetic petrol? How is it manufactured? (b) Discuss the manufacture of ethylene glycol. **[1 X 10 = 10]**

SIXTH SEMESTER B. Sc. DEGREE EXAMINATION

(CBCSSUG) - CHEMISTRY

BCH6E02- Core Course XIII

POLYMER CHEMISTRY

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

Section A (Short answers)

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

1. Describe the term tacticity of polymers.
2. Explain ring opening polymerization? Give an example.
3. Distinguish between thermoplastics and thermosetting plastics.
4. What is bulk polymerization?
5. What is meant by average molecular weight of polymers? Give mathematical expression for weight average molecular weight.
6. Define Tg. What are the factors affecting Tg?
7. What is meant by degradation of polymers?
8. What is Kevlar. Give two applications.
9. Give the structure of nylon 6 and nylon 66.
10. Explain the importance of vulcanization.
11. How silicones are prepared?
12. What is meant by resins? Give an example.

[Ceiling of marks: 20]

Section B (Paragraph)

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

13. Distinguish between plastics, fibers and elastomers with examples.
14. Write a short note on suspension polymerization.
15. How can you determine the molecular weight of polymers by viscosity method?
16. What is meant by recycling of plastics? What are its advantages?
17. Explain thermal and oxidative degradation of polymers with examples.
18. What is meant by dopping of polymers.
19. Distinguish between addition and condensation polymerization. **[Ceiling of marks: 30]**

Section C (Essay)

(Answer any one. Each question carries 10 marks)

20. Explain Zeigler Natta polymerization with mechanism.
21. Explain any three polymer processing techniques with neat diagram. **[1 X 10 = 10]**

SIXTH SEMESTER B. Sc. DEGREE EXAMINATION

(CBCSSUG) - CHEMISTRY

BCH6E03- Core Course XIII

MEDICINAL AND ENVIRONMENTAL CHEMISTRY

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

Section A (Short answers)

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

1. Explain the importance in sterilization of surgical instruments.
2. What precautions are to be taken during blood transfusion?
3. What is difference between LD50 and ED50?
4. What is systemic hypertension? Name a drug used for its treatment.
5. What is hepatitis A? What are its causes and symptoms?
6. What are the toxicological effects of phenol and benzene?
7. What are the analytical methods used for the detection of hydrocarbons?
8. Write a note on activated sludge process
9. Explain the working of Cottrell electrostatic precipitator.
10. What is BOD? How is it determined by Winkler's titration method?
11. What is USAB process?
12. Discuss the sources and harmful effects of Hg. **[Ceiling of marks: 20]**

Section B (Paragraph)

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

13. How is sugar content in urine determined?
14. Write notes on (a) Rain water harvesting (b) Sea water for agriculture.
15. Discuss the toxicological effects of phenylene diamines and nitroso amines.
16. Discuss the sampling methods used for gases.
17. Discuss how gravitational settling chamber and fabric filter are used in air pollution control.
18. Write notes on settlable solids and suspended solids related to water pollution.
19. Discuss the treatment for poisons due to snake bite. **[Ceiling of marks: 30]**

Section C (Essay)

(Answer any one. Each question carries 10 marks)

20. Discuss the major chemical constituents and medicinal uses of any five Indian medicinal plants.
21. Discuss the causes and drugs used for the treatment of influenza, cholera, kidney stone and myocardial infarction. **[1 X 10 = 10]**

SIXTH SEMESTER B. Sc. DEGREE EXAMINATION

CBCSSUG - CHEMISTRY

BCH6B13L - 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

BCH6B14L - 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
BCH6B15L - 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
BCH6B16L - 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)

MODEL QUESTION PAPER FOR COMPLEMENTARY COURSES

FIRST SEMESTER BSc. DEGREE EXAMINATION

CBCSSUG - CHEMISTRY

BCH1C01-Complementary course: I

GENERAL CHEMISTRY

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

Section A (Short answers)

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

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

Section B (Paragraph)

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

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

Section C (Essay)

(Answer any one. Each question carries 10 marks)

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

SECOND SEMESTER B. Sc. DEGREE EXAMINATION

CBCSSUG – CHEMISTRY

BCH2C02 - Complementary course: II

PHYSICAL CHEMISTRY

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

Section A (Short answers)

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

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

Section B (Paragraph)

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

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

Section C (Essay)

(Answer any one. Each question carries 10 marks)

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

THIRD SEMESTER BSc. DEGREE EXAMINATION
CBCSSUG - CHEMISTRY
BCH3C03-Complementary course: III

ORGANIC CHEMISTRY

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

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

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

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

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

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

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

FOURTH SEMESTER BSc. DEGREE EXAMINATION
CBCSSUG - CHEMISTRY
BCH4C04 - Complementary course: IV

PHYSICAL AND APPLIED CHEMISTRY

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

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

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

Section B (Paragraph)

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

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

Section C (Essay)

(Answer any one. Each question carries 10 marks)

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

FOURTH SEMESTER BSc. DEGREE EXAMINATION
CBCSSUG - CHEMISTRY
BCH4C05L - Complimentary Course V

CHEMISTRY PRACTICAL

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

Section A
Answer the following questions in 6 minutes.

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

Section B
Answer the following question in 10 minutes

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

Section C

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

Section D

Record (10 marks)

MODEL QUESTION PAPER FOR OPEN COURSES

FIFTH SEMESTER B. Sc. DEGREE EXAMINATION
CBCSSUG - CHEMISTRY
BCH5D01 - 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
BCH5D02 - 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. Describe 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 bio fertilizers.
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 classification 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
BCH5D03 - 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. Describe 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]**