SYLLABUS

Core, Complementary
& Open Courses

UG PROGRAMME
IN CHEMISTRY

Under Choice Based Credit Semester System

FAROOK COLLEGE

(AUTONOMOUS)

www.farookcollege.ac.in

CERTIFICATE

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

Principal

Date: 01 June 2023
Place: Farook College

TABLE OF CONTENT

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PROGRAMME SPECIFIC OUTCOMES (PSO)

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

PSO 01 Remember the prerequisites for the understanding of new concepts.

PSO 02 Understand of the major areas of inorganic, organic, theoretical, and physical chemistry including a wide range of other interdisciplinary subjects such as analytical, bio- and industrial chemistry.

PSO 03 Understand historical development of scientific ideas to develop innovative methods.

PSO 04 Quantitative and qualitative evaluation of chemical information and data verbally, mathematically, and graphically.

PSO 05 Analyse the concept to develop a sense of inquiry and problem-solving ability to pursue higher studies and succeed in competitive examinations.

PSO 06 Apply the concepts and techniques in Mathematics and Physics as tools to learn and interpret Chemical data.

PSO 07 Apply the laboratory skills acquired to design safe, eco-friendly, and novel chemical experiments to succeed in graduate and professional school, chemical industry, and research.

PSO 08 Analyse and interpret the concept using chemical simulations and data analysis.

PSO 09 Apply the problem solving and experimental skills to solve environmental issues.

PSO 10 Create a green protocol from the concepts acquired by understanding the problems for the wellbeing of society.

PSO 11 Create and design a project report which connect the theories and ideas from the curriculum and help to build up a skill set for career development.

PSO 12 Understand the physicochemical changes in nature.

SCHEME OF THE PROGRAMME

Credit and Mark Distribution in Each Semester Total Credits: 140

Semester	Course	Credit	Internal Mark	External Mark	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 Chemistry- I	2	15	60	75
	Complementary course: Mathematics	3	15	60	75
	Complementary course: Physics	2	15	60	75
	Audit Course -I	*4*	-	-	-
	Total	**19**			**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 Chemistry- II	2	15	60	75
	Complementary course: Mathematics	3	15	60	75
	Complementary course: Physics	2	15	60	75
	Audit Course -II	*4*	-	-	-
	Total	**23**			**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
	Audit Course -III	*4*	-	-	-
	Total	**20**			**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 Practical-I	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
	Audit Course -IV	*4*	-	-	-
	Total	**28**			**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 Chemistry	3	15	60	75
	Core Course XIII: Elective	2	15	60	75
	Core Course XIV: Physical Chemistry Practical	4	20	80	100
	Core Course XV: Organic Chemistry Practical	4	20	80	100
	Core Course XVI: Inorganic Chemistry Practical-II	4	20	80	100
	Core Course XVII: Inorganic Chemistry Practical-III	4	20	80	100
	Core Course XVIII: Project Work	2	15	60	75
	Total	**32**			**850**
English		22			550
Additional Language		16			400
Complementary Course: Mathematics		12			300
Complementary Course: Physics		12			400
Core Course: Chemistry		55			1475
Open Course		3			75
Audit Course		*16*			-
Extra Credit Activities		*4*			-
Total		**140**			**3200**

Credit Distribution

Semester	Common Course		Core Course	Complementary Course		Open Course	Project	Audit Course	Total
	English	Additional language		Mathematics	Physics				
1	**3***(A1)* + **3***(A2)*	**4***(A7)*	2	3	2			4	21
2	**4***(A3)* + **4***(A4)*	**4***(A8)*	2	3	2			4	23
3	**4***(A5)*	**4***(A9)*	3	3	2			4	20
4	**4***(A6)*	**4***(A10)*	3 + 4	3	2 + 4			4	28

5			3 + 3 + 3			3			12
6			$3 + 3 + 3 + 3 + 2^{\#} + 4^{*} + 4^{*} + 4^{*} + 4^{*}$				2^{**}		32
Total	**22**	**16**	**53**	**12**	**12**	**3**	**2**		**136**
Extra Credit Activities									**4**
Grand Total = (120 + 16 Audit Courses + 4 Extra Credit Activities)									**140**

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

$ Department can choose any one among the three courses.

† Includes 15 marks for the industrial visit also.

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			

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

ALLIED COURSE STRUCTURE

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

Semester	Code No	Course Title	Hrs/ Week	Total Hrs	Credit	Marks
I	CHE1IC01	Allied Course I: General Chemistry	4	64	4	100
	-	Allied Course III: Chemistry Practical	2	32	-*	-*
IV	CHE4IC02	Allied Course II: Physical and Inorganic Chemistry	4	64	4	100
	CHE4IH01	Allied Course III: Chemistry Practical	4	64	4	100
Total					12	300

CORE COURSE SYLLABUS

SEMESTER 1

COURSE CODE: BCH1B01 **CORE COURSE I**: THEORETICAL AND INORGANIC CHEMISTRY- I				
Credit	Hours/week	Marks		
		Internal	External	Total
2	2	15	60	75

Course Outcomes	**Expected Course Outcome** Upon completion of this course, students will be able to;	**Learning Domain**	**PSO No**
CO1	***Recall*** basic concepts	Remember	PSO 1
CO2	***Differentiate*** between science and non-science and identify characteristic features of scientific methods and steps of scientific research.	Analyse	PSO 3
CO3	***Explain*** basic principles of analytical Chemistry	Understand	PSO 2
CO4	***Generalize*** measures on laboratory hygiene, safety and biosafety issues.	Understand	PSO 7
CO5	***Define*** various periodic properties and explain their variation.	Remember Understand	PSO 2
CO6	***Summarize*** features and properties of representative elements.	Understand	PSO 2
CO7	***Identify*** acids and bases based on different acid-base concepts.	Remember	PSO 1, PSO 2
CO8	***Compare*** acid and base strengths	Evaluate	PSO 2

CO9	***Explain*** nuclear stability, nuclear forces, nuclear reactions and nuclear quantum numbers.	Understand	PSO 2
CO10	***Illustrate*** various nuclear models	Analyse	PSO 2
CO11	***Apply*** radiochemical methods	Apply	PSO 2

COURSE CONTENT	
Module 1. Chemistry as a discipline of science	**5 Hours**
1.1. Prerequisites: Evolution of chemistry – early form of chemistry: the panch tatvas and alchemy, idea of some technologies that eventually formed the basis of the various branches of chemistry, ancient speculations to particulate nature of matter, laws of chemical combination. Scope of chemistry, branches of chemistry, interdisciplinary areas involving Chemistry. 1.2. 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. 1.3. Scientific research: selecting a topic for research, design of an experiment, sampling, use of controls, experimental bias, analysis, results and discussion of results, statistical analysis of experimental data, preparation of seminar papers, major publishers in chemical science, author citation, reviews and keywords. 1.4. Publishing a research work: Introduction, review of literature, scope, materials and methods, results and discussion, conclusions and bibliography. 1.5. Intellectual Property Rights: Principles, Parent Law and Practices, Types of IPR.	
Module 2. Analytical Principles – I	**10 Hours**
2.1. Prerequisites: Awareness on nature of experiments performed in chemical laboratories. The health risks and hazards associated with chemicals. Concentrated and dilute solutions. Acids and bases, Organic and Inorganic chemicals. 2.2. 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). 2.3. Simple first aids: Electric shocks, fire, cut by glass and inhalation of poisonous gases - Accidents due to acids and alkali - Burns due to phenol and bromine. 2.4. Disposal of sodium and broken mercury thermometer. 2.5. Basic idea on biohazards and biosafety issues. 2.6. Accuracy, precision, types of errors - absolute and relative error, methods of eliminating or minimizing errors. Methods of expressing precision: mean, median, deviation, average deviation and coefficient of variation. Significant figures and its application. 2.7. 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.

2.8. Volumetric Analysis: Standard solutions- Primary and secondary standards, quantitative dilution – problems. Acid base titrations- titration curves – pH indicators.

2.9. Redox titrations – titration curve –titrations involving $KMnO_4$ and $K_2Cr_2O_7$, I_2 and liberated I_2 - redox indicators.

2.10. Complexometric titrations – EDTA titrations - titration curves – metal ion indicators.

2.11. Precipitation Titrations-Adsorption indicators.

2.12. Double burette method of titration.

Module 3. Periodic Properties	**3 Hours**

3.1. Prerequisites: Name and symbol of elements, Law of triads, octaves, X-ray studies of Henry Mosley, Mosley's periodic law - Modern periodic law – Long form periodic table. Periodicity in properties: Atomic and ionic radii.]

3.2. Ionization enthalpy, Electron affinity (electron gain enthalpy)

3.3. Electronegativity: Pauling's, Mulliken's, Allred Rachow's and Mulliken-Jaffé's electronegativity scales.

3.4. Effective nuclear charge – Slater rule and its applications, Polarising power – Fajans rule.

Module 4. Representative Elements	**6 Hours**

4.1. 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.

4.2. Diagonal relationship and Inert pair effect. Ionic compounds:

4.3. Lattice energy of ionic compounds – Born-Lande equation (derivation not expected)

4.4. Solvation enthalpy and solubility of ionic compounds

4.5. Born-Haber cycle and its applications - Properties of ionic compounds.

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

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

4.8. 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.

Module 5. Acid Base Concepts	**3 Hours**

5.1. Prerequisites: Arrhenius definition, Bronsted-Lowry definition and conjugate acid-base pairs, Lewis concept, ionization of acids and bases.

5.2. Arrhenius Concept

5.3. Bronsted-Lowry's concept, relative strength of acids, Pauling's rules

5.4. Lewis concept, group characteristics of Lewis acids

5.5. Lux-Flood concept, Usanovich concept.

Module 6. Nuclear Chemistry	**5 Hours**

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

6.2. Disintegration Laws and Radioactive equilibrium

6.3. Nuclear stability and nuclear binding energy, nuclear forces -meson exchange theory

6.4. Nuclear models (Liquid Drop and Shell Model), Concept of nuclear quantum number, magic numbers

6.5. Nuclear Reactions: Artificial radioactivity, transmutation of elements, fission, fusion and spallation.

6.6. Separation and uses of isotopes.

6.7. Radio chemical methods: principles of determination of age of rocks and minerals, radiocarbon dating.

6.8. Hazards of radiation and safety measures.

MODE OF TRANSACTION

Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

Peer to Peer learning: Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

a. Classroom participation (20%): 3 Mark
b. Test papers I (40%): 6 Mark
c. Assignment (20%): 3 Mark
d. Seminar/ Viva (20%): 3 Mark

External Assessment (60 Marks) Duration 2 Hours, No of Questions: 21

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	12	Up to 12	2	**20**
Paragraph	7	Up to 7	5	**30**
Essay	2	1	10	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION	
Module	**Mark**
Module 1. Chemistry as a discipline of science	10
Module 2. Analytical Principles – I	24
Module 3. Periodic Properties	8
Module 4. Representative Elements	15
Module 5. Acid Base Concepts	8
Module 6. Nuclear Chemistry	10

REFERENCES:

MODULE I:

1. J. A. Lee, The Scientific Endeavor: A Primer on Scientific Principles and Practice, Pearson Education, 1999.
2. 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

MODULE II

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 Textbook of Quantitative Chemical Analysis, 6th Ed., Pearson Education, Noida, 2013.

MODULE III & IV

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.

MODULE V

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.
3. D. F. Shriver, P. W. Atkins, Inorganic Chemistry, 5rd Ed., Oxford University Press, New York, 2010.

MODULE VI

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

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

5. D. A. Skoog, D. M. West, F. J. Holler, S. R. Crouch, Fundamentals of Analytical Chemistry, 8th Ed., Brooks/Cole, Thomson Learning, Inc., USA, 2004.
6. R. H. Hill, D. Finster, Laboratory Safety for Chemistry Students, 1st Ed., Wiley, Hoboken, NJ, 2010.
7. M. C. Day, J. Selbin, Theoretical Inorganic Chemistry, East West Press, New Delhi, 2002.
8. O.W. Hand, H. L. Blewitt, Acid Base Chemistry, Macmillan USA, 1986.
9. S. Glasstone, Source Book on Atomic Energy, 3rd Ed., East-West Press Pvt. Ltd., NewDelhi, 1967.
10. J. B. Rajam, L. D. Broglie, Atomic Physics, 7th Ed., S. Chand and Co. Pvt. Ltd., New Delhi, 1999.

SEMESTER 2

COURSE CODE: BCH2B02 **CORE COURSE II**: THEORETICAL AND INORGANIC CHEMISTRY- II				
Credit	Hours/week	Marks		
		Internal	External	Total
2	2	15	60	75

Course Outcomes

CO No.	**Expected Course Outcome** Upon completion of this course, students will be able to;	**Learning Domain**	**PSO No**
CO1	***Describe*** the importance and the impact of quantum revolution in science.	Remember	PSO3
CO2	***Generalize*** the theoretical frame work of quantum mechanics.	Understand	PSO4
CO3	***Solve*** the Schrodinger equation for simple systems.	Evaluate	PSO4
CO4	***Apply*** the concept that the wave functions of hydrogen atom are nothing but atomic orbitals.	Apply	PSO1
CO5	***Analyse*** chemical bonding is the mixing of wave functions of the two combining atoms.	Analyse	PSO4
CO6	***Demonstrate*** the concept of hybridization as linear combination of orbitals of the same atom.	Understand	PSO4
CO7	***Generate*** an atomic and molecular level philosophy.	Create	PSO4

COURSE CONTENT	
Module 1. The Quantum revolution and its early impact in atomic structure	**6 Hours**

1.1. 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

1.2. 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.

1.3. Atomic model partly based on quantum theory – Bohr's theory of the atom, calculation of Bohr radius, velocity and energy of an electron.

1.4. Atomic spectra of hydrogen and hydrogen like systems.

1.5. 1.5. Limitations of Bohr's theory. Louis de Broglie's matter waves – wave-particle duality. Electron diffraction.

Module 2. Introductory Quantum chemistry	**6 Hours**

2.1. 2.1. The Schrodinger wave equation, Postulates of Quantum mechanics, well behaved functions. Probabilistic interpretation of the wave function.

2.2. 2.2. Linear and Hermitian operators, Laplacian and Hamiltonian operators.

2.3. 2.3. Eigen functions and eigen values of an operator, Expectation values in Quantum mechanics.

2.4. 2.4. Particle in a one-dimensional box.

Module 3. Schrödinger treatment of one electron atom	**4 Hours**

3.1. Application of Schrödinger wave equation to hydrogen atom.

3.2. The wave equation in spherical polar coordinates. Wave functions or atomic orbitals, radial and angular parts of atomic orbitals.

3.3. Quantum numbers (n, l, m). Radial functions, Radial distribution functions and their plots, Angular functions and their plots (1s, 2s and 2pz only).

3.4. 3.4. Spin orbitals (elementary idea only). Pauli's exclusion principle.

Module 4. Bonding in diatomic molecules	**10 Hours**

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

4.2. Quantum mechanical concept of bonding – (mixing of wave functions of different atoms). Valence bond theory of H_2 molecule (derivation not required).

4.3. 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).

4.4. Potential energy diagram of H_2 molecule formation – equilibrium geometry. Bonding and antibonding molecular orbitals, bond order.

4.5. 4.5. 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 5. Bonding in Polyatomic molecules	**6 Hours**

5.1. Prerequisite: VSEPR theory: Postulates and applications

5.2. Concept of Hybridization: Need of hybridization, Definition (mixing of wave functions of the same atom),

5.3. LCAO of the central atom – coefficients of atomic orbitals in the linear combination of sp (BeH_2), sp2 (BH_3) and sp3 (CH_4) hybridization (derivation not required).

5.4. Other examples of hybridization – Geometry of molecules like PCl_5, SF_6 and IF_7.

MODE OF TRANSACTION

Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

Peer to Peer learning: Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

a. Classroom participation (20%): 3 Mark

b. Test papers I (40%): 6 Mark

c. Assignment (20%): 3 Mark

d. Seminar/ Viva (20%): 3 Mark

External Assessment (60 Marks) Duration 2 Hours, No of Questions: 21

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	12	Up to 12	2	**20**
Paragraph	7	Up to 7	5	**30**
Essay	2	1	10	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION	
Module	**Mark**
Module1: The Quantum revolution and its early impact in atomic structure	15
Module 2: Introductory Quantum chemistry	15
Module 3: Schrödinger treatment of one electron atom	10
Module 4: Bonding in diatomic molecules	24
Module 5: Bonding in polyatomic molecules	15

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. 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.

SEMESTER 3

COURSE CODE: BCH3B03 **CORE COURSE III:** PHYSICAL CHEMISTRY - I				
Credit	Hours/week	Marks		
		Internal	External	Total
3	3	15	60	75

Course Outcomes	**Expected Course Outcome** Upon completion of this course, students will be able to;	**Learning Domain**	**PSO No**
CO1	***Recall*** basic concepts.	Remember	PSO 1
CO2	***Differentiate*** between collision diameter, collision frequency, mean free path	Analyse	PSO 2
CO3	***Explain*** the deviation of real gases from ideal behaviour.	Understand	PSO 2
CO4	***Compare*** van der Waals equation of state and Virial equation and correlate them.	Analyse	PSO 2 PSO 4
CO5	***Distinguish*** between Boyle temperature and critical temperature.	Analyse	PSO 2
CO6	***Define*** and explain fundamental laws of thermodynamics.	Remember Understand	PSO 2
CO7	***Identify*** basic terms used in thermodynamics and their significance.	Analyse	PSO 2
CO8	***Predict*** spontaneity of chemical reactions.	Understand	PSO 3 PSO 5
CO9	***Summarize*** fundamental concepts and approximations used in statistical thermodynamics.	Understand	PSO 2
CO10	***Express*** equilibrium constant in terms of various parameters.	Understand	PSO 2
CO11	***Apply*** Le Chatelier principle to various chemical equilibria.	Apply	PSO 2
CO12	***Classify*** various symmetry elements and symmetry operations.	Understand	PSO 2
CO13	***Construct*** Group multiplication table.	Create	PSO 2

COURSE CONTENT	
Module 1. Gaseous State	**8 Hours**

1.1. 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.

1.2. Collision number - Mean free path - Collision diameter.

1.3. Deviation from ideal behaviour - Compressibility factor.

1.4. van der Waals equation of state (derivation required).

1.5. Virial equation - Expression of van der Waals equation in virial form and calculation of Boyle temperature.

1.6. PV isotherms of real gases - Continuity of states - Isotherm of van der Waals equation.

1.7. Critical phenomena - Critical constants and their determination - Relationship between critical constants and van der Waals constants.

Module 2. Chemical Thermodynamics – I	**16 Hours**

2.1. 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.

2.2. 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 . conditions - Work done in isothermal expansion and reversible isothermal expansion.

2.3. 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.

2.4. 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.

2.5. Second law of thermodynamics - Need for the law - Kelvin, Planck and Clausius statements and equivalence of the two statements with entropic formulation.

2.6. 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.

2.7. Entropy and unavailable work. Free energy functions (G and A) and their variation with T, P and V.

2.8. 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.

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

Module 3. Chemical Thermodynamics – II	**8 Hours**

3.1. Prerequisites: Module II: Chemical Thermodynamics - I, idea of permutation and combination.

3.2. Fundamental concepts of Statistical Thermodynamics - Probability - Partition function – ensembles.

3.3. Boltzmann distribution derivation - Relation between entropy and probability - Stirling's approximation.

Module 4. Chemical Equilibria	**8 Hours**

4.1. Law of mass action, thermodynamic derivation of law of chemical equilibrium.

4.2. Relation between Gibbs free energy of reaction and reaction quotient. 4.3. 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).

4.3. Van't Hoff's equation. Le Chatelier principle (quantitative treatment). Homogeneous and heterogenous equilibria.

Module 5. Module V: Molecular Symmetry and Group Theory	**8 Hours**

5.1. Elements of symmetry of molecules (Identity, proper axis of rotation, plane of symmetry, centre of symmetry and improper axis of rotation) – corresponding symmetry operations.

5.2. Schoenflies notation – binary combinations of symmetry operations.

5.3. Rules for a set of elements to form a mathematical group - point group classification of simple molecules – Cnv, Cnh, Dnh.

5.4. Group multiplication table for C2v and C2h.

MODE OF TRANSACTION

Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

Peer to Peer learning: Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

a. Classroom participation (20%): 3 Mark

b. Test papers I (40%):	6 Mark
c. Assignment (20%):	3 Mark
d. Seminar/ Viva (20%):	3 Mark

External Assessment (60 Marks) Duration 2 Hours, No of Questions: 21

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	12	Up to 12	2	**20**
Paragraph	7	Up to 7	5	**30**
Essay	2	1	10	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module 1: Gaseous State	14
Module 2: Chemical Thermodynamics – I	27
Module 3: Chemical Thermodynamics – I I	12
Module 4: Chemical Equilibria	12
Module 5: Molecular Symmetry and Group Theory	14

REFERENCES:

Module I

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.

Module II & III

1. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical Chemistry, 46th
2. Ed., Vishal Publishing Company, New Delhi, 2013.
3. P. W. Atkins, J. de Paula, Atkin's Physical Chemistry, 8th Ed., Oxford University Press, 2006.
4. D. A. McQuarrie, J. D. Simon, Physical Chemistry: A Molecular Approach, University Science Books: Sausalito, CA; 1997.
5. K. L. Kapoor, Physical Chemistry, Vol. II and III, Macmillan Publishers, Noida, 2004.

Module IV

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.

Module V

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. F. Daniels, R. A. Alberty, Physical Chemistry, 5th Ed., John Wiley and Sons, Canada, 1980.
2. P. Atkins, J. de Paula, The Elements of Physical Chemistry 7th Ed., Oxford University Press, Oxford, 2016.
3. S. Glasstone, D. H. Lewis, Elements of Physical Chemistry, 2nd Ed., Macmillan & Company, UK, 1962.
4. T. Engel, P. Reid, Thermodynamics, Statistical Thermodynamics & Kinetics, Pearson Education, Inc: New Delhi, 2007.
5. D. A. McQuarrie, Statistical Mechanics, University Science Books, 2000.
6. J. Rajaram, J. C. Kuriacose, Chemical Thermodynamics, Pearson Education, New Delhi, 2013.
7. G. M. Barrow, Physical Chemistry, 5th Ed., Tata McGraw Hill Education, New Delhi, 2006.
8. P. K. Bhattacharya, Group Theory and its Chemical Applications, Himalaya Publishing House, New Delhi, 1986.
9. F. A. Cotton, Chemical Applications of Group Theory, 3rd Ed., John Wiley & Sons, New York, 1990.

SEMESTER 4

COURSE CODE –BCH4B04 **CORE COURSE IV:** ORGANIC CHEMISTRY– I				
Credit	Hours/week	Marks		
		Internal	External	Total
3	3	15	60	75

Course Outcomes

CO No.	**Expected Course Outcome** Upon completion of this course, students will be able to;	**Learning Domain**	**PSO No**
CO1	***Recall*** and recognise various basic concepts, significance, and scope of organic chemistry	Remember	PSO1
CO2	***Analyse*** the stability of organic molecules by illustrating different types of effects.	Analyse	PSO5
CO3	***Represent*** and interprets different molecular representations in stereochemistry.	Understand	PSO4
CO4	***Distinguish*** between various types of organic reactions and identify its mechanism	Analyse	PSO5
CO5	***Make use*** of concepts and theories in the context of organic chemistry research	Apply	PSO7
CO6	***Develop*** new route for different reactions applying the mechanistic aspects of organic chemistry and relate with career.	Create	PSO11

COURSE CONTENT

Module 1. Reaction Mechanism: Basic Concepts	**10 Hours**

1.1. 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.

1.2. 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.

1.3. Mesomeric effect: Definition – Characteristics - +M and –M groups. Applications: Comparison of basicity of aniline, p-nitroaniline and p-anisidine.

1.4. 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.

1.5. 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.

1.6. Reaction intermediates: Carbocations, carbanions, free radicals and carbenes-hybridisation, structure, formation and stability.

1.7. 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.

Module 2. Reaction Mechanism -II	**6 Hours**

2.1. Prerequisites: Types of organic reactions- structure of benzene-resonance

2.2. Chemistry of reactive intemediates: Carbocations, carbanions, free radicals and carbenes-hybridization, nitrenes, benzynes, structure, formation and stability and reactions.

2.3. Solvent classification –basic idea about dipole moment and dielectric constant.

2.4. Nucleophilic and electrphilic substititution SNI, SN2, SNAr and SE (aromatic and aliphalic).

2.5. Elimination reactions E1, E2 and E1cb. (Mechanisms with stereochemical aspects and effects of substrate structure, solvent, nucleophile and leaving group).

2.6. 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.

Module 3. Module III: Stereochemistry	**16 Hours**

3.1. 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).

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

3.3. 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.

3.4. Configurational isomerism: Optical isomerism and Geometrical isomerism.

3.5. 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.

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

Module 4. Aliphatic Hydrocarbons	**8 Hours**

1.1. Prerequisites: Nomenclature of hydrocarbons.

1.2. 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.

1.3. 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).

4.1. 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 KMnO4). Chemistry of the test for unsaturation: Bromine water and Baeyer's reagent.

Module 5. Aromatic Hydrocarbons and Aromaticity	**8 Hours**

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

5.2. 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.

5.3. 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.

MODE OF TRANSACTION

Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

Peer to Peer learning: Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

a. Classroom participation (20%): 3 Mark
b. Test papers I (40%): 6 Mark
c. Assignment (20%): 3 Mark
d. Seminar/ Viva (20%): 3 Mark

External Assessment (60 Marks) *Duration 2 Hours, No of Questions: 21*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	12	Up to 12	2	**20**
Paragraph	7	Up to 7	5	**30**
Essay	2	1	10	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module I: Reaction Mechanism: Basic Concepts	14
Module II: Reaction Mechanism -II	18
Module III: Stereochemistry	22
Module IV: Aliphatic Hydrocarbons	15
Module V: Aromatic Hydrocarbons and Aromaticity	10

REFERENCES:

Module I: Reaction Mechanism: Basic Concepts

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.

Module II: Reaction Mechanism -II

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

Module III: Stereochemistry

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.

Module IV: Aliphatic Hydrocarbons & Module V: Aromatic Hydrocarbons and Aromaticity

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.

FURTHER READING

Module I: Reaction Mechanism: Basic Concepts

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

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 III: Stereochemistry

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 & Module V: Aromatic Hydrocarbons and Aromaticity

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.

COURSE CODE –BCH4B05L **CORE COURSE V**: INORGANIC CHEMISTRY PRACTICAL – I				
Credit	Hours/week	Marks		
		Internal	External	Total
2	2	20	80	100

Course Outcomes

CO No.	**Expected Course Outcome** Upon completion of this course, students will be able to;	**Learning Domain**	**PSO No.**
CO1	***Apply*** the theories of indicators for various volumetric estimation techniques	Apply	PSO6
CO2	***Illustrate*** the principles behind quantitative analysis.	Analyze	PSO5
CO3	***Apply*** appropriate techniques of volumetric quantitative analysis in estimations.	Apply	PSO7
CO4	***Express*** the strength of different solutions.	Understand	PSO2
CO5	***Apply*** laboratory skills for volumetric analysis	Apply	PSO7
CO6	***Utilize*** computational methods for docking studies	Analyze	PSO8
CO7	***Prepare*** organic derivatives and inorganic complexes	Apply	PSO7

COURSE CONTENT	
Experiments	**Total Hours: 128**

General Instructions

- Use safety coat, goggles, shoes and gloves in the laboratory.
- For weighing electronic balance may be used.
- 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).
- Experiments may be selected in such a way that preference may be given for Modules from IV to VII.
- 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.
- Practical examination will be conducted at the end of semester IV.

PART A *Wet chemistry experiments*

Module 1. Introduction to Volumetric Analysis

1.1. Weighing using electronic balance.

1.2. Preparation of standard solutions.

Module 2. Technique of Quantitative Dilution

2.1. Preparation of 100 mL 0.2 M H_2SO_4 from commercial acid.

2.2. Preparation of 250 mL 0.025 M thiosulphate from 0.1 M thiosulphate.

Module 3. Neutralization Titrations

3.1. Strong acid – strong base titration.

3.2. Strong acid – weak base titration.

3.3. Weak acid – strong base titration.

3.4. Estimation of NH_3 by indirect method.

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

3.6. Estimation of borax.

Module 4. Redox Titrations

4.1. Permanganometry

i) Estimation of oxalic acid.

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

iii) Estimation of hydrogen peroxide.

iv) Estimation of calcium.

4.2. Dichrometry

i) Estimation of Fe2+/FeSO4.7H2O/Mohr's salt using internal indicator.

ii) Estimation of Fe2+/FeSO4.7H2O/Mohr's salt using external indicator.

iii) Estimation of ferric iron (after reduction with stannous chloride) using internal indicator.

4.3. Iodimetry and Iodometry

i) Estimation of iodine.

ii) Estimation of copper.

iii) Estimation of chromium.

Module 5. Precipitation Titration (using adsorption indicator)

5.1. Estimation of chloride in neutral medium.

Module 6. Complexometric Titrations

6.1. Estimation of zinc.

6.2. Estimation of magnesium.

6.3. Estimation of calcium.

6.4. Determination of hardness of water.

Module 7. Some Estimations of Practical Importance

7.1. Determination of acetic acid content in vinegar by titration with NaOH.

7.2. Determination of alkali content in antacid tablets by titration with HCl.

7.3. Determination of available chlorine in bleaching powder.

7.4. Determination of COD of water samples.

7.5. Estimation of citric acid in lemon or orange.

Module 8. 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

PART-B *Non-Evaluative Experiments*

Semester 1: Organic Chemistry Experiments	**8 Hours**

1. To determine the Rf value of the amino acids present in a given mixture by paper chromatography.
    a. Group-A: Glutamic acid, Lysine, Histidine, Arginine, Serine, Glycine, Aspartic acid
    b. Group-B: Lucine, Phenyl alanine, Isoleucine, Tryptophan, Methionine, Valine, Tyrosine.
2. To determine the Rf 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 Rf values.
4. Identification of caffeine present in tea extract by thin layer chromatography.

Semester 2: 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: Molecular Modeling Studies- I	**8 Hours**

1. Creating H2O, CH4, NH3, C6H6, C2H4, H2O, HF dimer and HF trimer by using Molecular Editor and Visualization software Avogadro
2. Modeling of H2O, CH4, NH3, C6H6, C2H4, H2O, 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: Molecular Docking Studies- II	**16 Hours**

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.

MODE OF TRANSACTION

Demonstrations: Helps to illustrate and consolidate theoretical principles outlined in the course. Experimentation: This involves learning by doing or hands on experience by applying biological principles.

Experimentation: This involves learning by doing. or hands on experience by applying chemical principles.

Observation: It involves noticing or perceiving chemical change or measurements on equipment and acquisition of information from the primary source:

MODE OF ASSESSMENT

Internal Assessment (20 Marks)

a. Submission of Record* 12 Mark

b. Lab involvement 8Mark

i. Viva 4Mark

ii. Lab skill /performance# 2 Mark

iii. punctuality$ 2 Mark

**Every student has to submit record of experiments and other lab works which is duly certified by the HoD*

#*Skill and performance in doing experiments and observations*

$*Students involvement in the laboratory will be assessed by the course instructor*

External Assessment (80 Marks): Duration 3 Hours

MODULE WISE MARK DISTRIBUTION	Marks
Question on volumetric analysis	8
Procedure for volumetry	8
Procedure for inorganic preparation	4
Inorganic preparation	5
Result	35
Calculation	4
Record	8
Viva-Voce	8

Total	**80**

REFERENCES:

1. Plummer David, An introduction to practical biochemistry –Tata Mc Graw-Hill, New Delhi.
2. Oser, B.L., (1965) Hawk's Physiological Biochemistry, McGraw Hill Book Co.
3. Sadasivan, S. and Manickam, A., (2005), Biochemical methods, New Age International, New Delhi.
4. Keith Wilson and John Walker (2008), Principles and techniques of Biochemistry and Molecular biology – 6th edn, Cambridge University Press.
5. Jayaraman, J.(latest.) Laboratory Manual in Biochemistry, Wiley Eastern Ltd.

SEMESTER 5

COURSE CODE –BCH5B06 CORE COURSE VI: INORGANIC CHEMISTRY – III				
Credit	Hours/week	Marks		
		Internal	External	Total
3	3	15	60	75

Course Outcomes

CO No.	Expected Course Outcome	Learning Domain	PSO No
	Upon completion of this course, students will be able to;		
CO1	***Explain*** the principles behind qualitative and quantitative analysis.	Understand	PSO2
CO2	***Describe*** the basic processes of metallurgy.	Remember	PSO1
CO3	***Examine*** the composition of different alloys.	Apply	PSO7
CO4	***Classify*** different inorganic polymers based on their structure and applications.	Analyse	PSO8
CO5	***Illustrate*** different environment polluting agents.	Understand	PSO5
CO6	***Create*** an idea about social issues and environment	Create	PSO10
CO7	***Apply*** the principles of solid waste management.	Apply	PSO10
C08	***Design*** energy production from waste	Create	PSO11

COURSE CONTENT	
Module 1. Analytical Principles II	**6 Hours**
1.1. 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) 1.2. Introduction of micro scale experiments in inorganic and organic qualitative analysis & their advantages 1.3. Preparation of Na2CO3 extract for inorganic qualitative analysis for anions, and its advantages. 1.4. Gravimetric analysis – Principles of gravimetric Estimation. Mechanism of precipitate formation. Factors affecting stability of precipitates. Co-precipitation and post precipitation. Effects of digestion, washing, drying and ignition of precipitates. Use of calcium chloride and silica gel in desiccators.	
Module 2. Metallurgy	**Hours**
2.1. Prerequisites: Occurrence of metals based on standard electrode potential – Concentration of ores – Calcination and roasting – Reduction to free metal. 2.2. Electrometallurgy – Hydrometallurgy. Refining of metals: Electrolytic refining, ion exchange method, zone refining, vapour phase refining and oxidative refining – Ellingham diagrams for metal oxides 2.3. Extractive metallurgy of Al, Fe, Ni, Cu, Ti and U 2.4. 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.	
Module 3. Interhalogen compounds	**5 Hours**
3.1. Prerequisites: Halogens, properties, electronic configuration, electronegativity, electron affinity. 3.2. General preparation and properties of interhalogen compounds (study of individual members not required) 3.3. Electropositive character of iodine – Structure, hybridization and reactivity of ClF3, ICl3, IF5 and IF7 3.4. Comparison of properties of halogens and pseudohalogens (cyanogens as example) – Structure of polyhalide ions.	
Module 4. Noble Gases	**5 Hours**
4.1. Prerequisites: Why the name noble gas? Electronic configuration. 4.2. Occurrence and uses Separation of noble gases by charcoal adsorption method 4.3. Rationalization of inertness of noble gases - preparation, properties, structure and reactivities of fluorides (XeFn) and oxofluorides (XeOmFn) of xenon 4.4. Xenon-oxygen compounds - Fluorides of Krypton –Clathrates.	
Module 5. Module V - Inorganic Polymers	**5 Hours**
5.1. Prerequisites: Catenation 5.2. Inorganic Polymers: Heterocatenation. Structure and applications of silicones and silicates. 5.3. Phosphazenes: Preparation, properties, structure and uses of di and tri and poly phosphonitrilic chlorides.	

5.4. SN compounds: Preparation, properties, structure and uses of S2N2, S4N4 and (SN)x. Zeolites.

Module 6. Environmental Chemistry	**12 Hours**

6.1. Prerequisites: What is Pollution? Quality of drinking water.

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

6.3. 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.

6.4. Toxic metals in water (Pb, Cd and Hg) – Minamata disaster (a brief study). Control of water pollution – Need for the protection of water bodies.

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

6.6. Hiroshima, Nagasaki and Chernobyl accidents (a brief study).

6.7. Local environmental movements: Silent Valley, Plachimada, Narmada. Air pollution in Indian cities (Delhi, Agra and Kanpur).

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

6.9. Solid waste management - Household, municipal and industrial solid waste – non-degradable, degradable and biodegradable waste – Hazardous waste – Pollution due to plastics.

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

Module 7. Social Issues and the Environment	**12 Hours**

7.1. Urban problems related to energy. Water conservation, rainwater harvesting, water shed management.

7.2. Resettlement and rehabilitation of people: its problems and concerns. Environmental ethics: Issues and possible solutions.

7.3. 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.

MODE OF TRANSACTION

Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

Peer to Peer learning: Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

a. Classroom participation (20%): 3 Mark
b. Test papers I (40%): 6 Mark
c. Assignment (20%): 3 Mark
d. Seminar/ Viva (20%): 3 Mark

External Assessment (60 Marks) Duration 2 Hours, No of Questions: 21

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	12	Up to 12	2	**20**
Paragraph	7	Up to 7	5	**30**
Essay	2	1	10	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module 1: Analytical Principles II	9
Module 2: Metallurgy	12
Module 3: Interhalogen Compounds	8
Module 4: Noble Gases	8
Module 5: Inorganic Polymers	10
Module 6: Environmental Chemistry	20
Module 7: Social Issues and the Environment	8

REFERENCES:

Module I

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 Textbook of Quantitative Chemical Analysis, 6th Ed., Pearson Education, Noida, 2013.

Module II

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.

Module III

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.

Module IV

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.

Module V

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.

Module VI

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., New Delhi, 2006.
3. A. K. Ahluwalia, Environmental Chemistry, Ane Books India, New Delhi, 2008.

Module VII

1. Heywood, V.H & Watson, R.T. 1995. Global Biodiversity Assessment, Cambridge University Press.
2. Jadhav. H & Bhosale. V.M. 1995. Environmental Protection and Laws. Himalaya Pub. House, Delhi.
3. Mekinney, M.L & Schock. R.M. 1996 Environmental Science Systems & Solutions. Web enhanced edition.

FURTHER READING

MODULE I

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

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

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

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

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

MODULE VI

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

1. Miller T.G. Jr., Environmental Science, Wadsworth Publishing Co. (TB).

COURSE CODE –BCH5B07 **CORE COURSE VII:** ORGANIC CHEMISTRY – II				
Credit	Hours/week	Marks		
		Internal	External	Total
3	4	15	60	75

CO No.	**Expected Course Outcome** Upon completion of this course, students will be able to;	**Learning Domain**	**PSO No**
CO1	***Recall***, ***recognize*** and ***describe*** the nomenclature and general properties of organic compounds	Remember	PSO1
CO2	***Explain*** and ***interrelate*** the principles behind qualitative and quantitative analysis of organic compounds	Understand	PSO2
CO3	***Select*** and ***use*** organic compounds for the synthetic applications.	Apply	PSO7
CO4	***Identify*** and ***relate*** different organic rearrangements based on their structure and mechanism.	Analyze	PSO8
CO5	***Develop*** an idea about the environment issues during various synthesis and modify the methods.	Create	PSO10
CO6	***Justify*** and ***assess*** the principles and mechanism of various organic synthesis and its uses.	Apply	PSO10

COURSE CONTENT

Module 1. Module I: Alcohols and Phenols	**12 Hours**

1.1. Prerequisites: Monohydric alcohols – Nomenclature, hydrogen bonding

1.2. 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).

1.3. 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.

1.4. Phenols - Nomenclature, preparation of phenols (from cumene and aromatic sulphonic acid) and acidity of phenol (substituent effects).

1.5. 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.

1.6. Preparation of phenolphthalein and fluorescein and colour change of phenolphthalein with pH.

Module 2. Ethers and Epoxides	**4 Hours**

2.1. Reactions of ethers: Acidic cleavage and Claisen rearrangement (mechanism expected) – Zeisel's method of estimation of methoxy groups.

2.2. Crown ethers: Nomenclature – importance in organic synthesis and phase transfer catalysis (PTC).

2.3. Epoxides: Synthesis from alkenes – acid catalyzed ring opening of epoxides, orientation of epoxide ring opening.

Module 3. Halogen compounds and Organometallic Compounds	**6 Hours**

3.1. Preparation and reactions of alkyl and aryl halides.

3.2. Reactions of Grignard and organolithium reagents with epoxides.

3.3. Preparation and synthetic applications of Grignard reagent and organozinc compounds.

Module 4. Module IV: Carbonyl compounds and active methylene groups	**8 Hours**

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

4.2. 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).

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

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

4.5. Reactions involving α carbons of carbonyl compounds – Aldol condensation, Cannizzaro reaction.

Haloform reaction (mechanism expected

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

Module 5. Carboxylic Acids and Sulphonic Acids	**12 Hours**

5.1. Prerequisites: Carboxylic Acids: Nomenclature – Isomerism. Preparation.

5.2. 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).

5.3. Reactions of carboxylic acids – conversion to acid chlorides, esters, amides and acid anhydrides.

5.4. Relative reactivity of carboxylic acid derivatives (acid chlorides, esters, amides and acid anhydrides). Fischer esterification (mechanism expected), HVZ reaction – Decarboxylation – Kolbe electrolysis (mechanism expected).

5.5. 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.

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

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

Module 6. Nitrogen Compounds	**14 Hours**

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

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

6.3. Amines: Nomenclature – Isomerism. Preparation: From alkyl halides, nitro compounds, nitriles, isonitriles and amides – Hofmann's bromamide reaction, Schmidt reaction and Gabriel phthalmide synthesis.

6.4. 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.

6.5. Electrophilic substitution reactions of aniline: Halogenation, nitration and sulphonation.

6.6. Preparation and uses sulpha drugs – Structural formula of sulphapyridine, sulphadiazine, sulphathiazole and sulphaguanidine.

6.7. 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 7. Organic reactions mechanism and synthetic application	**8 Hours**

7.1. Pinacol-pinacolone rearrangement, Riemer-Tiemann reaction, Claisen rearrangement, Benzoin condensation, Perkin's reactions.

7.2. Wittig reaction, Beckmann rearrangement, Reformatsky reaction (citric acid preparation).

7.3. Hofmann's bromamide reaction, Schmidt, Curtius and Lossen rearrangement

7.4. Mcmurry reaction, Favorski, benzilic acid rearrangement, Baeyer-Villeger reaction.

MODE OF TRANSACTION

Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

Peer to Peer learning: Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

a. Classroom participation (20%): 3 Mark
b. Test papers I (40%): 6 Mark
c. Assignment (20%): 3 Mark
d. Seminar/ Viva (20%): 3 Mark

External Assessment (60 Marks) Duration 2 Hours, No of Questions: 21

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	12	Up to 12	2	**20**
Paragraph	7	Up to 7	5	**30**
Essay	2	1	10	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module I: Alcohols and Phenols	14
Module II: Ethers and Epoxides	6
Module III: Halogen compounds and Organometallic Compounds	8

Module IV: Carbonyl compounds and active methylene groups	12
Module V: : Carboxylic Acids and Sulphonic Acids	13
Module VI: Module VI: Nitrogen Compounds	14
Module VII: Organic reactions mechanism and synthetic application	12

REFERENCES:

1. R. T. Morrison, R. N. Boyd, Organic Chemistry, 7th Ed., Pearson Education, New Delhi, 2013. 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.
6. FURTHER READING
7. J. Clayden, N. Greeves, S. Warren, P. Wothers, Organic Chemistry, Oxford University Press, New York, 2012.
8. P. Y. Bruice, Essential Organic Chemistry, 3rd Ed., Pearson Education, 2015.
9. John McMurry, Organic Chemistry, 5th Ed., Thompson Asia Pvt Ltd, 2000.
10. C. N. Pillai, Organic Chemistry, Universities Press, 2008.
11. R. K. Bansal, A Textbook of Organic Chemistry, New Age International, 2010.

COURSE CODE –BCH5B08 **CORE COURSE VIII**: PHYSICAL CHEMISTRY – II				
Credit	Hours/week	Marks		
		Internal	External	Total
3	3	15	60	75

CO No.	**Expected Course Outcome** Upon completion of this course, students will be able to;	**Learning Domain**	**PSO No**
CO1	***Apply*** the concept of kinetics, catalysis and photochemistry to various chemical and physical processes.	Apply	PSO 2
CO2	***Interpret*** different types of adsorption and isotherms	Understand	PSO 4
CO3	***Discuss*** different types of catalysis	Understand	PSO 2
CO4	***Characterise*** different molecules using spectral methods.	Analyse	PSO 7
CO5	***Develop*** in-depth knowledge about various phase transitions and its applications.	Create	PSO 12

COURSE CONTENT	
Module 1. Kinetics	**10 Hours**
1.1. 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 nth order reactions) 1.2. 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) 1.3. Arrhenius equation – Effect of temperature on reaction rates. Determination and significance of Arrhenius parameters. 1.4. Theories of reaction rates – Collision theory – Derivation of rate equation for bimolecular reactions using collision theory – Transition state theory 1.5. Expression for rate constant based on equilibrium constant and thermodynamic aspects (derivation not required) – Unimolecular reactions – Lindemann mechanism.	
Module 2. Adsorption and Catalysis	**6 Hours**
2.1. Prerequisites: Physical and chemical adsorption, factors affecting adsorption. 2.2. 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. 2.3. 2.3. Catalysis: Homogeneous and heterogenous catalysis – Theories of homogenous and heterogenous catalysis – Enzyme catalysis – Michaelis-Menten equation (derivation not required).	
Module 3. Phase Equilibria	**10 Hours**
3.1. Prerequisites: Concept of phase - solid, liquid and gas - homogeneous and heterogeneous phase - component and degree of freedom 3.2. Gibbs phase rule and its derivation. Clausius-Clapeyron equation and its applications to solid-liquid, liquid-vapour and solid-vapour equilibria, 3.3. Phase diagram for one component systems, with applications. One component system: Water and sulphur systems. 3.4. 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). 3.5. Freezing mixtures – Thermal analysis – Cooling curve method – Deliquescence and efflorescence. 3.6. Liquid-liquid equilibria – Partially miscible and immiscible liquid systems – CST – Upper CST and lower CST – Steam distillation. Nernst distribution law: Derivation and applications.	
Module 4. Molecular Spectroscopy I	**12 Hours**

4.1. Prerequisites: Electromagnetic spectrum - wavelength, frequency, wavenumber. 4.2. Interaction of electromagnetic radiation with matter – Qualitative aspects, Einstein, absorption-emission and factors affecting line width and intensity of signal (elementary idea) – 4.3. Energy levels in molecules – Born-Oppenheimer approximation. 4.3. Rotational Spectroscopy: Introduction – Rigid rotor – Expression for energy – Selection rules – Intensities of spectral lines – Determination of bond lengths of diatomic molecules. 4.4. 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 CO2 and H2O. 4.5. 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. 4.6. 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 5. Molecular Spectroscopy II	**4 Hours**
5.1. Prerequisites: Electromagnetic spectrum – energy range and frequency 5.2. Nuclear Magnetic Resonance (NMR) Spectroscopy: Proton NMR and 13C NMR – Principle – Number and position of signals – Chemical shift – Different scales – Spin-spin coupling (qualitative idea). NMR spectra of simple molecules. 5.3. Electron Spin Resonance (ESR) Spectroscopy: Principle – Hyperfine structure – ESR of methyl, phenyl and cycloheptatrienyl radicals.	
Module 6. Photochemistry	**6Hours**
6.1. Prerequisites: Introduction – Difference between thermal and photochemical processes – Beer Lambert's law. 6.2. Laws of photochemistry: Grothus-Draper law and Stark-Einstein's law of photochemical equivalence. 6.3. Quantum yield and its explanation 6.4. Photophysical processes: Jablonski diagram – Fluorescence – Phosphorescence. Non-radiative processes: Internal conversion and inter system crossing. 6.5. Photosensitization – Chemiluminescence – Photochemical reactions (hydrogen-chlorine and hydrogen-bromine).	

MODE OF TRANSACTION
Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students. **Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity

for critical thinking and feedback.

Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

a. Classroom participation (20%): 3 Mark
b. Test papers I (40%): 6 Mark
c. Assignment (20%): 3 Mark
d. Seminar/ Viva (20%): 3 Mark

External Assessment (60 Marks) *D*uration 2 Hours, No of Questions: 21

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	12	Up to 12	2	**20**
Paragraph	7	Up to 7	5	**30**
Essay	2	1	10	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module1: Kinetics	17
Module 2: Adsorption and Catalysis	10
Module 3: Phase Equilibria	17
Module 4: Molecular Spectroscopy I	18
Module 5: Molecular Spectroscopy II	7
Module 6: Photochemistry	10

REFERENCES:

Module I & II

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
3. Press, 2006.
4. Donald A. McQuarrie, John D. Simon, Physical Chemistry: A Molecular Approach,
5. University Science Books: Sausalito, CA; 1997.
6. K. Laidler, Chemical Kinetics, 3rd Ed., Pearson Education, New Delhi, 2004.
7. P. L. Soni, O. P. Dharmarha, U. N. Dash, Textbook of Physical Chemistry, 23rd Ed., Sultan Chand & Sons, New Delhi, 2011.
8. K. L. Kapoor, Physical Chemistry, Vol. II and III, Macmillan Publishers, Noida,
9. 2004.

Module III

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. Donald A. McQuarrie, John D. Simon, Physical Chemistry: A Molecular Approach, University Science Books: Sausalito, CA; 1997.
4. P. L. Soni, O. P. Dharmarha, U. N. Dash, Textbook of Physical Chemistry, 23rd Ed., Sultan Chand & Sons, New Delhi, 2011.

Module IV & V

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. Donald A. McQuarrie, John D. Simon, Physical Chemistry: A Molecular Approach, University Science Books: Sausalito, CA; 1997.
4. C. N. Banwell, Fundamentals of molecular spectroscopy, McGraw-Hill, 1994.
5. G. M. Barrow, Introduction to Molecular Spectroscopy, McGraw Hill, London, 1962.

Module VI

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. Donald A. McQuarrie, John D. Simon, Physical Chemistry: A Molecular Approach, University Science Books: Sausalito, CA; 1997.
4. K. K. Rohatgi-Mukherjee, Fundamentals of Photochemistry, New Age International, 1978.

FURTHER READING

Module I & II

1. Gordon 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.

Module III

1. Gordon 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.
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1. G. M. Barrow, Physical Chemistry, 5th Ed., Tata McGraw Hill Education, New Delhi, 2006.
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4. F. Daniels, R. A. Alberty, Physical Chemistry, 5th Ed., John Wiley and Sons, Canada, 1980.
5. Peter Atkins, J. de Paula, The Elements of Physical Chemistry, 7th Ed., Oxford University Press, Oxford, 2016.
6. P. R. Singh, S. K. Dixit, Molecular Spectroscopy: Principles and Chemical Applications, S. Chand & Company, New Delhi 1980.
7. P. K. Bhattacharya, Group Theory and its Chemical Applications, Himalaya Publishing House, New Delhi, 1986.
8. F. A. Cotton, Chemical Applications of Group Theory, 3rd Ed., John Wiley & Sons, New Delhi.

Module VI

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. Peter Atkins, Julio de Paula, The Elements of Physical Chemistry, 7th Ed., Oxford University Press, Oxford, 2016.
6. K. Laidler, Chemical Kinetics, 3rd Ed., Pearson Education, New Delhi, 2004.

SEMESTER 6

COURSE CODE –BCH6B09 **CORE COURSE IX**: INORGANIC CHEMISTRY – IV				
Credits	Hours/week	Marks		
		Internal	External	Total
3	3	15	60	75

CO No.	**Expected Course Outcome** Upon completion of this course, students will be able to;	**Learning Domain**	**PSO No**
CO1	***Distinguish*** between lanthanides and actinides.	Remember	PSO 2
CO2	***Explain*** the principles behind different instrumental methods.	Understand	PSO 2
CO3	***Classify*** the basic reactions in non-aqueous solvents	Evaluate	PSO 4
CO4	***Analyse*** the importance of crystal field theory	Analyse	PSO 4
CO5	***Distinguish*** geometries of coordination compounds.	Understand	PSO 2

CO6	***Remember*** the importance of metals in living systems.	Remember	PSO 12

Course Outcomes

COURSE CONTENT

Module 1. Instrumental Methods of Analysis	**6 Hours**
1.1. Prerequisites: laws of spectrophotometry - Beer-Lambert's law. 1.2. Atomic Absorption Spectroscopy (AAS), Flame Emission Spectroscopy – Colorimetry – Spectrophotometry. 1.3. Scanning Electron Microscopy (SEM). 1.4. Transmission Electron Microscopy (TEM). 1.5. Thermogravimetry (TGA), Differential Scanning Calorimetry (DSC) [Principle and applications only.]	
Module 2. Non-aqueous Solvents	**3 Hours**
2.1. Prerequisites: Self-ionization of water 2.2. Non-aqueous Solvents: Classification – General properties – Self ionization and – levelling effect 2.3. Reactions in liquid ammonia, liquid N_2O_4, liquid SO_2 and liquid HF.	
Module 3. Transition and Inner Transition Elements	**8 Hours**
3.1. Prerequisites: Transition Metals: General characteristics: Metallic character, oxidation states, size, density, melting point, boiling point. Lanthanides: Electronic configuration and general characteristics. 3.2. 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. 3.3. Explanation of metallic properties of transition metals based on theories of Metallic Bonding: Free electron theory, valence bond theory and band theory (qualitative treatment only) 3.4. Lanthanides: Occurrence of lanthanides– Isolation of lanthanides from monazite sand – Separation by ion exchange method. Lanthanide contraction: Causes and consequences. Industrial importance of lanthanides. 3.5. Actinides: Electronic configuration and general characteristics – Comparison with lanthanides.	
Module 4. Coordination Chemistry	**16 Hours**
4.1. Prerequisites: Coordinate bond, postulates of Werner's theory, ligand, coordination number, homoleptic and heteroleptic complex, isomerism in coordination compounds, difference between double salt and complex. 4.2. Isomerism in coordination compounds –Structural isomerism and stereo isomerism. Chelates, chelate effect-Stability of complexes: Inert and labile complexes – Factors influencing stability. 4.3. 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. 4.4. 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. 4.5. 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.	

Module 5. Organometallic Compounds	**8 Hours**

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

5.2. 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.

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

5.4. 5.4. 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 Mn2CO10 and Co3(CO)12.

Module 6. Bioinorganic Chemistry	**7 Hours**

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

6.2. Essential and trace elements in biological systems

6.3. Evolution of bioinorganic chemistry as a branch. Biological functions and toxicity of metals – Fe, Cu, Zn, Cr, Mn, Ni, Co, Cd, Hg and Pb.

6.4. Structure and functions of haemoglobin and myoglobin, and Cobalamines. Metalloenzymes of zinc-carbonic anhydrase, carboxy peptidase, alcohol dehydrogenase. Cytochrome (structural feature).

6.5. Na/K pump.

6.6. Chlorophyll and photosynthesis (mechanism not expected)

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

MODE OF TRANSACTION

Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

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Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

a. Classroom participation (20%): 3 Mark

b. Test papers I (40%): 6 Mark

c. Assignment (20%): 3 Mark

d. Seminar/ Viva (20%): 3 Mark
External Assessment (60 Marks) *Duration 2 Hours, No of Questions: 21*

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Paragraph	7	Up to 7	5	**30**
Essay	2	1	10	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module 1: Instrumental Methods of Analysis	10
Module 2: Non-aqueous Solvents	8
Module 3: Transition and Inner Transition Elements	12
Module 4: Coordination Chemistry	24
Module 5: Organometallic Compounds	12
Module 6: Bioinorganic Chemistry	14

REFERENCES:

Module I

1. D. A. Skoog, F. James Holler, S. R. Crouch, Principles of Instrumental Analysis, 6th Ed., 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.

Module II

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

Module III

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, Milestone Publishers, New Delhi, 2010.
3. J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, Inorganic Chemistry, Pearson, 2006.

Module IV

1. R. Gopalan, V. Ramalingam, Concise Coordination Chemistry, 1st Ed., Vikas Publishing 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.

Module V

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.

Module VI

1. B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi, 2010.
2. G. L. Meissler, D. A. Tarr, Inorganic Chemistry, 3rd 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., John Wiley, 1995.

FURTHER READING

Module I

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

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

Module III

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

Module IV

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, New York, 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

1. R. C. Mehrothra, A. Singh, Organometallic chemistry, New age publishers, 1991.

Module VI

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. Silverstone Valentine, Bioinorganic Chemistry, Viva Books Pvt. Ltd., 2007.

COURSE CODE –BCH6B10 CORE COURSE X: ORGANIC CHEMISTRY – III				
Credit	Hours/week	Marks		
		Internal	External	Total
3	3	15	60	75

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Recognize*** and describe the structure of organic molecules and its purification methods.	Remember	PSO1
CO2	***Justify*** the structure of simple organic compounds using spectral techniques.	Evaluate	PSO8
CO3	***Predict*** and represents the basic components and importance of biomolecules.	Understand	PSO5
CO4	***Distinguish*** and illustrate different pericyclic reactions and their application.	Analyze	PSO5
CO5	***Examine*** the chemical characteristics of natural products and biomolecules and its important applications.	Apply	PSO9
CO6	***Combine*** the concept obtained and explain the role of organic chemistry in the existence of living organisms.	Create	PSO10

COURSE CONTENT	
Module 1. Structure Elucidation Using Spectral Data	**10 Hours**
1.1. Prerequisites: Electromagnetic spectrum- wavelength, frequency and energy relation. Beer-Lambert's law - chromophore and auxochrome, functional groups. 1.2. Purification of organic compounds: Column, paper and thin layer chromatography. Gas Chromatography. 1.3. 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. λmax calculation for dienes and α,β-unsaturated carbonyl compounds. 1.4. IR Spectroscopy: Concept of group frequencies – fingerprint region – IR spectra of alcohols, phenols, amines, ethers, aldehydes, ketones, carboxylic acids, esters and amides. 1.5. 1H NMR: Chemical shift – Spin-spin splitting – Chemical and magnetic equivalence Interpretation of 1H 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. 1.6. 1.6. Structure elucidation of simple organic compounds using UV, IR and 1H NMR spectroscopic techniques (ethanol, acetone, acetophenone, acetaldehyde, acetic acid, propanoic acid and ethyl acetate).	
Module 2. Bioorganic compounds - 1	**Hours**
2.1. Prerequisites: Classification. Monosaccharides: Fischer projection – D, L configuration. Cyclic structure of ribose, deoxy ribose, glucose and fructose.] 2.2. Carbohydrates: Monosaccharides: Ribose, Arabinose, Glucose, Galactose, Fructose, Psicose. Epimers and anomeres – Mutarotation 2.3. Reactions of glucose – Killiani-Fischer synthesis and Ruff degradation – Conversion of aldoses to ketoses and vice versa – Osazone formation. 2.4. Disaccharides: Cyclic structure of maltose, lactose and sucrose – Inversion of cane sugar. Reducing and non-reducing sugars. 2.5. Polysaccharides: Structure of cellulose, starch and glycogen (structure elucidation not required). 2.6. 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.	
Module 3. Bioorganic compounds – 2	**15 Hours**
3.1. Prerequisites: Amino acids – Classification – Structure of amino acids – Zwitter ion formation – Isoelectric point. 3.2. 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. 3.3. Denaturation of proteins. Enzymes – characteristics and examples. Tests for proteins: Chemistry of Xanthoprotein test, Biuret test and Ninhydrin test. 3.4. 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.

3.5. 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.

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

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

3.8. Vitamins: Fat soluble and water-soluble vitamins – Vitamin A, B, C, D, E, K - Sources and deficiency diseases – Structure of vitamin C.

Module 4. Heterocyclic compounds and Natural products	**7 Hours**

4.1. Prerequisites: Structure of heterocyclic systems.

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

4.3. Alkaloids: Extraction. Classification based on structure of heterocyclic ring. Physiological actions of nicotine, quinine, coniine.

4.4. 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.

Module 5. Pericyclic Reactions	**8 Hours**

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

5.2. Introduction – Molecular orbitals of conjugated π systems (C2, C3, C4, C5 and C6 systems). Frontier Molecular Orbitals (FMOs). Types of pericyclic reactions.

5.3. Electrocyclic reactions: Butadiene↔cyclobutene and hexatriene↔cyclohexadiene interconversions. Dis and con rotation.

5.4. Cycloaddition reactions: Dimerisation of ethylene and Diel's-Alder reaction. Supra-supra and supra-antara interactions.

5.5. 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).

5.6. Pericyclic reactions in human body – Vitamin D from cholesterol (elementary idea).

MODE OF TRANSACTION

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MODULE WISE MARK DISTRIBUTION

Module	Mark
Module I: Structure Elucidation Using Spectral Data	16
Module II: Bioorganic compounds - 1	16
Module III: Bioorganic compounds – 2	18
Module IV: Heterocyclic compounds and Natural products	13
Module V: Pericyclic Reactions	16

REFERENCES:

Module I

1. R. M. Silverstein, F. X. Webster, Spectrometric Identification of Organic Compounds, 6th Ed., John Wiley and Sons, New York, 2004.
2. Y. R. Sharma, Elementary Organic Spectroscopy, 5th Ed., S. Chand & Company Ltd., New Delhi, 2013.
3. D. L. Pavia, G. M. Lampman, G. S. Kriz, Introduction to Spectroscopy, 5th Ed., Thomson Brooks Cole, 2015.

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

Module II

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.

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1. I L. Finar, Organic Chemistry, Vol. I & II, Pearson Education.
2. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, A Textbook of Organic Chemistry, 2nd 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.

Module V

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

Module I

1. P. S. Kalsi, Applications of Spectroscopic Techniques in Organic Chemistry, 6th Ed., New Age International (P) Ltd., New Delhi, 2004.
2. William Kemp, Organic Spectroscopy, 2nd Ed., Macmillan, New York, 1987.
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.

Module II

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

Module III

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

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

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.

COURSE CODE –BCH6B11 **CORE COURSE XI**: PHYSICAL CHEMISTRY – III				
Credits	Hours/week	Marks		
		Internal	External	Total
3	3	15	60	75

Course Outcomes

CO No.	**Expected Course Outcome** Upon completion of this course, students will be able to;	**Learning Domain**	**PSO No**
CO1	***Explain*** the basic concepts of electrochemistry and generate ideas to tackle the global energy crisis.	Understand	PSO 7
CO2	***Show*** the importance of colligative properties.	Understand	PSO 2
CO3	***Describe*** the concept of buffer solutions and its applications.	Remember	PSO 2
CO4	***Sketch*** the properties of materials/solids to the geometrical	Apply	PSO 4

	properties and chemical compositions.		
CO5	***Classify*** the different types of defects in solids.	Understand	PSO 2

COURSE CONTENT

Module 1. Electrochemistry – I	**12 Hours**

1.1. Prerequisites: Fundamentals of Electrochemistry. Introduction (Faradays law, types of conductance)

1.2. Measurement of equivalent conductance – Variation of conductance with dilution – Kohlrausch's law – Arrhenius theory of electrolyte dissociation and its limitations.

1.3. Ionic mobility – relation with ion conductivity, influence of temperature onion 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.

1.4. 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.

1.5. Applications of conductivity measurements: Determination of degree of dissociation, ionic product of water and solubility product of sparingly soluble salts (work out problems)

1.6. Conductometric titrations, strong acid-strong base, weak acid-strong base, strong acid-weak base and weak acid-weak base

Module 2. Electrochemistry – II	**10 Hours**

2.1. Prerequisites: Module I – Electrochemistry. Basics of thermodynamics. Types of cell and electrodes (Reversible - SHE, calomel and quinhydrone electrode) – Standard electrode potential – Electrochemical series.

2.2. Nernst equation for electrode potential and EMF of a cell – Relationship between free energy and electrical energy. Gibbs Helmholtz equation to galvanic cells.

2.3. Concentration cells: Concentration cells with and without transference – Liquid junction potential (LJP).

2.4. Application of EMF measurements: Solubility of sparingly soluble salts – Determination of pH – pH measurement using glass electrode – Potentiometric titrations – Hydrogen-oxygen fuel cell – Electrochemical theory of corrosion of metals

Module 3. Solutions	**Hours**

3.1. 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

3.2. 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)

3.3. 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.

Module 4. Ionic Equilibria	**3 Hours**

4.1. Prerequisites: Introduction to acid base theories – pKa, pKb and pH – Buffer solutions. 4.2. Hard and soft acids and bases, HSAB principle and its applications 4.3. Mechanism of buffer action – Buffer index – Henderson equation 4.4. 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.	
Module 5. Solid State – I	**10 Hours**
5.1. Prerequisites: Introduction - Amorphous and crystalline solids – Law of constancy of interfacial angles and rational indices – Space lattice and unit cell. 5.2. Direct and reciprocal lattice (Miller indices) – Seven crystal systems and fourteen Bravais lattices – X-ray diffraction – Bragg's law (derivation required) - Planes 5.3. 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 5.4. Identification of cubic crystals from inter-planar ratio – Close packing of spheres 5.5. Structure of simple ionic compounds of the type AB 9naCl and CsCl) and AB2 (CaF2)	
Module 6. Solid State – II	**3 Hours**
6.1. Band theory (qualitative idea) for Metals, Insulators and Semiconductors: Intrinsic and extrinsic conduction (elementary idea). 6.2. Non-stoichiometric defects. 6.3. Liquid crystals: Classification and applications (elementary idea).	

MODE OF TRANSACTION

Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

Peer to Peer learning: Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

i. Classroom participation (20%): 3 Mark
j. Test papers I (40%): 6 Mark
k. Assignment (20%): 3 Mark
l. Seminar/ Viva (20%): 3 Mark

External Assessment (60 Marks)	*Duration 2 Hours, No of Questions: 21*			
PATTERN OF QUESTION PAPER				
Pattern	**Total No. of questions**	**No. of questions to be answered**	**Marks for each question**	**Ceiling of Marks**
Short answer	12	Up to 12	2	**20**
Paragraph	7	Up to 7	5	**30**
Essay	2	1	10	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION	
Module	**Mark**
Module I: Electrochemistry – I	17
Module 2: Electrochemistry – II	14
Module 3: Solutions	14
Module 4: Ionic Equilibria	8
Module 5: Solid State – I	17
Module 6: Solid State – II	9

REFERENCES

Module I & II

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. Donald A. McQuarrie, John D. Simon, Physical Chemistry: A Molecular Approach University Science Books: Sausalito, CA; 1997.
4. S. Glasstone, An Introduction to Electrochemistry, East-West Press Pvt. Ltd., New Delhi, 2007.

Module III

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. Donald A. McQuarrie, John D. Simon, Physical Chemistry: A Molecular Approach, University Science Books: Sausalito, CA; 1997.
4. P. L. Soni, O. P. Dharmarha, U. N. Dash, Textbook of Physical Chemistry, 23rd Ed., Sultan Chand & Sons, New Delhi, 2011.

Module IV

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. Donald A. McQuarrie, John D. Simon, Physical Chemistry: A Molecular Approach, University Science Books: Sausalito, CA; 1997.
4. P. L. Soni, O. P. Dharmarha, U. N. Dash, Textbook of Physical Chemistry, 23rd Ed., Sultan Chand & Sons, New Delhi, 2011.

Module V & VI

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. Donald A. McQuarrie, John D. Simon, Physical Chemistry: A Molecular Approach, University Science Books: Sausalito, 1997.
4. Anthony R. West, Solid State Chemistry and its Applications, 2nd Ed., Wiley-Blackwell, 2014.

FURTHER READING

Module I & II

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. Peter Atkins, Julio de Paula, The Elements of Physical Chemistry, 7th Ed., Oxford University Press, Oxford, 2016.
6. J. Bockris, A. K. N. Reddy, Modern Electrochemistry, Kluwer Academic/Plenum Publishers, New York, 2000.

Module III

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.

Module IV

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

Module V & VI

1. Gordon 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. Peter Atkins, Julio de Paula, The Elements of Physical Chemistry, 7th Ed., Oxford University Press, Oxford, 2016.
6. L. V. Azaroff, Introduction to Solids, Tata McGraw Hill Publishing Company, New Delhi, 1960.

COURSE CODE –BCH6B12 **CORE COURSE XII**: ADVANCED AND APPLIED CHEMISTRY				
Credit	Hours/week	Marks		
		Internal	External	Total
3	3	15	60	75

Course Outcomes

CO No.	**Expected Course Outcome** Upon completion of this course, students will be able to;	**Learning Domain**	**PSO No**
CO1	***Understand*** advanced chemistry and related research areas.	Understand	PSO2
CO2	***Appreciate*** the importance of green approach in chemistry.	Analyze	PSO8
CO3	***Examine*** the various types of noncovalent interactions in supramolecular chemistry.	Apply	PSO7

CO4	***Classify*** different types of nanomaterials.	Analyze	PSO8
CO5	***Evaluate*** different types of characterization techniques.	Evaluate	PSO4
CO6	***Create*** an idea about chemical industries in Kerala.	Create	PSO10
CO7	***Understand*** the relevance of biochemical analysis.	Understand	PSO2
C08	***Evaluate*** the role of chemistry in human happiness index and life expectancy.	Evaluate	PSO4
C09	***Understand*** the uses and importance of computational calculations in molecular design.	Understand	PSO2

COURSE CONTENT	
Module 1. Chemistry of Nanomaterials	**8 Hours**
1.1. Evolution of Nanoscience, Classification of nanomaterials (0D, 1D, and 2D) – Top down and bottom-up approaches in the synthesis 1.2. 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 1.3. Metal and semiconductor nanoparticles and carbon-based nanomaterials. Fullerenes, carbon nanotubes, and graphenes. 1.4. Characterization of nanomaterials - XRD, Atomic Force Microscopy (AFM), Scanning Tunneling Microscopy (STM), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM). 1.5. Applications of nanomaterials in nanoelectronics, nanosensors, nanocatalysts, nanofilteration, diagnostic and therapeutic applications.	
Module 2. Green Chemistry	**Hours**
2.1. Birth of green chemistry – need of green chemistry approach – Twelve principles of green chemistry with explanations - Atom economy and microwave assisted reactions – Green solvents 2.2. Green synthesis of ibuprofen. Microwave and ultrasound assisted green synthesis: Diels-Alder reaction and Cannizzaro reaction- Introduction to microscale experiments.	
Module 3. Molecular Recognition and Supramolecular Chemistry	**6 Hours**
3.1. The concepts of molecular recognition, host, guest and receptor systems. Supramolecular chemistry, Forces involved in molecular recognition. 3.2. Hydrogen bonding, ionic bonding, pi stacking, van der Waals and hydrophobic interactions. Molecular recognition in DNA and protein structures.	
Module 4. Introduction to Computational Chemistry	**8 Hours**
4.1. 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. 4.2. 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. 4.3. Geometry optimization. Software's used in computational chemistry calculations.	
Module 5. Medicinal Chemistry	**8 Hours**
5.1. Health and Biochemical Analysis: Biochemical analysis of urine and serum. Blood: Composition, grouping and Rh factor - Blood transfusion 5.2. 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.

5.3. 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

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

Module 6. Industrial Catalysis	**8 Hours**

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

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

6.3. Basic concepts in phase transfer catalysis – phase transfer catalysed reactions

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

6.5. 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., TiO2 pigment from ilmenite – Travancore Titanium Products Ltd.

Module 7. Food chemistry	**6 Hours**

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

7.2. 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)

7.3. Natural pigments in fruits and vegetables (carotenoids, chlorophylls and flavonoids). Artificial ripening of fruits. Composition of chocolate, milk powder and soft drinks.

MODE OF TRANSACTION

Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

Peer to Peer learning: Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

a. Classroom participation (20%): 3 Mark
b. Test papers I (40%): 6 Mark
c. Assignment (20%): 3 Mark
d. Seminar/ Viva (20%): 3 Mark

External Assessment (60 Marks) *Duration 2 Hours, No of Questions: 21*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	12	Up to 12	2	**20**
Paragraph	7	Up to 7	5	**30**
Essay	2	1	10	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module I: Chemistry of Nanomaterials	8
Module II: Green Chemistry	4
Module III: Molecular Recognition and Supramolecular Chemistry	6
Module IV: Introduction to Computational Chemistry	8
Module V: Medicinal Chemistry	8
Module VI: Industrial Catalysis	8
Module VII: Food chemistry	6

REFERENCES:

Module I

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

Module II

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.

Module III & IV

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

Module V

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

Module VI

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

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

Module I

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

Module II

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 & IV

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

Module V

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 VII

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

COURSE CODE –BCH6E01 **CORE COURSE XIII:** ELECTIVE 1. INDUSTRIAL CHEMISTRY				
Credit	Hours/week	Marks		
		Internal	External	Total
2	3	15	60	75

Course Outcomes

CO No.	**Expected Course Outcome** Upon completion of this course, students will be able to;	**Learning Domain**	**PSO No**
CO1	***Summarize*** various requirements of an industry and industrial safety.	Understand	PSO2
CO2	***List*** the various types of petroleum products.	Remember	PSO1

CO3	***Identify*** the various processes in petroleum industry.	Analyze	PSO2 PSO5
CO4	***Discuss*** the importance and to familiarize the opportunities of pharmaceutical, leather and sugar industries.	Understand	PSO2
CO5	***Distinguish*** different types of fibres and dyes.	Understand	PSO4
CO6	***List*** some important pigments of applications.	Remember	PSO1
CO7	***Generate*** an idea about the important requirement of a good paint.	Create	PSO4

COURSE CONTENT	
Module 1. Introduction	**4 Hours**
1.1. Requirements of an industry and location 1.2. Requirement water – industrial water treatment 1.3. Safety measures for industry 1.4. Pilot plants 1.5. ISO certification of industry.	
Module 2. Petrochemical Industry	**12 Hours**
2.1. Introduction to Natural gas – CNG, LNG and LPG. Coal and Classification based on carbon content. 2.2. Carbonisation of coal – composition and uses of various fractions. 2.3. Crude Oil: Constitution and distillation – composition and uses of different distillates 2.4. Ignition point, flash point and octane number – cracking. 2.5. Catalysts used in Petroleum Industries: Structure, selectivity and applications. Synthetic Petrol: Manufacture by Bergius and Fischer-Tropsch processes. 2.6. Manufacture of petrochemicals: Ethylene glycol, glycerine, acetone, phenol, vinyl acetate, toluene, linear alkyl benzenes and their sulphonates. 2.7. Usage and depletion of petroleum products – need for alternative fuel – hydrogen as the future fuel.	
Module 3. Pharmaceutical Industry	**8 Hours**
3.1. Definition and History of drugs 3.2. Prodrug – Drug toxicity – Thalidomide tragedy (a brief study) 3.3. Routes of drug administration and Effective use of drugs. 3.4. Drug over dosage, Prescription and non-prescription drugs and brief discussion on drug abuse. 3.5. Definition of cancer, Lung cancer (causes, symptoms and treatment). 3.6. Medical applications of nanomaterials.	
Module 4. Industrial Catalysis	**6 Hours**
4.1. Types of catalysts: Homogenous and heterogenous catalysis. 4.2. Applications of phase transfer catalysis and nano particle catalysts. 4.3. Uses of Zeigler Natta catalyst and Wilkinson catalyst (mechanism not expected). 4.4. Applications of raney nickel, platinum, palladium, ruthenium and TiO2 based catalysts.	
Module 5. Leather and Sugar Industries	**8 Hours**
5.1. Leather Industry and manufacture of leather, Preparatory stages, tanning (vegetable and chrome tanning), crusting and surface coating. 5.2. Tannery effluent and byproduct problems. 5.3. Sugar Industry: Manufacture of sugar from cane sugar-Double sulphitation process – Refining and grading of	

sugar.

Module 6. Textiles, Paints and Pigments	**8 Hours**

6.1. Textile Industry: Production of viscose fibre from cellulose. Properties and uses of nylon and polyester fibers.

6.2. Introduction to dyeing – Chromophore, auxochrome and chromogen – Primary and secondary colours – Chromatic and achromatic colours –

6.3. Dyeing of nylon with acid dyes.

6.4. 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.

6.5. Varnishes: Spirit varnishes and oleo resinous varnishes – Raw materials – Enamels and lacquers (brief study).

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

MODE OF TRANSACTION

Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

Peer to Peer learning: Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

a. Classroom participation (20%): 3 Mark
b. Test papers I (40%): 6 Mark
c. Assignment (20%): 3 Mark
d. Seminar/ Viva (20%): 3 Mark

External Assessment (60 Marks) *Duration 2 Hours, No of Questions: 21*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	12	Up to 12	2	**20**
Paragraph	7	Up to 7	5	**30**
Essay	2	1	10	**10**

Total	**60**

MODULE WISE MARK DISTRIBUTION	
Module	**Mark**
Module1: Introduction	4
Module 2: Petrochemical Industry	18
Module 3: Pharmaceutical Industry	13
Module 4: Industrial Catalysis	12
Module 5: Leather and Sugar Industries	14
Module 6: Textiles, Paints and Pigments	18

REFERENCES:

1. B. K. Sharma, Industrial chemistry, 11th Ed., Goel publishing House, Meerut, 2000. 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. E. Stocchi, Industrial Chemistry, Vol. I, Ellis Horwood Ltd. UK, 1990.
4. P. C. Jain, M. Jain, Engineering Chemistry, Dhanpat Rai & Sons, Delhi, 2015.
5. B. K. Sharma, H. Gaur, Industrial Chemistry, Goel Publishing House, Meerut, 1996.
6. G. L. Patrick, Introduction to Medicinal Chemistry, 6th Ed., Oxford University Press, UK, 2017.
7. Hakishan Singh, V. K. Kapoor, Medicinal and Pharmaceutical Chemistry, Vallabh Prakashan, Pitampura, New Delhi, 2005.
8. Thomas L. Lemke, David A. William, Foye's Principles of Medicinal Chemistry, 6th Ed., Wolters Kluwer Health, 2006.
9. Jayashree Ghosh, A Text Book of Pharmaceutical Chemistry, S. Chand and Co. Ltd, 1999.
10. O. Le. Roy, Natural and synthetic organic medicinal compounds, Ealemi, 1976.
11. P. H. Groggins, Unit Process in Organic Synthesis, 5th Ed., McGraw Hill, New York, 2001.
12. L. K. Doraiswamy, Organic Synthesis Engineering, Academic Press, New York, 2001.
13. M. Gopalarao, M. Sitting, Dryden's Outlines of Chemical Tech., 2nd Ed., EastWest Pub., New Delhi, 1997.
14. D. Woodroffe, Fundamental of Leather Science, 1st Ed., A Harvey, 1942.
15. N. J. Park Ridge, Chemical treatment of hides and leather, Noyes Publications, 1985.
16. Sara J. Kadolph, Anna L. Langford, Textiles, 10th Ed., Pearson/Prentice-Hall, New Delhi, 2007.
17. A A. Vidya, Production of Synthetic Fibers, Prentice-Hall of India, New-Delhi, 1988.

COURSE CODE –BCH6E02 CORE COURSE XIII: ELECTIVE 2. POLYMER CHEMISTRY				
Credit	Hours/week	Marks		
		Internal	External	Total
2	3	15	60	75

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Summarize*** the classification of polymers based on the structure and intermolecular interactions.	Understand	PSO2
CO2	***Identify*** the features of the mechanisms of different polymerization reactions.	Remember	PSO1
CO3	***Demonstrate*** the relevance of polymer molecular properties on properties of the polymers.	Understand	PSO2
CO4	List the types polymer degradations.	Remember	PSO1
CO5	***Classify*** different types of polymerization techniques and understand the advantages and disadvantages of each technique.	Analyse	PSO5
CO6	***Compare*** the different polymer processing techniques.	Evaluate	PSO4
CO7	***Propose*** suitable commercially important polymers for specific applications.	Create	PSO11

COURSE CONTENT	
Module 1. Introduction	**6 Hours**
1.1. Polymers and macromolecules, Monomers, Homo and hetero polymers and copolymers. 1.2. Classification based on origin (natural, semi synthetic and synthetic), synthesis (addition and condensation), structure (linear, branched chain and cross linked). 1.3. Classification based on intermolecular forces (elastomers, fibres, thermoplastics and thermosetting polymers), Tacticity.	
Module 2. Types of Polymerisation	**9 Hours**
2.1. Chain and step growth polymerizations 2.2. Types of chain groth polymerizations:Free radical, ionic and coordination polymerizations with mechanism – Zeigler-Natta polymerization (mechanism expected) and its advantages. 2.3. Ring-opening & group transfer polymerization (Mechanism not needed).	
Module 3. Properties and Degradation of Polymers	**9 Hours**
3.1. Glass Transition Temperature (Tg): Definition- Factors affecting Tg - Importance of Tg. 3.2. 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. 3.3. Polymer solubility (basic concept only), Viscoelasticity of polymers (basic concept only) - Vulcanisation and cyclisation reactions. 3.4. Polymer degradation; Photochemical degradation, Thermal degradation, Oxidative degradation, Chemical Hydrolytic, Biodegradation	
Module 4. Polymerisation Techniques	**12 Hours**
4.1. Bulk, solution, suspension, emulsion, melt condensation and interfacial polycondensation polymerisations. 4.2. Polymer Processing: Calendaring, rotational moulding, compression, injection moulding, blow moulding and thermoforming, Solution, suspension and casting process of plastics	
Module 5. Polymer Processing	**6 Hours**
5.1. Additives for Plastics and Rubbers. Fillers, Coupling Agents, Plasticisers, Flow promoters, 5.2. Elementary Idea about Anti-ageing additives, Flame retarders, Colouring agents, Blowing agents and cross-linking agents, (Elementary ideas)	
Module 6. Commercial Polymers	**12Hours**
6.1. Preparation, structure, properties and uses of polyethylene (LDPE and HDPE), polypropylene, polystyrene, PVC, PVP, teflon, PAN, PMMA, 6.2. Synthetic rubbers (BR, SBR, nitrile rubber, neoprene, butyl rubber and silicone rubber). 6.3. Terylene, glyptal, lexan, kevlar, nomex, polyurethanes, melmac, phenol-formaldehyde resin and urea-formaldehyde resin.	

6.4. Plastic identification codes, Recycling of plastics.

6.5. Polymers in medical field - High temperature and fire-resistant polymers

6.6. Conducting polymers - Carbon fibers (basic idea only).

MODE OF TRANSACTION

Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

Peer to Peer learning: Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

a. Classroom participation (20%): 3 Mark

b. Test papers I (40%): 6 Mark

c. Assignment (20%): 3 Mark

d. Seminar/ Viva (20%): 3 Mark

External Assessment (60 Marks) *Duration 2 Hours, No of Questions: 21*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	12	Up to 12	2	**20**
Paragraph	7	Up to 7	5	**30**
Essay	2	1	10	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module1: Introduction	4
Module 2: Types of Polymerisation	16
Module 3: Properties and Degradation of Polymers	16

Module 4: Polymerization Techniques	18
Module 5: Polymer Processing	6
Module 6: Commercial Polymers	18

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, 3rdEd.,Oxford University Press, 2005.

COURSE CODE –BCH6E03 CORE COURSE XIII: ELECTIVE 3. MEDICINAL AND ENVIRONMENTAL CHEMISTRY				
Credits	Hours/week	Marks		
		Internal	External	Total
2	3	15	60	75

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	Discuss the importance of drugs in human health.	Remember	PSO12
CO2	Illustrate the facts about common diseases and treatment.	Understand	PSO12
CO3	Identify the presence of toxic substances in atmosphere.	Remember	PSO10
CO4	Classify air pollution control measures and monitoring techniques.	Understand	PSO10
CO5	Apply chemistry in treatment of water and sewage.	Apply	PSO10

COURSE CONTENT	
Module 1. Health and Biochemical Analysis	**6 Hours**
1.1. Definition of health - WHO standard , Sterilization of surgical instruments 1.2. Biochemical analysis of urine and serum. 1.3. Blood: Composition, grouping and Rh factor - Blood transfusion.	
Module 2. Drugs	**4 Hours**
2.1. Definition – History of drugs – Prodrug, Prescription and non-prescription drugs, Routes of drug administration 2.2. Drug dosage -Effective use of drugs – Over dosage 2.3. Drug toxicity – Thalidomide tragedy (a brief study) – Drug abuse. 2.4. 2.6. Assay of Drugs: Chemical, biological and immunological assays - LD50 and ED50 and therapeutic index.	
Module 3. Common Diseases and Treatment	**10 Hours**
3.1. Diseases - Communicable and non-communicable diseases - Causes, symptoms 3.2. 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) 3.3. Bronchial asthma, kidney stone, diabetes – Drugs used in the treatment for systemic hypertension and hypercholesterolemia. 3.4. 3.4. Cancer: Definition - Lung cancer (causes, symptoms and treatment) – Avenues for the treatment of terminal cancer.	
Module 4. Environmental Toxicology	**6 Hours**
4.1. Introduction – Threshold Limiting Value 4.2. Source and toxicological effects of inorganic compounds (H2S, Cl2 and asbestos), organic compounds (CCl4, phenol, benzene, phenylene diamines, nitroso amines and p-dichlorobenzene), 4.3. Persistent organic pollutants (dioxins, TCDD, pesticides: Endosulphan, carbaryl and DDT), phthalates and heavy metals (As and Hg). 4.4. 4.4. Endosulfan disaster in Kerala (brief study).	
Module 5. Control and Monitoring of Air Pollutants	**12 Hours**
5.1. 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. 5.2. Air Pollutant Monitoring: Sampling methods for particulate analysis - Filtration, sedimentation, electrostatic samplers, thermal precipitators and impingers. 5.3. Sampling methods for gases and vapours – Cold trapping, absorption and adsorption. 5.4. 5.4. Analytical methods for the determination of CO, NOx, SOx, H2S, hydrocarbons and particulate matter.	
Module 6. Water Treatment Processes	**10 Hours**

6.1. Types and characteristics of industrial waste water - Aerobic and anaerobic oxidation - Sedimentation, coagulation, filtration, disinfection, desalination and ion exchange.

6.2. Primary treatment - Secondary treatment - Trickling filters, activated sludge process and sludge digestion - Tertiary treatment - USAB process and deep well injection.

6.3. 6.3. Sewage and sewage analysis - Total solids, settable solids, suspended solids - Protection of surface waters from pollution with industrial sewage

MODE OF TRANSACTION

Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

Peer to Peer learning: Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

a. Classroom participation (20%): 3 Mark
b. Test papers I (40%): 6 Mark
c. Assignment (20%): 3 Mark
d. Seminar/ Viva (20%): 3 Mark

External Assessment (60 Marks) *Duration 2 Hours, No of Questions: 21*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	12	Up to 12	2	**20**
Paragraph	7	Up to 7	5	**30**
Essay	2	1	10	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module 1: Health and Biochemical Analysis	6

Module 2: Drugs	8
Module 3: Common Diseases and Treatment	17
Module 4: Environmental Toxicology	12
Module 5: Control and Monitoring of Air Pollutants	18
Module 6: Water Treatment Processes	18

REFERENCES:

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

COURSE CODE –BCH6B13L **CORE COURSE XIV**: PHYSICAL CHEMISTRY PRACTICAL				
Credit	Hours/week	Marks		
		Internal	External	Total
4	5	20	80	100

* Examination will be held at the end of sixth semester

Course Outcomes

CO No.	**Expected Course Outcome** Upon completion of this course, students will be able to;	**Learning Domain**	**PSO No**
CO1	***Develop*** analytical skills in determining the physical properties (physical constants).	Create	PSO4 PSO7
CO2	***Develop*** skill in setting up an experimental method to determine the physical properties.	Create	PSO7
CO3	***Estimate*** physical constants	Understand	PSO4
CO4	Explain the principles of Viscosity, Spectroscopy, Refractometry, Potentiometry and Conductometry; and to apply the skill to determine unknown concentration	Understand Apply	PSO4 PSO7
CO5	***Compare*** various instrumentation techniques	Analyze	PSO7
C06	***Interpret*** the measured data and draw conclusion	Understand Evaluate	PSO4
C07	***Calculate*** various physical parameters	Apply	PSO4
C08	***Compute*** and analyse chemical data using Gaussian 16 program.	Apply Analyze	PSO8

COURSE CONTENT	
Experiments	**Total Hours: 80**

General Instructions

- General Instructions
- For weighing electronic balance may be used.
- Use safety coat, goggles, shoes and gloves in the laboratory.
- A minimum number of 10 experiments must be done, covering at least six modules, to appear for the examination.
- The practical must be completed in the semester V. *Practical examination will be conducted at the end of semester VI*

Module 1. Viscosity and Surface tension

1.1. Determination of viscosity of various liquids using Ostwald's viscometer.

1.2. 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)].

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

Module 2. Colligative properties (Cooling curve method)

2.1. Determination of cryoscopic constant (Kf) of solid solvent using a solute of known molecular mass.

2.2. Determination of molecular mass of the solute using a solvent of known cryoscopic constant (Kf).

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

Module 3. Transition Temperature

3.1. Determination of molal transition point depression constant (Kt) of salt hydrate using solute of known molecular mass.

3.2. Determination of molecular mass of the solute using a solvent of known molal transition point depression constant (Kt).

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

Module 4. Phase Equilibria

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

4.2. Influence of KCl impurity on miscibility temperature of phenol-water system and determination of

concentration of given KCl solution.
Module 5. Spectroscopy
5.1. 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. 5.2. Find out the unknown concentration of the given solution. (Five standards may be prepared).
Module 6. Refractometry
6.1. Determination of composition of glycerine-water mixture by refractive index method. 6.2. Determination of refractive indices of KCl solutions of different concentration and concentrations of unknown KCl solution. 6.3. Estimation of citric acid in lemon or orange.
Module 7. Conductometry and Potentiometry
7.1. Conductometric titration of strong acid x strong base. 7.2. Potentiometric titration of strong acid x strong base.
Module 8. pHmetry
8.1. Preparation of acidic / alkaline buffer solutions and measure their pH. 8.2. pH metric titration of strong acid with strong base.
Module 9. Kinetics
9.1. Determination of specific reaction rate of the hydrolysis of methyl acetate catalysed by hydrogen ion at room temperature. 9.2. Determination of overall order of saponification of ethyl acetate.
PART-B
Computational and instrumental experiments
Module 10. 1 - Computational Chemistry Experiments with Gaussian 16 program.
10.1. Single point energy calculations of simple molecules like H_2O and NH_3 at the B3LYP /3-21G level of theory 10.2. 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). 10.3. Geometry optimization of molecules like H_2O, NH_3, HCHO & C_2H_4 at the B3LYP/6-31G* level of theory

10.4. Computation of dipole and quadrupole moments of HCHO & C2H4 at the B3LYP /6-31G level of theory.

10.5. Comparison of stability of cis- and trans- isomers of difluoroethylene at the B3LYP /6-31G* level of theory.

10.6. Computation of the energy of HOMO and LUMO of H2O and NH3

10.7. at the B3LYP /6-31G* level of theory.

10.8. Comparison of stability of cis-planar and trans-planar conformers of H2O2 at the

10.9. B3LYP /6-31G* level of theory

Module 11. 2-Physical chemistry experiments

11.1. Determination of Activity Coefficient of Silver ions by Potentiometric measurements. (a) with transference (b) without transference.

11.2. Determination of dissociation constant of weak acid.

11.3. Determination of concentration of an optically active substance by Polarimetric measurements (Glucose/Fructose/Sucrose).

11.4. Determination of equivalent conductance of strong electrolytes at several concentrations and verification of Onsager equation.

11.5. Determination of equivalent conductance of weak electrolytes at infinite dilution by using Kohlrausch's law.

MODE OF TRANSACTION

Demonstrations: Helps to illustrate and consolidate theoretical principles outlined in the course. Experimentation: This involves learning by doing or hands on experience by applying biological principles.

Experimentation: This involves learning by doing.or hands on experience by applying chemical principles.

Observation: It involves noticing or perceiving biological specimens or equipments and acquisition of information from the primary source:

MODE OF ASSESSMENT

Internal Assessment (20 Marks)

a. Submission of Record* 12 Mark

b. Lab involvement 8Mark

i. Viva 4Mark

ii. Lab skill /performance# 2 Mark

iii. punctuality$ 2 Mark

**Every student has to submit record of experiments and other lab works which is duly certified by the HoD*

#*Skill and performance in doing experiments and observations*

$*Students involvement in the laboratory will be assessed by the course instructor*

External Assessment (80 Marks): *Duration 3 Hours*

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

**SEE will be at the end of Sixth Semester*

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.

COURSE CODE –BCH6B14L
CORE COURSE XV: ORGANIC CHEMISTRY PRACTICAL

Credit	Hours/week	Mark		
		Internal	External	Total
4	5	20	80	100

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Develop*** analytical skills in organic qualitative analysis.	Create	PSO7
CO2	***Develop*** talent in organic preparations to ensure maximum yield.	Create	PSO10
CO3	***Apply*** the concept of melting or boiling points to check the purity of compounds.	Apply	PSO9
CO4	***Analyse*** and characterise simple organic functional groups.	Analyse	PSO8
CO5	***Analyse*** individual amino acids from a mixture using chromatography.	Analyse	PSO8

COURSE CONTENT	
Experiments	**Total Hours: 80**

General Instructions

- Semi-micro analysis must be adopted for organic qualitative analysis.
- Use safety coat, goggles, shoes and gloves in the laboratory.
- Reactions must be carried out on tiles, wherever possible.
- A minimum number of 7 organic analysis, 6 organic preparations and 1 chromatographic separation shall be done to appear for the examination.
- The practical must be completed in the semester V. *Practical examination will be conducted at the end of semester VI*

PART A

Organic Chemistry Experiments

Module 1. Reagent Preparation

1.1. Preparation of Borsche's reagent, Schiff's reagent, Tollen's Reagent, Fehling's solution, phenolphthalein, methyl orange, N-Phenylanthranilic acid and neutral FeCl3.

Module 2. Determination of Physical Constants

2.1. Determination of boiling point.

2.2. Determination of melting point (capillary method and using melting point apparatus).

Module 3. Recrystallization Techniques

3.1. Recrystallize any four organic compounds using ethyl acetate, ethanol and water.

3.2. Note the crystalline shape.

Module 4. Solvent Extraction (Use ether and record the yield recovery)

4.1. Aniline from water.

4.2. Methyl benzoate from water.

Module 5. Reactions of Organic Compounds

5.1. 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).

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

Module 6. Organic Preparations

6.1. Halogenation: p-bromoacetanilide from acetanilide, tribromoaniline from aniline.

6.2. Nitration: p-nitroacetanilide from acetanilide.

6.3. Oxidation: Benzoic acid from benzaldehyde, Benzoic acid from toluene.

6.4. Hydrolysis: Benzoic acid from ethyl benzoate, Benzoic acid from benzamide.

6.5. Diazo-coupling: Methyl orange from aniline, Phenylazo-β-naphthol from aniline.

6.6. Haloform reaction: Iodoform from acetone or ethyl methyl ketone.

6.7. Acylation: Acetylation of salicylic acid or aniline, Benzoylation of aniline or phenol.

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

Module 7. Chromatography

7.1. Paper chromatographic separation of mixture of two amino acids

PART B

Organic Chemistry Preparations (8 Hours)

Module 8. Preparation of drug/intermediates

8.1. Aspirin

8.2. Benzimidazole

8.3. Benzotriazole

8.4. Sulphanilamide

8.5. 1,2,3,4-tetrahydrocarbazole

MODE OF TRANSACTION

Demonstrations: Helps to illustrate and consolidate theoretical principles outlined in the course. Experimentation: This involves learning by doing or hands on experience by applying biological principles.

Experimentation: This involves learning by doing.or hands on experience by applying chemical principles.

Observation: It involves noticing or perceiving biological specimens or equipments and acquisition of information from the primary source:

MODE OF ASSESSMENT

Internal Assessment (20 Marks)

a. Submission of Record* 12 Mark

b. Lab involvement 8Mark

i. Viva 4Mark

ii. Lab skill /performance# 2 Mark

iii. punctuality$ 2 Mark

**Every student has to submit record of experiments and other lab works which is duly certified by the HoD*

#*Skill and performance in doing experiments and observations*

$*Students involvement in the laboratory will be assessed by the course instructor*

External Assessment (80 Marks): *Duration 3 Hours*

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

**SEE will be at the end of Sixth Semester*

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

COURSE CODE –BCH6B15L **CORE COURSE XVI**: INORGANIC CHEMISTRY PRACTICAL-II				
Credit	Hours/week	Mark		
		Internal	External	Total
4	5	20	80*	100

* *Includes 15 mark for Industrial Visit*

Course Outcomes

CO No.	**Expected Course Outcome** Upon completion of this course, students will be able to;	**Learning Domain**	**PSO No.**
CO1	***Recognize*** methods to precipitate different ions.	Remember	PSO 1
CO2	***Discuss*** changes on the nature of compounds upon heating.	Understand	PSO 2
CO3	***Compare*** different filtration methods and chose the best.	Evaluate	PSO 4
CO4	***Develop*** analytical skills in inorganic quantitative analysis.	Analyse	PSO 4 PSO 10
CO5	***Determine*** the quantity of different ions.	Evaluate	PSO 4
CO6	***Assess*** completeness of precipitation reaction.	Evaluate	PSO 5
CO7	***Recognize*** principles behind colourimetry.	Remember	PSO 2
CO8	***Determine*** quantity of ions by colourimetry.	Evaluate	PSO 7

CO9	***Test*** validity of Beer-lamberts Law.	Evaluate	PSO 3

COURSE CONTENT

Experiments	**Total Hours: 80**

General Instructions

- For weighing, electronic balance may be used.
- Use safety coat, goggles, shoes and gloves in the laboratory.
- A minimum number of 7 experiments must be done, covering the three modules, to appear for the examination.
- The report of industrial visit must be submitted, along with the practical record, to appear for the examination.

Module 1. Gravimetric Analysis – I (using silica crucible)

1.1. Determination of water of hydration in crystalline barium chloride.
1.2. Determination of water of hydration in crystalline magnesium sulphate.
1.3. Estimation of Ba^{2+} as $BaSO_4$
1.4. Estimation of SO_4^{2-} as $BaSO_4$
1.5. Estimation of Fe^{3+} as Fe_2O_3
1.6. Estimation of Ca^{2+} as $CaCO_3$
1.7. Estimation of Al^{3+} as Al_2O_3

Module 2. Gravimetric Analysis – II (using sintered crucible)

2.1. Estimation Ni^{2+} as nickel dimethyl glyoximate.
2.2. Estimation Cu^{2+} as cuprous thiocyanate.
2.3. Estimation Mg^{2+} as magnesium oxinate.

Module 3. Colorimetry

3.1. Verification of Beer-Lambert law for $KMnO_4$ and $K_2Cr_2O_7$ and determination of concentration of the given solution.
3.2. Estimation of iron.
3.3. Estimation of chromium.
3.4. Estimation of nickel.

MODE OF TRANSACTION

Demonstrations: Helps to illustrate and consolidate theoretical principles outlined in the course. Experimentation: This involves learning by doing or hands on experience by applying biological principles.

Experimentation: This involves learning by doing.or hands on experience by applying chemical principles.

Observation: It involves noticing or perceiving biological specimens or equipments and acquisition of information from the primary source:

MODE OF ASSESSMENT

Internal Assessment (20 Marks)

a. Submission of Record* 12 Mark

b. Lab involvement 8Mark

i. Viva 4Mark

ii. Lab skill /performance# 2 Mark

iii. punctuality$ 2 Mark

**Every student has to submit record of experiments and other lab works which is duly certified by the HoD*

#*Skill and performance in doing experiments and observations*

$*Students involvement in the laboratory will be assessed by the course instructor*

External Assessment (80 Marks): *Duration 3 Hours; Includes 15 mark for Industrial Visit*

Pattern	Marks
Gravimetry and Colorimetry	
Procedure of colorimetry	4
Procedure of gravimetry	8
Result	35
Calculation	2
Record	8
Viva-Voce	8
Industrial Visit	
Report	8
Viva-Voce	7
Total	**80**

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.

COURSE CODE –BCH6B16L
CORE COURSE XVII: INORGANIC CHEMISTRY PRACTICAL-III

Credit	Hours/week	Mark		
		Internal	External	Total
4	5	20	80	100

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Develop*** skills in inorganic qualitative analysis.	Create	PSO7
CO2	***Demonstrate*** the reactions of common cations and anions.	Understand	PSO8
CO3	***Identify*** interfering radicals and explain their elimination.	Analyse	PSO9
CO4	***Explain*** the principles behind inorganic mixture analysis and to apply it in qualitative analysis.	Apply	PSO5
CO5	***Analyse*** systematically mixtures containing two cations and two anions.	Analyse	PSO10

COURSE CONTENT

Experiments	**Total Hours: 80**

General Instructions

- Semi-micro analysis must be adopted for inorganic qualitative analysis.
- Mixtures containing more than one interfering anion must be avoided.
- If interfering anions are not present, cations may be given from the same group.
- Use safety coat, goggles, shoes and gloves in the laboratory.
- A minimum of 7 inorganic mixtures must be done to appear for the examination

Module 1. Inorganic Qualitative Analysis

1.1. Study of the reactions of following ions.

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

ii) Cations: Lead, bismuth, copper, cadmium, iron, aluminium, cobalt, nickel, manganese, zinc, barium, calcium, strontium, magnesium, and ammonium.

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

MODE OF TRANSACTION

Demonstrations: Helps to illustrate and consolidate theoretical principles outlined in the course. Experimentation: This involves learning by doing or hands on experience by applying biological principles.

Experimentation: This involves learning by doing.or hands on experience by applying chemical principles.

Observation: It involves noticing or perceiving biological specimens or equipments and acquisition of information from the primary source:

MODE OF ASSESSMENT

Internal Assessment (20 Marks)

a. Submission of Record* 12 Mark

b. Lab involvement 8Mark

i. Viva 4Mark

ii. Lab skill /performance# 2 Mark

iii. punctuality$ 2 Mark

**Every student has to submit record of experiments and other lab works which is duly certified by the HoD*

[#]*Skill and performance in doing experiments and observations* [$]*Students involvement in the laboratory will be assessed by the course instructor*
External Assessment (80 Marks): *Duration 3 Hours*

Pattern	**Marks**
Question on qualitative analysis	4
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
Total	**80**

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, 3rdEd., The National Publishing Company, Chennai, 1974.
3. W. G. Palmer, Experimental Inorganic Chemistry, Cambridge University Press, 1970.

COURSE CODE – BCH6B17P
CORE COURSE XVIII: PROJECT WORK

Credit	Hours/week	Marks		
		Internal	External	Total
2	0	15	60	75

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

Course Outcomes

CO No.	Expected Course Outcome	Learning Domain	PSO No

	Upon completion of this course, students will be able to;		
CO1	***Propose*** a problem for the project work.	Create	PSO2
CO2	***Summarize*** review of literature.	Understand	PSO2
CO3	***Design*** a methodology for carrying out the project work.	Create	PSO2
CO4	***Develop*** analytical skills in setting up experimental techniques and operate it to determine the data required.	Create Apply	PSO4 PSO7
CO5	***Measure*** and ***interpret*** the data to draw conclusion.	Understand	PSO4 PSO6 PSO8
CO6	***Make*** a project report.	Create	PSO11

MODE OF TRANSACTION
Demonstrations: Helps to illustrate and consolidate theoretical principles outlined in the course. **Experimentation:** This involves learning by doing.or hands on experience by applying chemical principles. **Observation:** It involves noticing or perceiving biological specimens or equipments and acquisition of information from the primary source:

MODE OF ASSESSMENT
Internal Assessment (15 Marks) a. *Originality of content (20%)* — *3* Mark b. *Methodology of presentation (20%)* — *3* Mark c. *Organisation of report and conclusion (30%)* — *4.5* Mark d. *Viva-voce (30%)* — *4.5* Mark Supervising teachers will assess the project and award internal marks
External Assessment (60 Marks):

Criteria	**Marks**
Content and relevance of the project (20%)	12
Presentation and quality of analysis (20%)	12
Findings and recommendations (30%)	18
Viva-voce (30%)	18
Total	**60**

OPEN COURSE SYLLABUS

SEMESTER 5

COURSE CODE – BCH5D01 OPEN COURSE 1: ENVIRONMENTAL CHEMISTRY				
Credits	Hours/week	Marks		
		Internal	External	Total
3	3	15	60	75

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Recall*** the technical/scientific terms involved in pollution.	Remember	PSO 1
CO2	***Identify*** the causes and effects of air pollution	Understand	PSO 10
CO3	***Explain*** the sources, types and effects of water pollution.	Create	PSO 10
CO4	***Describe*** water quality parameters.	Understand	PSO 4
CO5	***Know*** soil, noise, thermal and radioactive pollutions and their effects.	Apply	PSO 10
CO6	***Analyse*** various pollution control measures.	Analyse	PSO 10
CO7	***Discuss*** the basics of green chemistry.	Understand	PSO 10

COURSE CONTENT	
Module 1. Introduction to Environment and Environmental pollution	**4 Hours**
1.1. Environmental chemistry - introduction, Environmental segments – Lithosphere: components of soils, Hydrosphere: water resources, Biosphere, Atmosphere - regions of atmosphere – Troposphere, stratosphere, mesosphere, and thermosphere. 1.2. Environmental pollution – Concepts and definition – Pollutant, contaminant, receptor and sink 1.3. Classification of pollutants – Global, regional, local, persistent and non-persistent pollutants.	
Module 2. Air Pollution	**8 Hours**
2.1. Tropospheric pollution – Gaseous air pollutants – Hydrocarbons, oxides of sulphur, nitrogen and carbon – Global warming, greenhouse effect, acid rain 2.2. Particulates – Smog: London smog and photochemical smog – effects and control of photochemical smog 2.3. Stratospheric pollution - depletion of ozone layer, chlorofluorocarbons 2.4. Automobile pollution. 2.5. Control of air pollution – Alternate refrigerants 2.6. Bhopal Tragedy (a brief study). 2.7. Air pollution in Indian cities (Delhi, Agra and Kanpur).	
Module 3. Water Pollution	**10 Hours**
3.1. Impurities in water – cause of pollution – natural and anthropogenic – Marine water pollution – Underground water pollution. 3.2. Source of water pollution – Industrial waste, Municipal waste, Agricultural waste, Radioactive waste, Petroleum, Pharmaceutical, heavy metal, pesticides, soaps and detergents. 3.3. Types of water pollutants: Biological agents, physical agents and chemical agents – Eutrophication - biomagnification and bioaccumulation. 3.4. Water quality parameters: DO, BOD, COD, alkalinity, hardness, chloride, fluoride and nitrate. 3.5. 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.	
Module 4. Soil, Noise, Thermal, Light and Radioactive Pollutions	**8 Hours**
4.1. 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. 4.2. Non-degradable, degradable and biodegradable wastes. Hazardous waste. 4.3. Noise Pollution – physiological response to noise, Noise categories - effect of noise – biological effects. 4.4. Thermal pollution – definition, sources, harmful effects and prevention. Light pollution. 4.5. Radioactive pollution (source, effects and control measures) – Hiroshima, Nagasaki and Chernobyl accidents (brief study). Endosulfan disaster in Kerala (brief study).	
Module 5. Pollution Control Measures	**12 Hours**

5.1. 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.

Module 6. Green Chemistry	**6 Hours**

6.1. Introduction- Definition of green Chemistry, need of green chemistry

6.2. Basic principles of green chemistry.

6.3. Applications of green chemistry in daily life.

MODE OF TRANSACTION

Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

Peer to Peer learning: Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

a. Classroom participation (20%): 3 Mark
b. Test papers I (40%): 6 Mark
c. Assignment (20%): 3 Mark
d. Seminar/ Viva (20%): 3 Mark

External Assessment (60 Marks) *Duration 2 Hours, No of Questions: 21*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	12	Up to 12	2	**20**
Paragraph	7	Up to 7	5	**30**
Essay	2	1	10	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module I: Introduction to Environment and Environmental Pollution	9
Module II: Air Pollution	14
Module III : Water Pollution	18
Module IV: Soil, Noise, Thermal, light and Radioactive Pollutions	14
Module V: Pollution Control Measures	16
Module VI: Green Chemistry	8

REFERENCES:

Module 1

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

Module 2

1. S. K. Banergy, Environmental Chemistry, 2nd Ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 2005.
2. V. N. Bashkin, Environmental Chemistry: Asian Lessons, Springer Science & Business Media, 2003.
3. S. E. Manahan, Environmental Chemistry, 8th Ed., CRC Press, Florida, 2004.
4. A. K. Ahluwalia, Environmental Chemistry, The Energy and Resources Institute, 2017.
5. Balram Pani, Textbook of Environmental Chemistry, I. K. International Pvt. Ltd., 2010.

Module 3

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

Module 4

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

Module 5

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 6

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.

COURSE CODE –BCH5D02 OPEN COURSE 2: CHEMISTRY IN DAILY LIFE				
Credit	Hours/week	Marks		
		Internal	External	Total
3	3	15	60	75

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Understand*** various applications of Chemistry in daily life.	Understand	PSO2
CO2	***Evaluate*** the importance chemistry in agriculture, food industry, cosmetics, and cleaning.	Evaluate	PSO4
CO3	***Classify*** different types of polymers.	Analyse	PSO8
CO4	***Create*** an awareness on various food habits and harmful effects of modern food habits.	Create	PSO10
CO5	***Understand*** the functions of biomolecules, vitamins, enzymes, hormones and nucleic acid.	Understand	PSO2
CO6	***Recognize*** the common classes of drugs in pharmaceutical industry and their application.	Analyse	PSO8
CO7	***Understand*** the uses of pesticides and fertilizers and their impacts on the environment.	Understand	PSO2
C08	***Understand*** the basic concepts and processes in petroleum industry.	Understand	PSO2
C09	***Evaluate*** the role of chemistry in human happiness index and life expectancy.	Evaluate	PSO4

COURSE CONTENT	
Module 1. Polymers	**8 Hours**
1.1. Classification of polymers: Origin, structure, synthesis, molecular forces. Commercially important polymers 1.2. Application of polyethylene, polystyrene, polyhaloolefines, Nylon 6, Nylon 66, Melamine, Terylene, Bakelite, natural and synthetic rubber, vulcanization 1.3. Advantages of vulcanized rubber, natural silk and artificial silk, inorganic polymer: (Examples Only). 1.4. Plastic identification codes – Applications of biodegradable polymers (PGA, PLA and PHBV) – Importance of plastic recycling.	
Module 2. Chemistry in Biological Systems	**8 Hours**
2.1. Vitamins: Name, source, function and deficiency diseases. Enzymes - Classifications, characteristics, role, examples. 2.2. Hormones - Sex hormones - Androgens, oestrogens, progesterone, example, function. Cortical hormones - a few examples with function. 2.3. Nucleic acid - RNA, DNA: Introduction - role in life process (No structure or chemical reactions needed).	
Module 3. Food Chemistry	**8 Hours**
3.1. Common adulterants in different foods: Milk and milk products, vegetable oils, cereals, tea, coffee powder, chili powder and beverages. 3.2. 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. 3.3. Modern Food Habits: Definition and health effects of fast foods, instant foods, dehydrated foods and junk foods. Harmful effects of modern food habits. 3.4. Importance of milk, coconut water and Neera.	
Module 4. Agriculture	**4 Hours**
4.1. 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 4.2. 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.	
Module 5. Cleansing Agents and Cosmetics	**6 Hours**
5.1. Cleansing Agents: Soaps – Hard and soft soaps – Alkali content – TFM – Detergents (classification) 5.2. 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. 5.3. Cosmetics: Hair dye: Chemicals used and its harmful effects. Face and skin powders: Types, ingredients and functions.	

5.4. Cleansing creams: Cold creams, vanishing creams and bleach creams.

5.5. Perfumes, antiperspirants, sun screen preparations, nail polishes, lipsticks, rouges, eyebrow pencils and eye liners (ingredients and functions) – Harmful effects of cosmetics.

Module 6. Pharmaceuticals and Vaccines	**8 Hours**

6.1. Drug: Chemical name, generic name and trade names with examples.

6.2. Terminology: Prodrug, pharmacy, pharmacology, pharmacophore, pharmacognosy, pharmacodynamics and pharmacokinetics (elementary idea only).

6.3. Antipyretics, analgesics, antacids, antihistamines, antibiotics, antiseptics, disinfectants, anaesthetics, tranquilizers, narcotics, antidepressants and psychedelic drugs (definition and examples).

6.4. History of Vaccines & Vaccinology, over view of bacterial and viral vaccines and their importance to public health.

6.5. Epidemiology and pathophysiology of vaccine preventable diseases with special emphasis on Diphtheria, Tetanus and Pertussis, vaccine preventable infectious diseases.

6.6. Overview of national and international regulatory requirements/ guidance for production

Module 7. Fuels	**6 Hours**

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

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

7.3. 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.

7.4. Pollution due to burning of fossil fuels

7.5. Solar energy and solar cells (applications only).

MODE OF TRANSACTION

Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

Peer to Peer learning: Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

a. Classroom participation (20%): 3 Mark
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Paragraph	7	Up to 7	5	**30**
Essay	2	1	10	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module I: Polymers	8
Module II: Chemistry in Biological Systems	8
Module III: Food Chemistry	8
Module IV: Agriculture	4
Module V: Cleansing Agents and Cosmetics	6
Module VI: Pharmaceuticals and Vaccines	8
Module VII: Fuels	6

REFERENCES:

Module I

1. B K. Sharma, Industrial Chemistry, 11th Ed., Goel publishing House, Meerut, 2000.
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. B. K. Sharma, Polymer Chemistry, Goel Publishing House, Meerut, 1989.
5. M. G. Arora, M. Singh, M. S. Yadav, Polymer Chemistry, 2nd Revised Ed., Anmol
6. Publications Private Ltd., New Delhi, 1989.

7. Catia Bastioli, Handbook of Biodegradable Polymers, Smithers Rapra Publishing, 2005.

Module II

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

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

Module IV

1. H. S. Rathore, L. M. L. Nollet, Pesticides: Evaluation of Environmental Pollution, CRC Press, USA, 2012.
2. Murray Park, The Fertilizer Industry, Elsevier, 2001.
3. B. K. Sharma, Industrial Chemistry, Krishna Prakashan Media, 1991.

Module V

1. B K. Sharma, Industrial Chemistry, Krishna Prakashan Media, 1991.
2. M. S. R. Winter, A Consumer's Dictionary of Cosmetic Ingredients, 7th Ed., Three Rivers Press, New York, 2009.

Module VI

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

1. B. K. B. Rao, Modern Petroleum Refining Processes, 4th Ed., Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 2002.
2. B. K. Sharma, Industrial Chemistry, Krishna Prakashan Media, 1991.

COURSE CODE – BCH5D03
OPEN COURSE 3: FOOD SCIENCE AND MEDICINAL CHEMISTRY

Credit	Hours/week	Marks		
		Internal	External	Total
3	3	15	60	75

Course Outcomes

CO No.	Expected Course Outcome	Learning	PSO No

	Upon completion of this course, students will be able to;	**Domain**	
CO1	***Explain*** applications of chemistry in food science.	Understand	PSO2
CO2	***Evaluate*** the importance chemistry in food industry and medicine.	Evaluate	PSO5
CO3	***Classify*** and distinguish different types of food additives and its use.	Analyse	PSO8
CO4	***Plan*** and ***create*** an awareness on various food habits and harmful effects of modern food habits.	Create	PSO9 PSO10
CO5	***Understand*** the functions of biomolecules in living organism.	Understand	PSO2 PSO10
CO6	***Categorize*** the common classes of drugs in pharmaceutical industry and their application.	Analyse	PSO8
CO7	***Understand*** the uses of pesticides and fertilizers and their impacts on the environment	Understand	PSO2
C08	***Evaluate*** the role of chemistry in human wellbeing.	Evaluate	PSO4 PSO10

COURSE CONTENT

Module 1. Food Adulteration and Preservation	**6 Hours**

1.1. Common adulterants in different foods and their identification: Milk and milk products, vegetable oils and fats, spices and condiments.

1.2. Cereals, pulses, tea, coffee powder, chili powder, turmeric powder and beverages - Contamination with toxic chemicals, pesticides and insecticides.

1.3. 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.

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

Module 2. Chemistry of Food	**10 Hours**

2.1. Food additives: Antioxidants and food preservatives – Commonly used permitted and non-permitted food colours

2.2. Artificial sweeteners - Taste enhancers – Monosodium glutamate – Vinegar

2.3. Artificial ripening of fruits and its health effects.

2.4. Modern food habits: Introduction – Definition and health effects of fast foods, instant foods, dehydrated foods, junk foods and condiments.

2.5. Composition and health effects of chocolates, soft drinks and soda water.

2.6. Natural Food: Importance of milk, coconut water and Neera - Importance of regional and seasonal fruits.

2.7. Traditional Kerala foods and their advantages.

Module 3. Beverages	**4 Hours**

3.1. 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.

Module 4. Biochemistry	**5 Hours**

4.1. Vitamins (name, source, function and deficiency diseases).

4.2. Enzymes (classification, characteristics, function and examples).

4.3. Hormones (classification, organ of secretion and functions).

4.4. Nucleic acids (introduction and role in life processes) – DNA finger printing (a brief study).

Module 5. Medicinal Chemistry – I	**5 Hours**

5.1. Health and Biochemical Analysis: Definition of health - WHO standard - Biochemical analysis of urine and serum.

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

5.3. Indian Medicinal Plants: Kizharnelli, Thumbai, Hibiscus, Adathodai, Nochi, Thulasi, Brahmi, Aloe Vera and

Neem plant (major chemical constituents and medicinal uses).

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

Module 6. Medicinal Chemistry – II	**12 Hours**

6.1. Medicines: Drug - Chemical name, generic name and trade names with examples – Terminology: Prodrug, pharmacy, pharmacology, pharmacophore, pharmacognosy, pharmacodynamics and pharmacokinetics (elementary idea only).

6.2. 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.

6.3. Drug toxicity – Thalidomide tragedy (a brief study) - Effective use of drugs – Prescription and non-prescription drugs – Over dosage – Drug abuse.

6.4. 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.

6.5. 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.

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

Module 7. Clinical chemistry	**6 Hours**

7.1. First aid to prevent bleeding and maintain breathing.

7.2. Causes and symptoms of food poisoning, botulism - mushroom and plant poisoning - first aid.

7.3. Causes, symptoms and treatment of anemia, diabetes, tuberculosis, asthma, jaundice.

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

MODE OF TRANSACTION

Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

Peer to Peer learning: Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

a. Classroom participation (20%): 3 Mark
b. Test papers I (40%): 6 Mark
c. Assignment (20%): 3 Mark
d. Seminar/ Viva (20%): 3 Mark

External Assessment (60 Marks) *Duration 2 Hours, No of Questions: 21*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	12	Up to 12	2	**20**
Paragraph	7	Up to 7	5	**30**
Essay	2	1	10	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module I: Food Adulteration and Preservation	13
Module II: Chemistry of Food	16
Module III: Beverages	6
Module IV: Biochemistry	8
Module V: Medicinal Chemistry – I	8
Module VI: Medicinal Chemistry – II	18
Module VII: Clinical chemistry	10

REFERENCES:

Module I

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

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

Module III

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

Module IV

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

Module V

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

Module VI

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

Module VII

1. Jayashree Ghosh, A Textbook of Pharmaceutical Chemistry, 3rd Ed., S. Chand and Company Ltd., New Delhi, 1999.
2. A H. Beckett, J. B Stenlake, Practical Pharmaceutical Chemistry, 4th Ed., CBS Publishers and Distributors, New Delhi, 2000.

COMPLEMENTARY COURSE SYLLABUS

SEMESTER 1

COURSE CODE –BCH1C01 COMPLEMENTARY COURSE I: GENERAL CHEMISTRY				
Credit	Hours/week	Marks		
		Internal	External	Total
2	2	15	60	75

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Distinguish*** quantitative and qualitative analysis.	Understand	PSO2
CO2	***Apply*** the theories of quantitative and qualitative analysis	Apply	PSO4
CO3	***Explain*** chemical bonding in simple molecules	Apply	PSO6
CO4	***Outline*** the uses of radioactive isotopes.	Analyse	PSO5
CO5	***Express*** the importance of metals in biological systems.	Understand	PSO2

COURSE CONTENT	
Module 1. Analytical Chemistry	**10 Hours**

1.1. Atomic mass - Molecular mass - Mole concept – Molar volume - Oxidation and reduction – Oxidation number and valency - Equivalent mass

1.2. Methods of expressing concentration: Molality, molarity, normality and mole fraction. Calculation of concentration on dilution of given solution (problems).

1.3. Theory of volumetric analysis – Acid-base, redox and complexometric titrations – Acid-base, redox and complexometric indicators

1.4. Double burette method of titration: Principle and advantages.

1.5. Principles in the separation of cations in qualitative analysis - Applications of common ion effect and solubility product - Microanalysis and its advantages. Accuracy & Precision (mention only).

Module 2. Atomic Structure and Chemical Bonding	**10 Hours**

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

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

2.3. Chemical Bonding: Introduction – Type of bonds. Ionic bond: Factors favouring the formation of ionic bonds - Lattice energy of ionic compounds and its application

2.4. 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, IF5, XeF4, IF_7 and XeF6.

2.5. Valence Bond theory –Hybridisation involving s, p and d orbitals: sp (acetylene), sp2 (ethylene), sp3 (CH_4), sp3d (PCl_5), sp3d2 (SF_6).

2.6. 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.

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

Module 3. Nuclear Chemistry	**6 Hours**

3.1. Natural radioactivity – Modes of decay – Group displacement law.

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

3.3. Nuclear fission - Atom bomb - nuclear fusion – Hydrogen bomb - nuclear reactors

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

Module 4. Bioinorganic Chemistry	**6 Hours**

4.1. Metal ions in biological systems

4.2. Biochemistry of iron – Haemoglobin and myoglobin -

4.3. O2 and CO2 transportation (mechanism not required)

4.4. Chlorophyll and photosynthesis (mechanism not expected) – Elementary idea of structure and mechanism of action of sodium potassium pump –

4.5. Biochemistry of zinc and cobalt.

MODE OF TRANSACTION

Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

Peer to Peer learning: Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

a. Classroom participation (20%)*: 3 Mark
b. Test papers I (40%): 6 Mark
c. Assignment (20%)#: 3 Mark
d. Seminar/ Viva (20%)$: 3 Mark

*Student involvement in the classroom discussions will be assessed by the course instructor

#Submission of case study report – every student has to conduct a case study submit the case report (Consider as assignment)

$Seminar Presentation – Course instructor gives a list of topics based on the syllabus and the students have to select a topic and present in the class

External Assessment (60 Marks) *Duration 2 Hours, No of Questions: 21*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	12	Up to 12	2	**20**
Paragraph	7	Up to 7	5	**30**
Essay	2	1	10	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION

Module	Mark

Module 1. Analytical Chemistry	22
Module 2. Atomic Structure and Chemical Bonding	25
Module 3. Nuclear Chemistry	16
Module 4. Bioinorganic Chemistry	16

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. G.Svehla, Vogel's Qualitative Inorganic Analysis, 7th Ed., Prentice Hall, New Delhi, 1996
3. C. N. R. Rao, Understanding Chemistry, Universities Press India Ltd., Hyderabad, 1999.
4. RK. Prasad, Quantum Chemistry, 4th Ed., New Age International Ltd., New Delhi, 2012
5. Manas Chanda, Atomic Structure and Chemical Bonding, 4th Ed., Tata McGraw Hill Publishing Company, Noida, 2007.
6. R. Puri, L. R. Sharma K. C. Kalia, Principles of Inorganic Chemistry, 31st Ed., Milestone Publishers and Distributors, New Delhi, 2013.
7. H. J. Arnikar, Essentials of Nuclear Chemistry, 4th Ed., New Age International (P) Ltd., New Delhi, 2005.
8. R. Gopalan, Elements of Nuclear Chemistry, Vikas Publ. House, 2000.
9. B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi, 2010.
10. G. L. Meissler, D. A. Tarr, Inorganic Chemistry, 3rd Ed. Pearson Education, 2004.
11. J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, Inorganic Chemistry, 5th Ed., Pearson, 2009.
12. F. A. Cotton, G. Wilkinson, P. L. Gaus, Basic Inorganic Chemistry, 3rd Ed., John –Wiley, 1995.

SEMESTER 2

COURSE CODE – BCH2C02 **COMPLEMENTARY COURSE II**: PHYSICAL CHEMISTRY				
Credit	Hours/week	Marks		
		Internal	External	Total
2	2	15	60	75

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Represent*** laws of thermodynamics	Understand	PSO2
CO2	***Analyse*** the theories of different states of matter and their implication.	Analyse	PSO5
CO3	***Apply*** the basic principles of electrochemistry.	Apply	PSO6
CO4	***Incorporate*** laws of solution for daily life	Apply	PSO9

COURSE CONTENT	
Module 1. Thermodynamics	**6 Hours**
1.1. Definition of thermodynamic terms - System – Surroundings - Types of systems. 1.2. First law of Thermodynamics - Internal energy - Significance of internal energy change – Enthalpy. 1.3. 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. 1.4. 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. 1.5. Third law of Thermodynamics.	
Module 2. Gaseous and Solid States	**10 Hours**

2.1. Gaseous State: Introduction - Kinetic molecular model of gases –

2.2. Maxwell distribution of velocities and its use in calculating molecular velocities – Average velocity, RMS velocity and most probable velocity (derivations not required)

2.3. Boyle's law – Charles's law – Ideal gas equation – Behaviour of real gases – Deviation from ideal behavior - van der Waals equation (derivation not required).

2.4. 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).

2.5. Defects in crystals: non-stoichiometric and stoichiometric defects - Extrinsic and intrinsic defects.

Module 3. Liquid State and Solutions	**6 Hours**

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

3.2. Solutions: Kinds of solutions - Solubility of gases in liquids – Henry's law and its applications

3.3. Colligative properties - Osmotic pressure - Laws of osmotic pressure - Reverse osmosis and its applications - Determination of molecular mass using colligative properties.

Module 4. Electrochemistry	**10 Hours**

4.1. Specific conductance, equivalent conductance and molar conductance –

4.2. Variation of conductance with dilution - Kohlrausch's law - Degree of ionization of weak electrolytes

4.3. Application of conductance measurements – Conductometric titrations.

4.4. Galvanic cells - Cell and electrode potentials - IUPAC sign convention –

4.5. Reference electrodes – Standard Hydrogen electrode – Calomel electrode - Standard electrode potential - Nernst equation - H_2-O_2 fuel cell.

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

MODE OF TRANSACTION

Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

Peer to Peer learning: Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

a. Classroom participation (20%): 3 Mark
b. Test papers I (40%): 6 Mark
c. Assignment (20%): 3 Mark
d. Seminar/ Viva (20%): 3 Mark

External Assessment (60 Marks) *Duration 2 Hours, No of Questions: 21*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	12	Up to 12	2	**20**
Paragraph	7	Up to 7	5	**30**
Essay	2	1	10	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module 1: Thermodynamics	16
Module 2: Gaseous and Solid States	23
Module 3: Liquid State and Solutions	16
Module 4: Electrochemistry	24

REFERENCES:

1. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical Chemistry, 46th Ed., Vishal Publishing Company, New Delhi, 2013.
2. J. Rajaram, J. C. Kuriacose, Chemical Thermodynamics, Pearson Education, New Delhi, 2013.
3. K L. Kapoor, A Textbook of Physical chemistry, Vol. 1, 4th Ed., Macmillan India Ltd., 2011
4. B. R. Puri, L. R. Sharma, M. S. Pathania, Elements of Physical chemistry, Vishal Pub. Co., 2013.
5. P. Atkins, J. Paula Atkins, Physical Chemistry, 8th Ed., Oxford University Press, 2006.
6. K. K. Sharma, L. K. Sharma, A Textbook of Physical Chemistry, 5th Ed., Vikas Publishing House, New Delhi, 2012.
7. Gordon M. Barrow, Physical Chemistry, 5th Ed., Tata McGraw Hill Education, New Delhi, 2006.
8. F. Daniels, R. A. Alberty, Physical Chemistry, 5th Ed., John Wiley and Sons, Canada, 1980.

SEMESTER 3

COURSE CODE –BCH3C03 **COMPLEMENTARY COURSE III**: ORGANIC CHEMISTRY				
Credit	Hours/week	Marks		
		Internal	External	Total
2	3	15	60	75

Course Outcomes

CO No.	**Expected Course Outcome** Upon completion of this course, students will be able to;	**Learning Domain**	**PSO No**
CO1	Explain basic factors effecting reaction mechanism of organic compounds	Understand	PSO3
CO2	Identify the importance of optical activity and chirality.	Analyse	PSO5
CO3	Associate presence of functional groups in organic reactivity	Understand	PSO3
CO4	Compare the basic structure and importance of carbohydrates, nucleic acids, alkaloids and terpenes.	Analyse	PSO5
CO5	Classify aromatic hydrocarbons	Analyse	PSO5

COURSE CONTENT	
Module 1. Organic Chemistry – Some Basic Concepts	**10 Hours**
1.1. Introduction: Homolysis and heterolysis of bonds – Electrophiles and nucleophiles. 1.2. Reaction Intermediates: Carbocations, carbanions and free radicals (types, hybridization and stability). 1.3. Types of organic reactions: Addition, elimination, substitution and rearrangement reactions (definition and one example each). 1.4. Electron Displacement Effects: Inductive effect: Definition – Characteristics - +I and –I groups. 1.5. 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. 1.6. 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).	
Module 2. Stereochemistry	**6 Hours**
2.1. Conformations: Conformations of ethane, cyclohexane and methylcyclohexane – Explanation of stability. 2.2. 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. 2.3. Optical Isomerism: Optical activity – Chirality – Enantiomers – Meso compounds – Diastereoisomers – Optical isomerism in lactic acid and tartaric acid.	
Module 3. Aromatic Hydrocarbons	**5 Hours**
3.1. Nomenclature and isomerism in substituted benzene. Structure and stability of benzene: Kekule, resonance and molecular orbital description. 3.2. Mechanism of aromatic electrophilic substitution: Halogenation, nitration, sulphonation and Friedel-Craft's reactions – orientation effect of substituents. 3.3. Aromaticity and Huckel's rule: Application to benzenoid (benzene, naphthalene and anthracene) and nonbenzenoid (pyrrole, pyridine and indol) aromatic compounds.	
Module 4. Chemistry of Functional Groups – I	**8 Hours**

4.1. Halogen Compounds: Preparation of alkyl halides from alkanes and alkenes – Wurtz reaction and Fittig's reaction – Mechanism of SN1 and SN2 reactions of alkyl halides – Effect of substrate and stereochemistry.

4.2. Alcohols: Preparation from Grignard reagent – Preparation of ethanol from molasses – Wash, rectified spirit, absolute alcohol, denatured spirit, proof spirit and power alcohol (mention only) –

4.3. Comparison of acidity of ethanol, isopropyl alcohol and tert-butyl alcohol

4.4. Haloform reaction and iodoform test – Luca's test – Chemistry of methanol poisoning – Harmful effects of ethanol in the human body.

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

Module 5. Chemistry of Functional Groups – II	**8 Hours**

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

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

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

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

Module 6. Biomolecules	**8 Hours**

6.1. Carbohydrates: Classification with examples - cyclic structures of glucose and fructose -Applications of carbohydrates.

6.2. 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.

6.3. Enzymes: Characteristics and examples.

6.4. 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.

Module 7. Alkaloids and Terpenes	**3 Hours**

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

7.2. Terpenes: Classification with examples – Isoprene rule – Isolation of essential oils by steam distillation –

7.3. Uses of lemongrass oil, eucalyptus oil and sandalwood oil – Source, structure and uses of citral and menthol –

7.4. Natural rubber – Vulcanization and its advantages.

7.5. Note: Structural elucidation not expected in any case.

MODE OF TRANSACTION

Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

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Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

a. Classroom participation (20%)*: 3 Mark
b. Test papers I (40%): 6 Mark
c. Assignment (20%)#: 3 Mark
d. Seminar/ Viva (20%)$: 3 Mark

*Student involvement in the classroom discussions will be assessed by the course instructor

#Submission of case study report – every student has to conduct a case study submit the case report (Consider as assignment)

$Seminar Presentation – Course instructor gives a list of topics based on the syllabus and the students have to select a topic and present in the class

External Assessment (60 Marks) *Duration 2 Hours, No of Questions: 21*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	12	Up to 12	2	**20**
Paragraph	7	Up to 7	5	**30**
Essay	2	1	10	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module 1: Organic Chemistry – Some Basic Concepts	15
Module 2: Stereochemistry	10
Module 3: Aromatic Hydrocarbons	10

Module 4: Chemistry of Functional Groups – I	14
Module 5: Chemistry of Functional Groups – II	13
Module 6: Biomolecules	12
Module 7: Alkaloids and Terpenes	5

REFERENCES:

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

SEMESTER 4

COURSE CODE –BCH4C04 COMPLEMENTARY COURSE IV: PHYSICAL & APPLIED CHEMISTRY				
Credit	Hours/week	Marks		
		Internal	External	Total
2	3	15	60	75

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Illustrate*** the basic concepts behind colloidal state and nano chemistry.	Understand	PSO3
CO2	***Apply*** the principles of green chemistry in designing of experiments	Apply	PSO7
CO3	***Select*** different separation methods and spectral techniques for analysis of compounds	Apply	PSO6
CO4	***Interpret*** the extent of chemistry in daily life.	Understand	PSO12
CO5	***Examine*** the different environmental issues in world	Apply	PSO9
CO6	***Classify*** different polymer used in daily life	Understand	PSO2

COURSE CONTENT	
Module 1. Colloidal Chemistry	**6 Hours**
1.1. True solution, colloidal solution and suspension. 1.2. Classification of colloids: Lyophilic, lyophobic, macromolecular, multimolecular and associated colloids with examples. Purification of colloids by electrodialysis and ultrafiltration. 1.3. Properties of colloids: Brownian movement – Tyndall effect – Electrophoresis. 1.4. Origin of charge and stability of colloids – Coagulation, Hardy Schulze rule – Protective colloids - Gold number. 1.5. Emulsions. Applications of colloids: Delta formation, medicines, emulsification, cleaning action of detergents and soaps.	
Module 2. New Vistas in Chemistry	**6 Hours**
2.1. Nanochemistry: Introduction – classification of nanomaterials (0D, 1D, 2D) – size dependence of material properties (optical, electrical and catalytic) - surface to volume ratio and its significance 2.2. Application of nanomaterials in electronics, optics, catalysis and medicine (detailed discussion not expected). 2.3. Green Chemistry: Definition and need of green chemistry - principles (detailed discussion not expected) - atom economy - green solvents - green synthesis of Ibuprofen.	
Module 3. Chromatography	**6 Hours**
3.1. Chromatography- Introduction – Adsorption and partition chromatography 3.2. Principle and applications of column, thin layer, paper and gas chromatography 3.3. Rf value – Relative merits of different techniques.	
Module 4. Spectroscopy	**10 Hours**
4.1. 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). 4.2. 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. 4.3. 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. 4.4. NMR Spectroscopy: Introduction - Chemical shift and spin-spin coupling 4.5. Application in elucidating the structure of ethanol, dimethyl ether, propanal and acetone (detailed study not required).	

Module 5. Polymers	**4 Hours**

5.1. Classification of polymers - Addition and condensation polymers –

5.2. Thermoplastics and thermosetting plastics - Structure and applications of synthetic rubbers (Buna-S, Buna-N and neoprene), synthetic fibres (Nylon 66, Nylon 6 and dacron),

5.3. Thermoplastics (polyethene, polystyrene, PVC and teflon) and thermosetting plastics (bakelite and melmac).

5.4. Uses of kevlar, nomex and lexan – Biodegradable polymers (PGA, PLA and PHBV) and their applications.

Module 6. Environmental Pollution	**6 Hours**

6.1. Definition – Types of pollution.

6.2. Air pollution: Pollution by oxides of nitrogen, carbon and sulphur. Effects of air pollution: 6.3 Depletion of ozone, greenhouse effect and acid rain.

6.3. Water pollution: Pollution due to sewage, industrial effluents, soaps, detergents, pesticides, fertilizers and heavy metals

6.4. Eutrophication - Biological magnification and bioaccumulation

6.5. Effects of water pollution. Water quality parameters – DO, BOD and COD (elementary idea only).

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

Module 7. Chemistry in Daily Life	**10 Hours**

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

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

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

7.4. 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).

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

MODE OF TRANSACTION

Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

Peer to Peer learning: Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students'

thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

a. Classroom participation (20%)*: 3 Mark
b. Test papers I (40%): 6 Mark
c. Assignment (20%)#: 3 Mark
d. Seminar/ Viva (20%)$: 3 Mark

*Student involvement in the classroom discussions will be assessed by the course instructor

#Submission of case study report – every student has to conduct a case study submit the case report (Consider as assignment)

$Seminar Presentation – Course instructor gives a list of topics based on the syllabus and the students have to select a topic and present in the class

External Assessment (60 Marks) *Duration 2 Hours, No of Questions: 21*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	12	Up to 12	2	**20**
Paragraph	7	Up to 7	5	**30**
Essay	2	1	10	**10**
			Total	**60**

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module 1: Colloidal Chemistry	10
Module 2: New Vistas in Chemistry	10
Module 3: Chromatography	10
Module 4: Spectroscopy	15
Module 5: Polymers	7
Module 6: Environmental Pollution	10

Module 7: Chemistry in Daily Life	17

REFERENCES:

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
3. M. A. Shah, Tokeer Ahmad, Principles of Nanoscience and Nanotechnology, Narosa Publishing House, New Delhi, 2010.
4. T. Pradeep, A Textbook of Nanoscience and Nanotechnology, McGrawhill, 2012
5. V. K. Ahluwaliya, Green Chemistry, Narosa Publishing House, New Delhi, 2011.
6. R. A. Day Junior, A. L. Underwood, Quantitative Analysis, 5th Ed., Prentice Hall of India Pvt. Ltd., New Delhi, 1988.
7. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, Vogel's Text Book of Quantitative Chemical Analysis, 6th Ed., Pearson Education, 2003.
8. R. Gopalan, P.Subramanian, K Rengarajan, Elements of Analytical Chemistry, S. Chand and Co., New Delhi, 2004.
9. R. P. Budhiraja, Separation chemistry, New Age International (P) Ltd., 2007.
10. P. S. Kalsi, Applications of Spectroscopic Techniques in Organic Chemistry, 6th Ed., New Age International (P) Ltd., New Delhi, 2004.
11. C. N. Banwell, E. M. Mc Cash, Fundamentals of Molecular Spectroscopy, 4th Ed., McGraw–Hill publishing Company Limited, New Delhi, 2002.
12. V. R. Gowarikar, Polymer Chemistry, New Age International Pvt. Ltd., New Delhi, 2010
13. Fred. W. Billmeyer, Textbook of Polymer Science, 3rd Ed., Wiley India, Delhi, 2008.
14. A K. De, Environmental Chemistry, 6th Ed., New Age International Pvt. Ltd., New Delhi, 2006.
15. A K. Ahluwalia, Environmental Chemistry, Ane Books India, New Delhi, 2008.
16. Gurdeep R. Chatwal, Synthetic Drugs, Himalaya Publishing House, Bombay, 1995.
17. Jayashree Ghosh, A Textbook of Pharmaceutical Chemistry, 3rd Ed., S. Chand and Company Ltd., New Delhi, 1999.
18. B Sivasankar, Food processing and preservation, Prentice – Hall of India Pvt. Ltd., New Delhi, 2002.
19. Srinivasan Damodaran, Kirk L. Parkin, Owen R. Fennema, Food Chemistry, 4th Ed., CRC Press, New York, 2007.

COURSE CODE – BCH4C05L **COMPLEMENTARY COURSE V**: CHEMISTRY PRACTICAL				
Credit	Hours/week	Marks		
		Internal	External	Total
2	2	20	80	100

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Apply*** the knowledge of reactions of common cations for identification of cations in mixture	Apply	PSO7
CO2	***Classify*** different cations into different groups for intergroup separation	Understand	PSO2
CO3	***Apply*** the theories of indicators for various volumetric estimation techniques	Apply	PSO6
CO4	***Apply*** laboratory skills for separation of cations and volumetric analysis	Apply	PSO7

COURSE CONTENT

Experiments — **Total Hours: 128**

General Instructions

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

Module 1. Laboratory Safety, First Aid and Treatment of Fires

1.1. Laboratory Safety, First Aid and Treatment of Fires

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

Module 2. Volumetric Analysis

2.1. Weighing using chemical balance and electronic balance.

2.2. Preparation of standard solutions.

2.3. Neutralization Titrations

(a) Strong acid – strong base.

(b) Strong acid – weak base.

(c) Weak acid – strong base.

2.4. Redox Titrations

i) Permanganometry:

(a) Estimation of oxalic acid.

(b) Estimation of Fe2+/FeSO4.7H2O/Mohr's salt.

ii) Dichrometry:

(a) Estimation of Fe2+/FeSO4.7H2O/Mohr's salt using internal indicator.

(b) Estimation of Fe2+/FeSO4.7H2O/Mohr's salt using external indicator.

iii) Iodimetry and Iodometry:

(a) Estimation of iodine.

(b) Estimation of copper.

(c) Estimation of chromium.

2.5. Complexometric Titrations

(a) Estimation of zinc.

(b) Estimation of magnesium

2.6. Determination of hardness of water.

Module 3. Gravimetric Analysis

3.1. Determination of water of hydration in crystalline barium chloride.

3.2. Estimation of Ba2+ as BaSO4.

Module 4. Inorganic Qualitative Analysis

4.1. Reactions of Cations: Study of the reactions of the following cations with a view of their identification and confirmation. Pb2+, Bi3+, Cu2+, Cd2+, Fe2+, Fe3+, Al3+, Ni2+, Co2+, Mn2+, Zn2+, Ba2+, Sr2+, Ca2+, Mg2+ and NH4+.

4.2. Systematic qualitative analysis of a solution containing any two cations from the above list.

Module 5. Determination of Physical Constants

5.1. Determination of boiling point.

5.2. Determination of melting point

Module 6. Organic Preparations

6.1. p-Bromoacetanilide from acetanilide.

6.2. p-Nitroacetanilide from acetanilide.

6.3. Benzoic acid from benzaldehyde.

6.4. Benzoic acid from benzamide.

MODE OF TRANSACTION

Demonstrations: Helps to illustrate and consolidate theoretical principles outlined in the course. Experimentation: This involves learning by doing or hands on experience by applying biological principles.

Experimentation: This involves learning by doing.

Observation: It involves noticing or perceiving biological specimens or equipments and acquisition of information from the primary source:

MODE OF ASSESSMENT

Internal Assessment (20 Marks)

a. Submission of Record* 12 Mark
b. Lab skill /performance)# 2 Mark
c. Lab involvement based on attendance (punctuality)$ 2 Mark
d. Viva 4 Mark

**Every student has to submit record of experiments and other lab works which is duly certified by the HoD*

#Skill and performance in doing experiments and observations

$Students involvement in the laboratory will be assessed by the course instructor

External Assessment (80 Marks): *Duration 3 Hours*

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

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.

ALLIED COURSE SYLLABUS

SEMESTER 1

COURSE CODE –CHE1IC01 ALLIED COURSE I: GENERAL CHEMISTRY				
Credit	Hours/week	Marks		
		Internal	External	Total
4	4	20	80	100

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Distinguish*** quantitative and qualitative analysis.	Understand	PSO2
CO2	***Apply*** the theories of quantitative and qualitative analysis	Apply	PSO4
CO3	***Explain*** chemical bonding in simple molecules	Apply	PSO6
CO4	Explain basic factors effecting reaction mechanism of organic compounds	Understand	PSO3
CO5	***Represent*** laws of thermodynamics	Understand	PSO2
CO6	***Analyse*** the theories of different states of matter and their implication.	Analyse	PSO5
CO7	***Apply*** basic principles of electrochemistry.	Apply	PSO6
CO8	***Incorporate*** laws of solution for daily life	Apply	PSO9
CO9	***Differentiate*** types of conductance	Understand	PSO2
CO10	***Compare*** Buffer capacity	Analyse	PSO4

COURSE CONTENT	
Module 1. Analytical Chemistry	**10 Hours**
1.1. Atomic mass - Molecular mass - Mole concept – Molar volume - Oxidation and reduction – Oxidation number and valency - Equivalent mass 1.2. Methods of expressing concentration: Molality, molarity, normality and mole fraction. Calculation of concentration on dilution of given solution (problems). 1.3. Theory of volumetric analysis – Acid-base, redox and complexometric titrations – Acid-base, redox and complexometric indicators 1.4. Double burette method of titration: Principle and advantages. 1.5. Principles in the separation of cations in qualitative analysis - Applications of common ion effect and solubility product - Microanalysis and its advantages. Accuracy & Precision (mention only).	
Module 2. Atomic Structure and Chemical Bonding	**10 Hours**
2.1. Atomic Structure: Bohr atom model and its limitations, de Broglie equation – Heisenberg uncertainty principle - Schrödinger wave equation (mention only) - Atomic orbitals - 2.2. Quantum numbers and their significance - Pauli's Exclusion principle - Hund's rule of maximum multiplicity - Aufbau principle – Electronic configuration of atoms. 2.3. Chemical Bonding: Introduction – Type of bonds. Ionic bond: Factors favouring the formation of ionic bonds - Lattice energy of ionic compounds and its application 2.4. 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, IF5, XeF4, IF_7 and XeF6. 2.5. Valence Bond theory –Hybridisation involving s, p and d orbitals: sp (acetylene), sp2 (ethylene), sp3 (CH_4), sp3d (PCl_5), sp3d2 (SF_6). 2.6. 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. 2.7. Intermolecular forces, Hydrogen bonding in H_2O - Dipole-dipole interactions	
Module 3. Organic Chemistry – Some Basic Concepts	**10 Hours**

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

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

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

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

3.5. 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.

3.6. 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).

Module 4. Thermodynamics	**6 Hours**

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

4.2. First law of Thermodynamics - Internal energy - Significance of internal energy change – Enthalpy.

4.3. 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.

4.4. 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.

4.5. Third law of Thermodynamics.

Module 5. Gaseous and Solid States	**10 Hours**

5.1. Gaseous State: Introduction - Kinetic molecular model of gases –

5.2. Maxwell distribution of velocities and its use in calculating molecular velocities – Average velocity, RMS velocity and most probable velocity (derivations not required)

5.3. Boyle's law – Charles's law – Ideal gas equation – Behaviour of real gases – Deviation from ideal behavior - van der Waals equation (derivation not required).

5.4. 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).

5.5. Defects in crystals: non-stoichiometric and stoichiometric defects - Extrinsic and intrinsic defects.

Module 6. Liquid State and Solutions	**6 Hours**

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

6.2. Solutions: Kinds of solutions - Solubility of gases in liquids – Henry's law and its applications 6.3. Colligative properties - Osmotic pressure - Laws of osmotic pressure - Reverse osmosis and its applications - Determination of molecular mass using colligative properties.	
Module 7. Electrochemistry	**10 Hours**
7.1. Specific conductance, equivalent conductance and molar conductance – 7.2. Variation of conductance with dilution - Kohlrausch's law - Degree of ionization of weak electrolytes 7.3. Application of conductance measurements – Conductometric titrations. 7.4. Galvanic cells - Cell and electrode potentials - IUPAC sign convention – 7.5. Reference electrodes – Standard Hydrogen electrode – Calomel electrode - Standard electrode potential - Nernst equation - H_2-O_2 fuel cell. 7.6. Ostwald's dilution law – Buffer solutions – Buffer action [acetic acid/sodium acetate & NH_4OH/NH_4Cl], applications of buffers.	
Module 8. Alkaloids and Terpenes	**3 Hours**
8.1. Alkaloids: Classification – Source, structure and physiological functions of nicotine, coniine and piperine. 8.2. Terpenes: Classification with examples – Isoprene rule – Isolation of essential oils by steam distillation – 8.3. Uses of lemongrass oil, eucalyptus oil and sandalwood oil – Source, structure and uses of citral and menthol – 8.4. Natural rubber – Vulcanization and its advantages. 8.5. Note: Structural elucidation not expected in any case.	

MODE OF TRANSACTION

Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

Peer to Peer learning: Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

e. Classroom participation (20%)*: 4 Mark
f. Test papers I (40%): 8 Mark
g. Assignment (20%)#: 4 Mark

h. Seminar/ Viva (20%)[$]: 4 Mark

[*]Student involvement in the classroom discussions will be assessed by the course instructor

[#]Submission of case study report – every student has to conduct a case study submit the case report (Consider as assignment)

[$]Seminar Presentation – Course instructor gives a list of topics based on the syllabus and the students have to select a topic and present in the class

External Assessment (80 Marks) *Duration 2.5 Hours, No of Questions: 27*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	15	Up to 15	2	**25**
Paragraph	8	Up to 8	5	**35**
Essay	4	2	10	**20**
			Total	**80**

MODULE WISE MARK DISTRIBUTION

Module	Mark
Module 1: Analytical Chemistry	17
Module 2: Atomic Structure and Chemical Bonding	17
Module 3: Organic Chemistry – Some Basic Concepts	22
Module 4: Thermodynamics	10
Module 5: Gaseous and Solid States	17
Module 6: Liquid State and Solutions	10
Module 7: Electrochemistry	17

REFERENCES:

Module: 1

1. . 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: 2

3. C. N. R. Rao, Understanding Chemistry, Universities Press India Ltd., Hyderabad, 1999.
4. RK. Prasad, Quantum Chemistry, 4th Ed., New Age International Ltd., New Delhi, 2012
5. Manas Chanda, Atomic Structure and Chemical Bonding, 4th Ed., Tata McGraw Hill Publishing Company, Noida, 2007.

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

Module: 3

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

Module: 4

13. B. R. Puri, L. R. Sharma, M. S. Pathania, Elements of Physical chemistry, Vishal Pub. Co., 2013.
14. J. Rajaram, J. C. Kuriacose, Chemical Thermodynamics, Pearson Education, New Delhi, 2013

Module: 5 and 6

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

Module: 7

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

SEMESTER 4

COURSE CODE –CHE4IC02 **ALLIED COURSE II**: PHYSICAL AND INORGANIC CHEMISTRY				
Credit	Hours/week	Marks		
		Internal	External	Total
4	4	20	80	100

Course Outcomes

CO No.	**Expected Course Outcome** Upon completion of this course, students will be able to;	**Learning Domain**	**PSO No**
CO1	***Outline*** the uses of radioactive isotopes.	Analyse	PSO5
CO2	***Express*** the importance of metals in biological systems.	Understand	PSO2
CO3	***Compare*** basic structure of carbohydrates, nucleic acids, alkaloids and terpenes.	Analyse	PSO5
CO4	***Illustrate*** the basic concepts behind colloidal state and nanochemistry.	Understand	PSO3
CO5	***Apply*** the principles of green chemistry in designing of experiments	Apply	PSO7
CO6	***Select*** different separation methods and spectral techniques for analysis of compounds	Apply	PSO6
CO7	***Determine*** spectral features of simple molecule	Analyse	PSO5
CO8	***Examine*** environmental issues in world	Apply	PSO9
CO9	***Interpret*** the extent of chemistry in daily life.	Understand	PSO12

COURSE CONTENT	
Module 1. Nuclear Chemistry	**6 Hours**
1.1. Natural radioactivity – Modes of decay – Group displacement law. 1.2. Nuclear forces - n/p ratio - nuclear stability - Mass Defect - Binding energy. Isotopes, isobars and isotones with examples. 1.3. Nuclear fission - Atom bomb - nuclear fusion – Hydrogen bomb - nuclear reactors 1.4. Application of radioactive isotopes – ^{14}C dating, Rock dating, Isotopes as tracers, Radio diagnosis, Radiotherapy.	
Module 2. Bioinorganic Chemistry	**6 Hours**
2.1. Metal ions in biological systems 2.2. Biochemistry of iron – Haemoglobin and myoglobin - 2.3. O2 and CO2 transportation (mechanism not required) 2.4. Chlorophyll and photosynthesis (mechanism not expected) – Elementary idea of structure and mechanism of action of sodium potassium pump 2.5. Biochemistry of zinc and cobalt.	
Module 3. Biomolecules	**8 Hours**
3.1. Carbohydrates: Classification with examples - cyclic structures of glucose and fructose -Applications of carbohydrates. 3.2. 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. 3.3. Enzymes: Characteristics and examples. 3.4. 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.	
Module 4. Colloidal Chemistry	**6 Hours**
4.1. True solution, colloidal solution and suspension. 4.2. Classification of colloids: Lyophilic, lyophobic, macromolecular, multimolecular and associated colloids with examples. Purification of colloids by electrodialysis and ultrafiltration. 4.3. Properties of colloids: Brownian movement – Tyndall effect – Electrophoresis. 4.4. Origin of charge and stability of colloids – Coagulation, Hardy Schulze rule – Protective colloids - Gold number. 4.5. Emulsions. Applications of colloids: Delta formation, medicines, emulsification, cleaning action of detergents and soaps.	
Module 5. New Vistas in Chemistry	**6 Hours**

5.1. Nanochemistry: Introduction – classification of nanomaterials (0D, 1D, 2D)

5.2. Size dependence of material properties (optical, electrical and catalytic) - surface to volume ratio and its significance

5.3. Application of nanomaterials in electronics, optics, catalysis and medicine (detailed discussion not expected).

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

Module 6. Chromatography	**6 Hours**

6.1. Chromatography- Introduction – Adsorption and partition chromatography

6.2. Principle and applications of column, thin layer, paper and gas chromatography

6.3. Rf value – Relative merits of different techniques.

Module 7. Spectroscopy	**10 Hours**

7.1. Origin of spectra - Interaction of electromagnetic radiation with matter. Different types of energy levels in molecules: Rotational, vibrational and electronic levels.

7.2. Statement of Born-Oppenheimer approximation - Fundamental laws of spectroscopy and selection rules (derivations not required).

7.3. 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.

7.4. 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.

7.5. NMR Spectroscopy: Introduction - Chemical shift and spin-spin coupling

7.6. Application in elucidating the structure of ethanol, dimethyl ether, propanal and acetone (detailed study not required).

Module 8. Environmental Pollution	**6 Hours**

8.1. Definition – Types of pollution.

8.2. Air pollution: Pollution by oxides of nitrogen, carbon and sulphur. Effects of air pollution

8.3. Depletion of ozone, greenhouse effect and acid rain.

8.4. Water pollution: Pollution due to sewage, industrial effluents, soaps, detergents, pesticides, fertilizers and heavy metals

8.5. Eutrophication - Biological magnification and bioaccumulation

8.6. Effects of water pollution. Water quality parameters – DO, BOD and COD (elementary idea only).

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

Module 9. Chemistry in Daily Life	**10 Hours**

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

9.2. Pharmaceuticals: Drug - Chemical name, generic name and trade names with examples. Antipyretics,

analgesics, antibiotics, antacids, antiseptics (definition and examples, structure not expected).

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

9.4. 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).

9.5. Cement: Manufacture, composition and setting.

9.6. Glass: Types of glasses and use

MODE OF TRANSACTION

Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

Peer to Peer learning: Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT

Internal Assessment (15 Marks)

e. Classroom participation (20%)*: 4 Mark

f. Test papers I (40%): 8 Mark

g. Assignment (20%)#: 4 Mark

h. Seminar/ Viva (20%)$: 4 Mark

*Student involvement in the classroom discussions will be assessed by the course instructor

#Submission of case study report – every student has to conduct a case study submit the case report (Consider as assignment)

$Seminar Presentation – Course instructor gives a list of topics based on the syllabus and the students have to select a topic and present in the class

External Assessment (80 Marks) *Duration 2.5 Hours, No of Questions: 27*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	15	Up to 15	2	**25**
Paragraph	8	Up to 5	5	**35**
Essay	4	2	10	**20**
			Total	**80**

MODULE WISE MARK DISTRIBUTION	
Module	**Mark**
Module 1: Nuclear Chemistry	10
Module 2: Bioinorganic Chemistry	10
Module 3: Biomolecules	14
Module 4: Colloidal Chemistry	10
Module 5: New Vistas in Chemistry	10
Module 6: Chromatography	10
Module 7: Spectroscopy	18
Module 8: Environmental Pollution	10
Module 9: Chemistry in Daily Life	18

REFERENCES:

Module 1

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

Module 2

3. B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi, 2010.
4. G. L. Meissler, D. A. Tarr, Inorganic Chemistry, 3rd Edn. Pearson Education, 2004.
5. J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, Inorganic Chemistry, 5th Edn., Pearson, 2009.
6. F. A. Cotton, G. Wilkinson, P. L. Gaus, Basic Inorganic Chemistry, 3rd Edn., John Wiley, 1995.Module 3
7. R. T. Morrison, R. N. Boyd, Organic Chemistry, 7th Edn., Pearson Education, New Delhi, 2013.
8. I. L. Finar, Organic Chemistry, Vol. I, 5th Edn., Pearson Education, New Delhi, 2013.
9. M. K. Jain, S. C. Sharma, Modern Organic Chemistry, 3rd Edn., Vishal Publishing Company Co., 2010.
10. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, A Textbook of Organic Chemistry, 2nd Edn., Vikas Publishing House, New Delhi, 2004

Module 4

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

Module 5

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

Module 6

16. R. A. Day Junior, A. L. Underwood, Quantitative Analysis, 5th Ed., Prentice Hall of India Pvt. Ltd., New Delhi, 1988.

17. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, Vogel's Text Book of Quantitative Chemical Analysis, 6th Ed., Pearson Education, 2003.
18. R. Gopalan, P.Subramanian, K Rengarajan, Elements of Analytical Chemistry, S. Chand and Co., New Delhi, 2004.
19. R. P. Budhiraja, Separation chemistry, New Age International (P) Ltd., 2007.

Module 7

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

Module 8

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

Module 9

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

COURSE CODE –CHE4IH01 **ALLIED COURSE III**: CHEMISTRY PRACTICAL				
Credit	Hours/week	Marks		
		Internal	External	Total
4	4*	20	80	100

**2 Hours in semester 1 and 4 Hours in Semester IV*

Course Outcomes

CO No.	**Expected Course Outcome** Upon completion of this course, students will be able to;	**Learning Domain**	**PSO No**
CO1	***Apply*** the knowledge of reactions of common cations for identification of cations in mixture	Apply	PSO7
CO2	***Classify*** different cations into different groups for intergroup separation	Understand	PSO2

CO3	***Apply*** the theories of indicators for various volumetric estimation techniques	Apply	PSO6
CO4	***Apply*** laboratory skills for separation of cations and volumetric analysis	Apply	PSO7

COURSE CONTENT

Experiments	**Total Hours: 96**

General Instructions

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

Module 1. Laboratory Safety, First Aid and Treatment of Fires

1.1. Laboratory Safety, First Aid and Treatment of Fires

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

Module 2. Volumetric Analysis

2.1. Weighing using chemical balance and electronic balance.

2.2. Preparation of standard solutions.

2.3. Neutralization Titrations

(a) Strong acid – strong base.

(b) Strong acid – weak base.

(c) Weak acid – strong base.

2.4. Redox Titrations

i) Permanganometry:

(a) Estimation of oxalic acid.

(b) Estimation of Fe2+/FeSO4.7H2O/Mohr's salt.

ii) Dichrometry:

(a) Estimation of Fe2+/FeSO4.7H2O/Mohr's salt using internal indicator.

(b) Estimation of Fe2+/FeSO4.7H2O/Mohr's salt using external indicator.

2.5. Determination of hardness of water.

Module 3. Gravimetric Analysis

3.1. Determination of water of hydration in crystalline barium chloride. 3.2. Estimation of Ba^{2+} as $BaSO_4$.
Module 4. Inorganic Qualitative Analysis
4.1. Reactions of Cations: Study of the reactions of the following cations with a view of their identification and confirmation. Pb2+, Bi3+, Cu2+, Cd2+, Fe2+, Fe3+, Al3+, Ni2+, Co2+, Mn2+, Zn2+, Ba2+, Sr2+, Ca2+, Mg2+ and NH4+. 4.2. Systematic qualitative analysis of a solution containing any two cations from the above list.
Module 5. Determination of Physical Constants
5.1. Determination of boiling point. 5.2. Determination of melting point

MODE OF TRANSACTION
Demonstrations: Helps to illustrate and consolidate theoretical principles outlined in the course. Experimentation: This involves learning by doing or hands on experience by applying biological principles. **Experimentation:** This involves learning by doing. **Observation:** It involves noticing or perceiving biological specimens or equipments and acquisition of information from the primary source:
MODE OF ASSESSMENT
Internal Assessment (20 Marks) e. Submission of Record* 12 Mark f. Lab skill /performance)# 2 Mark g. Lab involvement based on attendance (punctuality)$ 2 Mark h. Viva 4 Mark **Every student has to submit record of experiments and other lab works which is duly certified by the HoD* #*Skill and performance in doing experiments and observations* $*Students involvement in the laboratory will be assessed by the course instructor*
External Assessment (80 Marks): *Duration 3 Hours*

Pattern	**Marks**	**Total**
Question on qualitative and quantitative analysis	8	80
Procedure on volumetric analysis	6	

Volumetric analysis	28	
Mixture analysis	28	
Record	10	

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.