UNIVERSITY OF CALICUT

B.Sc. DEGREE PROGRAMME

IN

CHEMISTRY

(CBCSSUG 2019)

UNDER CHOICE BASED CREDIT AND SEMESTER SYSTEM

SCHEME AND SYLLABI

2019 ADMISSION ONWARDS

CORE COURSES, COMPLEMENTARY COURSES, OPEN COURSES & AUDIT COURSES

UNDERGRADUATE PROGRAMME – AN OVERVIEW

Programme means the entire course of study and examinations for the award of a degree. **Duration** of an undergraduate programme is six semesters distributed in a period of 3 years. An **academic week** is a unit of five working days in which distribution of work is organized from Monday to Friday with five contact periods of one hour duration on each day. A sequence of 18 such weeks (16 instructional weeks and two weeks for examination) constitutes a **semester**.

Course means a segment of subject matter to be covered in a semester. The undergraduate programme includes 5 types of courses, *viz.,* common courses, core courses, complementary courses, open course and audit course. **Common courses** include English and additional language courses. Every undergraduate student shall undergo 10 common courses [6 English courses and 4 additional language courses] for completing the programme. **Core courses** comprise compulsory course in a subject related to a particular degree programme offered by the parent department. There are 18 core courses including a project work. **Complementary courses** cover two disciplines that are related to the core subject and are distributed in the first four semesters. There shall be one **open course** in the 5th semester. Students can opt one open course of their choice offered by any department in the institution other than their parent department. **Audit courses** are courses which are mandatory for a programme but not conducted for the calculation of SGPA or CGPA. There shall be one audit course each in the first 4 semesters. Audit courses are not meant for class room study. The students can attain only pass (Grade P) for these courses. At the end of each semester there shall be examination conducted by the college from a pool of questions (Question Bank).

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

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

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

UNDERGRADUATE PROGRAMME IN CHEMISTRY

PREAMBLE

Science education is central to the development of any society. This can be achieved only by revamping the undergraduate teaching to make it effective and meaningful. The creation of a scientific thinking in society necessitates proper education and guidance. In order to achieve this, one must update the developments in the field of science. An effective science education can be imparted at the undergraduate level only by revamping the present curriculum. To achieve this goal, the curriculum should be restructured by giving emphasis on various aspects such as the creativity of students, knowledge of current developments in the discipline, awareness of environmental impacts due to the development of science and technology, and the skills essential for handling equipments and instruments in laboratories and industries.

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

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

The units of the syllabus are well defined. The number of contact hours required for each unit is given which excludes prerequisites. Prerequisites are previous knowledge required for the study of corresponding unit. Topics given as prerequisites can be given as seminar or assignment. A list of references and further readings are provided at the end of each unit.

AIMS

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

BROAD OBJECTIVES

To enable the students

To understand basic facts and concepts in chemistry.

To apply the principles of chemistry.

To appreciate the achievements in chemistry and to know the role of chemistry in nature and in society.

To familiarize the emerging areas of chemistry and their applications in various spheres of chemical sciences and to apprise the students of its relevance in future studies.

To develop skills in the proper handling of instruments and chemicals.

To be exposed to the different processes used in industries and their applications.

To make the students eco-friendly by creating a sense of environmental awareness in them.

To make the students aware of the applications of chemistry in day-to-day life.

COURSE STRUCTURE

Semester	*Common course*		*Core course*	*Complementary course*		*Open course*	*Total*
	English	*Additional Language*		*Mathematics*	*Physics*		
I	4+3	4	2	3	2	-	18
II	4+3	4	2	3	2	-	18
III	4	4	3	3	2	-	16
IV	4	4	3+4*	3	2+4*	-	24
V	-	-	3+3+3	-	-	3	12
VI	-	-	3+3+3+3+2# +4*+4*+4*+ 4*+2**	-	-	-	32
Total	**22**	**16**	**55**	**12**	**12**	**3**	**120**

*Practical **Project #Elective

Mark and Indirect Grading System

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

Mark Distribution

Sl. No.	*Course*	*Marks*
1	English	550
2	Additional Language	400
3	Core course: Chemistry	1475
4	Complementary course: Mathematics	300
5	Complementary course: Physics	380
6	Open Course	75
	Total Marks	3180

Ten point Indirect Grading System

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

CREDIT DISTRIBUTION IN EACH SEMESTER

Total Credits: 120

Semester	*Course*	*Credit*	
I	Common course: English	4	100
	Common course: English	3	75
	Common course: Additional Language	4	100
	Core Course I: Theoretical and Inorganic Chemistry- I	2	75
	Complementary course: Mathematics	3	75
	Complementary course: Physics	2	75
	Total	**18**	**500**
II	Common course: English	4	100
	Common course: English	3	75
	Common course: Additional Language	4	100
	Core Course II: Theoretical and Inorganic Chemistry- II	2	75
	Complementary course: Mathematics	3	75
	Complementary course: Physics	2	75
	Total	**18**	**500**
III	Common course: English	4	100
	Common course: Additional Language	4	100
	Core Course III: Physical Chemistry-I	3	75
	Complementary course: Mathematics	3	75
	Complementary course: Physics	2	75
	Total	**16**	**425**
IV	Common course: English	4	100
	Common course: Additional Language	4	100
	Core Course IV: Organic Chemistry-I	3	75
	Core Course V: Inorganic Chemistry Practical-I	4	100
	Complementary course: Mathematics	3	75
	Complementary course: Physics	2	75
	Complementary course: Physics Practical	4	80
	Total	**24**	**605**
V	Core Course VI: Inorganic Chemistry-III	3	75
	Core Course VII: Organic Chemistry-II	3	75
	Core Course VIII: Physical Chemistry-II	3	75
	Open course	3	75
	Total	**12**	**300**
VI	Core Course IX: Inorganic Chemistry-IV	3	75
	Core Course X: Organic Chemistry-III	3	75
	Core Course XI: Physical Chemistry-III	3	75
	Core Course XII: Advanced and Applied Chemistry	3	75
	Core Course XIII: Elective	2	75
	Core Course XIV: Physical Chemistry Practical	4	100
	Core Course XV: Organic Chemistry Practical	4	100
	Core Course XVI: Inorganic Chemistry Practical-II	4	100
	Core Course XVII: Inorganic Chemistry Practical-III	4	100
	Core Course XVIII: Project Work	2	75
	Total	**32**	**850**

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

Semester	*Code No*	*Course Title*	*Hrs/ Week*	*Total Hrs*	*Credit*	*Marks*
I	CHE1B01	Core Course I: Theoretical and Inorganic Chemistry- I	2	32	2	75
	-	Core Course V : Inorganic Chemistry Practical-I	2	32	-*	-
II	CHE2B02	Core Course II: Theoretical and Inorganic Chemistry- II	2	32	2	75
	-	Core Course V : Inorganic Chemistry Practical-I	2	32	-*	-
III	CHE3B03	Core Course III: Physical Chemistry-I	3	48	3	75
	-	Core Course V : Inorganic Chemistry Practical-I	2	32	-*	-
IV	CHE4B04	Core Course IV: Organic Chemistry-I	3	48	3	75
	CHE4B05(P)	Core Course V : Inorganic Chemistry Practical-I	2	32	4	100
V	CHE5B06	Core Course VI: Inorganic Chemistry-III	3	48	3	75
	CHE5B07	Core Course VII: Organic Chemistry-II	4	64	3	75
	CHE5B08	Core Course VIII: Physical Chemistry-II	3	48	3	75
	-	Core Course XIV: Physical Chemistry Practical	5	80	-**	-
	-	Core Course XV: Organic Chemistry Practical	5	80	-**	-
	-	Core Course XVIII: Project Work	2	32	-**	-
VI	CHE6B09	Core Course IX: Inorganic Chemistry-IV	3	48	3	75
	CHE6B10	Core Course X: Organic Chemistry-III	3	48	3	75
	CHE6B11	Core Course XI: Physical Chemistry-III	3	48	3	75
	CHE6B12	Core Course XII: Advanced and Applied Chemistry	3	48	3	75
	CHE6B13(E1)	Core Course XIII: Elective*** 1. Industrial Chemistry	3	48	2	75
	CHE6B13(E2)	2. Polymer Chemistry				
	CHE6B13(E3)	3. Medicinal and Environmental Chemistry				
	CHE6B14(P)	Core Course XIV: Physical Chemistry Practical	-	-	4**	100
	CHE6B15(P)	Core Course XV: Organic Chemistry Practical	-	-	4**	100
	CHE6B16(P)	Core Course XVI: Inorganic Chemistry Practical-II #	5	80	4	100
	CHE6B17(P)	Core Course XVII: Inorganic Chemistry Practical-III	5	80	4	100
	CHE6B18(Pr)	Core Course XVIII: Project Work	-	-	2**	75
Total					**55**	1475

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

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

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

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

SEMESTER I

Course Code: CHE1B01

Core Course I: Theoretical and Inorganic Chemistry- I

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

CHE1B01	Theoretical and Inorganic Chemistry-I	L*	T**	P***	C#
		2	0	0	2
Objective (s)	To gain detailed knowledge of the principle of volumetric analysis and properties of *s* and *p* block elements. To give a basic understanding of groundwork for a research project. Student will be able to analyse basic theory of acid base concept.				
Course outcome (s)					
CO1	To apply the methods of a research project				
CO2	To understand the principles behind volumetry				
CO3	To analyse the characteristics of different elements				
CO4	To distinguish between different acid base concepts				
CO5	To analyse the stability of different nuclei				

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

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

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

References

1. J. A. Lee, *The Scientific Endeavor: A Primer on Scientific Principles and Practice*, Pearson Education, 1999.
2. C. N. R. Rao, *Understanding Chemistry*, Universities Press India Ltd., Hyderabad, 1999.
3. George Gamow, *One, Two, Three...Infinity: Facts and Speculations of Science*, Dover Publications, 1988.
4. *Resonance – Journal of Science Education*, Indian Academy of Sciences.
5. *Nature Chemistry*, Nature Publishing Group.
6. BBC documentary, *Chemistry: A Volatile History*.

Further reading

1. T. F. Gieryn, *Cultural Boundaries of Science*, University of Chicago Press, Chicago, 1999.
2. H. Collins and T. Pinch, *The Golem: What Everyone Should Know about Science*, Cambridge University Press, Cambridge, 1993.
3. C.R. Kothari, *Research Methodology: Methods and Techniques*, 2nd Revised Edition, New Age International Publishers, New Delhi, 2004.

Module II: Analytical Principles – I (10 hrs)

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

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

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

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

References

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

Further reading

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

Module III : Periodic Properties (3 hrs)

[Prerequisites: Name and symbol of elements, Law of triads, octaves, Mosleys periodic law - Modern periodic law – Long form periodic table. Periodicity in properties: Atomic and ionic radii.]

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

Module IV: Representative Elements (8 hrs)

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

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

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

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

References

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

Further reading

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

Module V: Acid Base Concepts (3 hrs)

[Prerequisites: Arrhenius definition, Bronsted- Lowry definition and conjugate acid –base pairs.]

Lux- Flood Definition, Solvent System Definition, Lewis definition, Usanovich definition.

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

References

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

Further reading

1. J. E. Huheey, E. A. Keitler and R. L. Keitler, *Inorganic Chemistry – Principles of Structure and Reactivity,* 4th Edn., Pearson Education, New Delhi, 2013.
2. M. C. Day and J. Selbin, *Theoretical Inorganic Chemistry*, East West Press, New Delhi, 2002.

Module VI: Nuclear Chemistry (5 hrs)

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

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

References

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

Further reading

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

SEMESTER II

Course Code: CHE2B02

Core Course II: Theoretical and Inorganic Chemistry- II

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

CHE2B02	Theoretical and Inorganic Chemistry- II	L	T	P	C
		2	0	0	2
Objective(s)	Module I - The failures of classical physics theories in explaining many experiments and the emergence of quantum theory with which all of them could be satisfactorily explained. Module II – The basic postulates of quantum mechanics and how to solve the time-independent Schrödinger wave equation of different systems including H atom. Module III - The quantum mechanical treatment of chemical bonding in diatomic molecules using VB and MO theories. Module IV - The quantum mechanical treatment of hybridisation and bonding in polyatomic systems.				
Course outcome (s)					
CO1	To realize the importance and the impact of quantum revolution in science.				
CO2	To understand and apply the concept that the wave functions of hydrogen atom are nothing but atomic orbitals.				
CO3	To realize that chemical bonding is the mixing of wave functions of the two combining atoms.				
CO4	To understand the concept of hybridization as linear combination of orbitals of the same atom.				
CO5	To inculcate an atomic/molecular level philosophy in the mind.				

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

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

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

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

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

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

Postulates of quantum mechanics. Well behaved functions. Time independent Schrödinger wave equation for conservative systems. Application to particle in a one dimensional box – normalization of wave function. Particle in a three-dimensional box – separation of variables, degeneracy.

Application of Schrödinger wave equation to hydrogen atom. The wave equation in spherical polar coordinates. Separation of variables. Wave functions or atomic orbitals, Radial and angular parts of atomic orbitals. Quantum numbers (n, l, m). Radial functions, Radial distribution functions and their plots, Angular functions and their plots (1s, 2s and $2p_z$ only).

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

Module III: Bonding in diatomic molecules (10 hrs)

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

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

Module IV: Bonding in polyatomic molecules (6 hrs)

Concept of Hybridization: Need of hybridization, Definition (mixing of wave functions of the same atom), LCAO of the central atom – coefficients of atomic orbitals in the linear combination of sp (BeH_2), sp^2 (BH_3) and sp^3 (CH_4) hybridisation (derivation not required). Other examples hybridization – Geometry of molecules like PCl_5, SF_6 and IF_7.

Reference

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

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

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

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

Further reading

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

SEMESTER III

Course Code: CHE3B03

Core Course III: PHYSICAL CHEMISTRY - I

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

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

Module I: Gaseous State (8 hrs)

[Prerequisites: Fundamentals of Gaseous state. Postulates of kinetic theory of gases - Derivation of kinetic gas equation - Maxwell's distribution of molecular velocities - Root mean square, average and most probable velocities.]

Collision number - Mean free path - Collision diameter - Deviation from ideal behavior - Compressibility factor – van der Waals equation of state (derivation required) - Virial equation - Expression of van der Waals equation in virial form and calculation of Boyle temperature - PV isotherms of real gases - Continuity of states - Isotherm of van der Waals equation - Critical phenomena - Critical constants and their determination - Relationship between critical constants and van der Waals constants.

References

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

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

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

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

Further reading

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

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

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

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

Module II: Chemical Thermodynamics – I (16 hrs)

[Prerequisites: Fundamentals of Chemical Thermodynamics. Path function and state function - Thermodynamic terms for defining System – Surroundings - Types of systems - intensive and extensive properties - Steady state and equilibrium state. Concept of thermal equilibrium - Zeroth law of thermodynamics.]

First law of thermodynamics – Concept of heat, work, internal energy and enthalpy - Heat capacities at constant volume and at constant pressure & their relationship - Expansion of an ideal gas under isothermal and adiabatic conditions - Work done in isothermal expansion and reversible isothermal expansion - Joule-Thomson effect- significance of term $(\delta U/\delta V)_T$ - Liquefaction of gases - Derivation of the expression for Joule Thomson coefficient – Inversion temperature. Maxwell's relations.

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

Second law of thermodynamics - Need for the law - Kelvin – Planck and Clausius statements and equivalence of the two statements with entropic formulation. Calculation of entropy change for reversible and irreversible processes. Entropy change of systems and surroundings for various processes and transformations. Entropy change during the isothermal mixing of ideal gases. Entropy and unavailable work. free energy functions (G and A) and their variation with T, P and V. Criteria for spontaneity and equilibrium.as a criteria of spontaneity and equilibrium. Carnot's theorem - Carnot's cycle and its efficiency.

Module III: Chemical Thermodynamics – II (8 hrs)

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

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

References

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

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

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

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

Further reading

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

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

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

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

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

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

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

Module IV: Chemical Equilibria (8 hrs)

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

References

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

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

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

Further reading

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

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

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

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

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

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

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

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

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

References

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

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

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

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

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

Further reading

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

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

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

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

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

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

SEMESTER IV

Course Code: CHE4B04

Core Course IV: ORGANIC CHEMISTRY– I

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

CHE4B04	ORGANIC CHEMISTRY– I	L	T	P	C
		3	0	0	3
Objective (s)	Student will be able to analyse basic theory and concepts of organic chemistry and appreciate different organic reaction mechanism and their stereochemistry				
Course outcome (s)					
CO1	To apply the concept of stereochemistry to different compounds				
CO2	To understand the basic concepts of reaction mechanism				
CO3	To analyse the mechanism of a chemical reaction				
CO4	To analyse the stability of different aromatic systems				

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

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

Electron Displacement Effects: Inductive effect: Definition – Characteristics - +I and –I groups. Applications: Comparison of acidity of (i) formic acid and acetic acid (ii) chlorobutanoic acids. Mesomeric effect: Definition – Characteristics - +M and –M groups. Applications: Comparison of basicity of aniline, p-nitroaniline and p-anisidine. Hyperconjugation: Definition – Characteristics. Examples: Propene, ethyl carbocation and ethyl free radical. Applications: relative stability of alkenes, comparison of stabilities of (i) 1-butene and 2-butene (ii) toluene, ethyl benzene and tert-butyl benzene. Electromeric effect: Definition – Characteristics - +E effect (addition of H^+ to 21aloge) and –E effect (addition of CN- to acetaldehyde). Comparison of electron density in benzene, toluene, phenol, chlorobenzene and nitrobenzene. Steric effect: Definition, reason and examples.

Reaction Intermediates: Carbocations, carbanions, free radicals and carbenes (21alogenations, structure, formation and stability).

References

1. Peter Sykes, *A Guide book to Mechanism in Organic Chemistry*: 6th Edition, Pearson Education.
2. S. M. Mukherjee, S.P. Singh, *Reaction Mechanism In Organic Chemistry*, Macmillan.
2. P. S. Kalsi, *Organic Reactions and their Mechanisms*, New Age International Publishers.
3. K. S. Tewari, N.nK. Vishnoi, *Organic Chemistry*, 3rd Edition, Vikas Publishing House.
4. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edition, Vishal Publishing Company Co.
5. R. T. Morrison, R. N. Boyd, *Organic Chemistry*, 6th Edition – Prentice Hall of India.
6. I. L. Finar, *Organic Chemistry*, 6th Edition. Vol.- I, Pearson.

Further Reading

1. J. March, *Advanced Organic Chemistry*, IV Edn, John Wiley & Sons, NY.

2. Reinhard Bruckner, *Advanced Organic Chemistry*, Elsevier.
4. J. Clayden, N. Greeves, S. Warren, P. Wothers, *Organic Chemistry*, Oxford University Press.
5. V. K. Ahluwalia, *Green Chemistry*, Ane Books India.

Module II: Stereochemistry (13 hrs)

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

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

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

Configurational isomerism: Optical isomerism and Geometrical isomerism.

Optical Isomerism: Optical activity – Concept of chirality – Chirality in organic molecules: Enantiomers, Diastereomers and Meso compounds. Optical isomerism in 22alogenations22s, lactic acid and tartaric acid. Relative and absolute configuration- DL system, R- S systems of nomenclature for acyclic optical isomers with one and two asymmetric carbon atoms – sequence rules. Erythro and threo representations(basic idea only). Racemic mixture – Resolution methods – Enantiomeric excess. Asymmetric synthesis (partial and absolute).

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

References:

1. D. Nasipuri, *Stereochemistry of Organic Compounds*, New Age International Publishers.
2. P. S. Kalsi, *Stereochemistry, Conformation and Mechanisms*, New Age International Publishers.
1. R. T. Morrison, R. N. Boyd, *Organic Chemistry*, 6th Edition – Prentice Hall of India.
2. I. L. Finar, *Organic Chemistry* – Vol.1- 6th Edition, Pearson Education.
3. M. K. Jain, S. C. Sharma, Modern, *Organic Chemistry*, 3rd Edition, Vishal Publishing Company Co.
4. K. S. Tewari, N. K. Vishnoi, *Organic Chemistry*, 3rd Edition, Vikas Publishing House.

Further Reading

3. C. N. Pillai, *Organic Chemistry*, Universities Press.
4. P. Y. Bruice, *Organic Chemistry* – 3rd Edn. Pearson Education.
5. J. Clayden, N. Greeves, S. Warren, P. Wothers, *Organic Chemistry*, Oxford University Press

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

[Prerequisites: Nomenclature of hydrocarbons and alkyl halides].

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

Alkenes: Preparation: dehalogenation of dihalides (stereochemistry expected) and dehydration of alcohols. Dehydrohalogenation of alkyl halides (Saytzeff's rule). Chemical reactions: Addition of halogens (electrophilic addition with mechanism), addition of hydrogen halides (Markownikov and Anti-Markownikov addition with mechanism) and addition of water (mechanism expected) – conversion to alcohol (oxymercuration-reduction and hydroboration-oxidation) – Oxidation of alkenes– Epoxidation, dihydroxylation (cis and trans hydroxylation) and oxidative cleavage (permanganate cleavage and ozonolysis).

Alkynes: Preparation from dihalides and acetylides. Chemical reactions: Addition of hydrogen using Lindlar's catalyst and Na/liquid ammonia –Electrophilic addition of halogens and hydrogen halides – Acidity of alkynes – test for terminal alkynes – Oxidation – (Ozonolysis and reaction with alkaline $KmnO_4$). Chemistry of the test for unsaturation: Bromine water and Baeyer's reagent.

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

References

1. Peter Sykes, *A Guide book to Mechanism in Organic Chemistry*: 6th Edition, Pearson Education.
2. K. S. Tewari, N. K. Vishnoi, *Organic Chemistry*, 3rd Edition, Vikas Publishing House.
3. M. K. Jain, S.C. Sharma, *Modern Organic Chemistry*, 3rd Edition, Vishal Publishing Company Co.
4. R. T. Morrison, R. N. Boyd, *Organic Chemistry*, 6th Edition – Prentice Hall of India,
5. I. L. Finar, *Organic Chemistry*, 6th Edition. Vol.- I, Pearson

Further Reading

1. J. March, *Advanced Organic Chemistry*, 4th Edn, John Wiley & Sons, NY.
2. J. Clayden, N. Greeves, S. Warren, P. Wothers, *Organic Chemistry*, Oxford University Press.
3. V. K. Ahluwalia, *Green Chemistry*, Ane Books India.

Module IV: Aromaticity (3 hrs)

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

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

References:

1. R. T. Morrison, R.N Boyd, *Organic Chemistry*, 6th Edn., Prentice Hall of India.
2. I. L. Finar, *Organic Chemistry* – Vol.-1, 6th Edn., Pearson Education.
3. M. K. Jain, S.C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co.
4. K. S. Tewari, N. K. Vishnoi, *Organic Chemistry*, 3rd Edn., Vikas Publishing House.
5. Peter Sykes, *A Guide book to Mechanism in Organic Chemistry*, 6th Edn., Pearson Education.

Further Reading

1. P. S. Kalsi, *Organic Reactions and their Mechanisms*, New Age International Publishers.
2. S. H. Pine, *Organic Chemistry*, McGraw Hill.
3. J. March, *Advanced Organic Chemistry*, 4th Edn, John Wiley & Sons, NY
4. Paula Y. Bruice, *Organic Chemistry*, 3rd Edn. Pearson Education.
5. J. Clayden, N. Greeves, S. Warren, P. Wothers, *Organic Chemistry*, Oxford University Press.

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

[Prerequisites: Module IV: Aromaticity. Electrophile and nucleophile].

Nomenclature of benzene derivatives – Structure and stability of benzene (Kekule, Resonance and Molecular Orbital concepts). Aromatic Electrophilic substitution. Mechanism of nitration, 24alogenations, sulphonation, Friedel-Craft's alkylation and acylation. Orientation of aromatic substitution – Ring activating and deactivating groups with examples – ortho, para and meta directing groups. Birch reduction of benzene.

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

References:

1. R. T. Morrison, R.N Boyd, *Organic Chemistry*, 6th Edn., Prentice Hall of India.
2. I. L. Finar, *Organic Chemistry* – Vol.-1, 6th Edn., Pearson Education.
3. M. K. Jain, S.C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co.
4. K. S. Tewari, N. K. Vishnoi, *Organic Chemistry*, 3rd Edn., Vikas Publishing House.
5. Peter Sykes, *A Guide book to Mechanism in Organic Chemistry*, 6th Edn., Pearson Education.

Further Reading

1. P. S. Kalsi, *Organic Reactions and their Mechanisms*, New Age International Publishers.
2. S. H. Pine, *Organic Chemistry*, McGraw Hill.
3. J. March, *Advanced Organic Chemistry*, 4th Edn, John Wiley & Sons, NY
4. Paula Y. Bruice, *Organic Chemistry* – 3rd Edn. Pearson Education.
5. J. Clayden, N. Greeves, S. Warren, P. Wothers, *Organic Chemistry*, Oxford University Press.

SEMESTER IV

Course Code: CHE4B05 (P)

Core Course V: INORGANIC CHEMISTRY PRACTICAL – I

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

CHE4B05 (P)	**INORGANIC CHEMISTRY PRACTICAL – I**	L	T	P	C
		0	0	2	4
Objective (s)	Development of skills in preparation of standard solutions and quantitative volumetric analysis.				
Course outcome (s)					
CO1	To enable the students to develop skills in quatitative analysis and preparing inorganic complexes.				
CO2	To understand the principles behind quantitative analysis				
CO3	To apply appropriate techniques of volumetric quantitative analysis in estimations				
CO4	To analyze the strength of different solutions				

General Instructions

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

2. For weighing electronic balance must be used.

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

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

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

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

Module I: Introduction to Volumetric Analysis

1. Weighing using electronic balance.

2. Preparation of standard solutions.

Module II: Technique of Quantitative Dilution

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

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

Module III: Neutralization Titrations

1. Strong acid – strong base titration.

2. Strong acid – weak base titration.

3. Weak acid – strong base titration.

4. Estimation of NH_3 by indirect method.

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

6. Estimation of borax.

Module IV: Redox Titrations

a) Permanganometry

1. Estimation of oxalic acid.

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

3. Estimation of hydrogen peroxide.

4. Estimation of calcium.

b) Dichrometry

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

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

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

c) Iodimetry and Iodometry

1. Estimation of iodine.

2. Estimation of copper.

3. Estimation of chromium.

Module V: Precipitation Titration (using adsorption indicator)

1. Estimation of chloride in neutral medium.

Module VI: Complexometric Titrations

1. Estimation of zinc.

2. Estimation of magnesium.

3. Estimation of calcium.

4. Determination of hardness of water.

Module VII: Some Estimations of Practical Importance

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

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

3. Determination of available chlorine in bleaching powder.

4. Determination of COD of water samples.

5. Estimation of citric acid in lemon or orange.

Module VIII: Inorganic Preparations

1. Ferric alum

2. Potash alum

3. Mohr's salt

4. Nickel(II) dimethylglyoximate

5. Potassium trisoxalatoferrate(III)

6. Potassium trioxalatochromate(III)

7. Tris(thiourea)copper(I) sulphate

8. Tetraamminecopper(II) sulphate

9. Microcosmic salt

10. Sodium nitroprusside

References

1. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Edn., Pearson Education, Noida, 2013.
2. D.A. Skoog, D. M. West, F.J. Holler, S.R. Crouch, *Fundamentals of Analytical Chemistry*, 8th Edition, Brooks/Cole, Thomson Learning, Inc., USA, 2004.
3. G.D. Christian, *Analytical Chemistry*, 7th Edn., John Wiley and Sons, New York, 2013.
4. A. L. Underwood, *Quantitative Analysis*, 6th Edn., Prentice Hall of India Pvt. Ltd, New Delhi, 1999.
5. D. N. Bajpai, O. P. Pandey, S. Giri, *Practical Chemistry; For I, II & III B. Sc. Students*, S. Chand & Company Ltd, New Delhi, 2012.
6. W.G. Palmer, *Experimental Inorganic Chemistry*, Cambridge University Press, 1970.

SEMESTER V

Course Code: CHE5B06

Core Course VI: INORGANIC CHEMISTRY – III

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

CHE5B06	**INORGANIC CHEMISTRY – III**	L	T	P	C
		3	0	0	3
Objective (s)	To gain detailed knowledge of the chemistry of different analytical principles and to develop concerns for environment. To give a basic understanding of different metallurgical processes, interhalogen compounds and inorganic polymers.				
Course outcome (s)					
CO1	To understand the principles behind quanlitative and quantitative analysis				
CO2	To understand basic processes of metallurgy and to analyse the merit of different alloys				
CO3	To understand the applications of different inorganic polymers				
CO4	To analyse different polluting agents				
CO5	To apply the principles of solid waste management				

Module I: Analytical Principles II (6 hrs)

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

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

References

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

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

Further reading

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

Module II: Metallurgy (10 hrs)

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

Electrometallurgy – Hydrometallurgy. Refining of metals: Electrolytic refining, ion exchange method, zone refining, vapour phase refining and oxidative refining – Ellingham diagrams for metal oxides – Extractive metallurgy of Al, Fe, Ni, Cu Ti and U. Alloys: Definition – Composition and uses of German silver, brass, bronze, gunmetal and alnico. Steel: Open hearth process – Classification of steel – Composition and uses of alloy steels – Intramedullary rods (a brief study).

References

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

Further reading

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

Module III: Interhalogen compounds (5 hrs)

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

Electropositive character of iodine – General preparation and properties of interhalogen compounds (study of individual members not required) – Structure and hybridization and reactivity of ClF_3, Icl_3 IF_5 and IF_7- Comparison of properties of halogens and pseudohalogens (29yanogens as example) – Structure of polyhalide ions.

References

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

Further reading

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

Module IV: Noble Gases (3 hrs)

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

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

References

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

Further reading

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

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

[Prerequisites: Catenation, Self ionization of water].

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

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

References

1. B. R. Puri, L. R. Sharma, K. C. Kalia, *Principles of Inorganic Chemistry*, 31st Edn. Milestone Publishers, New Delhi, 2010.
2. S. Prakash, G. D. Tuli, S. K. Basu, R. D. Madan, Advanced Inorganic Chemistry,Volume I, S Chand.
3. J. E. Huheey, E. A. Keiter, R. L. Keiter, O K Medhi, *Inorganic Chemistry*, 4th Edn., Pearson. 2006.

Further reading

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

Module V: Environmental Pollution (12 hrs)

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

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

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

Thermal pollution, noise pollution and radioactive pollution (Sources, effects and consequences).

Hiroshima, Nagasaki and Chernobyl accidents (a brief study). Local environmental movements: Silent Valley, Plachimada, Narmada.

References

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

Further reading

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

Module VI: Solid Waste Management (4 hrs)

[Prerequisites: aerobic and anaerobic degradation].

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

References

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

SEMESTER V

Course Code: CHE5B07

Core Course VII: ORGANIC CHEMISTRY – II

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

CHE5B07	ORGANIC CHEMISTRY – II	L	T	P	C
		4	0	0	3
Objective (s)	To give the students a thorough knowledge about the chemistry of selected functional groups and their applications in organic preparations				
Course outcome (s)					
CO1	To understand the difference between alcohols and phenols				
CO2	To understand the importance of ethers and epoxides				
CO3	To apply organometallic compounds in preparation of different functional groups				
CO4	To apply different reagents for the inter conversion of aldehydes, carboxylic acids and acid derivatives				
CO5	To apply active methylene compounds in organic preparations				

Module I: Alcohols and Phenols (14 hrs)

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

Methods of formation of alcohols by reduction of carbonyl compounds. Reaction of carbonyl compounds with Grignard reagent. From alkenes (hydration, hydroboration oxidation and oxymercuration-demercuration reactions). Reactions of alcohols: Acidic and basic nature of alcohols, formation of ester, reaction with hydrogen halides (Lucas test), oxidation (with PCC and $KmnO_4$) – pinacol-pinacolone rearrangement (mechanism expected). Victor Meyer's test. Phenols–Nomenclature, preparation of phenols (from cumene and aromatic sulphonic acid) and acidity of phenol (substituent effects). Reactions of phenols – electrophilic aromatic substitution (Bromination, Nitration and sulphonation) and carboxylation (Kolbe Schmitt reaction). Riemer-Tiemann reaction (mechanism expected), Liebermann's nitroso reaction and Hauben-Hoesch reaction. Preparation of phenolphthalein and fluorescein and colour change of phenolphthalein with pH.

References

1. R. T. Morrison, R. N. Boyd, *Organic Chemistry*, 6th Edn., Prentice Hall of India,
2. I. L. Finar, *Organic Chemistry* – 6th Edn., Vol- I, Pearson.
3. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co.
4. K. S. Tewari, N K Vishnoi, *Organic Chemistry*, 3rd Edn., Vikas Publishing House.

Further reading

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

Module II: Ethers and Epoxides (5 hrs)

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

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

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

References

1. R. T. Morrison, R. N. Boyd, *Organic Chemistry*, 6th Edn., Prentice Hall of India,
2. I. L. Finar, *Organic Chemistry* – 6th Edn., Vol- I, Pearson.
3. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co.
4. K. S. Tewari, N K Vishnoi, *Organic Chemistry*, 3rd Edn., Vikas Publishing House.

Further reading

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

Module III: Organometallic Compounds (2 hrs)

Preparation and synthetic applications of Grignard reagent and organozinc compounds.

References

1. R. T. Morrison, R. N. Boyd, *Organic Chemistry*, 6th Edn., Prentice Hall of India,
2. I. L. Finar, *Organic Chemistry*, 6th Edn., Vol- I, Pearson.
3. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co.
4. K. S. Tewari, N K Vishnoi, *Organic Chemistry*, 3rd Edn., Vikas Publishing House.
5. B. S. Bahl, *Advanced organic Chemistry*, S. Chand.

Further reading

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

Module IV: Aldehydes and Ketones (11 hrs)

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

Nucleophilic addition reactions – Carbon nucleophiles (addition of HCN, wittig reaction), Oxygen nucleophiles (H_2O, alcohols,), Nitrogen nucleophiles (NH_3, hydroxyl amine,

hydrazine, semicarbazide and DNP reagent) and Sulfur nucleophiles (sodium bisulfate). Oxidation – acidified $K_2Cr_2O_7$, $KmnO_4$, CrO_3; Oppenauer oxidation. Distinguishing aldehydes and ketones (Tollen's reagent, Fehling's solution); Reduction – Catalytic hydrogenation, Wolf-Kishner, Clemmensen, metal hydride ($LiAlH_4$ and $NaBH_4$), and MPV reduction. Reactions involving α carbons of carbonyl compounds – Aldol condensation, Cannizzaro reaction Benzoin condensation and Perkin's reactions. Haloform reaction (mechanism expected). Synthetic utility of Wittig reaction, Reformatsky reaction and Beckmann rearrangement.

References

1. R. T. Morrison and R. N. Boyd, *Organic Chemistry*, 6th Edn., Prentice Hall of India.
2. I. L. Finar, *Organic Chemistry*, 6th Edn., Vol.- I, Pearson.
3. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co.
4. K. S. Tewari, N. K. Vishnoi, *Organic Chemistry*, 3rd Edn., Vikas Publishing House.
5. B. S. Bahl, *Advanced organic Chemistry*, S. Chand.

Further reading

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

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

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

Carboxylic acids – Hydrolysis of nitrile and carboxylation of Grignard reagent. Chemical properties: Acidity (effect of substituent on the acidity of aliphatic and aromatic carboxylic acids). Reactions of carboxylic acids – conversion to acid chlorides, esters, amides and acid anhydrides. Relative reactivity of carboxylic acid derivatives (acid chlorides, esters, amides and acid anhydrides). Fisher esterification (mechanism expected) HVZ reaction – Decarboxylation – Kolbe electrolysis (mechanism expected). Hydroxy acids – Citric acid– preparation by Reformatsky reaction and uses. Lactic acid, Malic acid and Tartaric acid (Structure only). Methods of formation and chemical reactions of unsaturated monocarboxylic acids (Cinnamic acid and crotonic acid). Ascend and descend in carboxylic acid series.

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

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

References

1. R. T. Morrison and R. N. Boyd, *Organic Chemistry*, 6th Edn., Prentice Hall of India.
2. I. L. Finar, *Organic Chemistry*, 6th Edn., Vol.- I, Pearson.
3. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co.
4. K. S. Tewari, N. K. Vishnoi, *Organic Chemistry*, 3rd Edn., Vikas Publishing House.
5. B. S. Bahl, *Advanced organic Chemistry*, S. Chand.

Further reading

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

Module VI: Nitrogen Compounds (14 hrs)

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

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

Amines: Nomenclature – Isomerism. Preparation: From alkyl halides, nitro compounds, nitriles, isonitriles and amides – Hofmann's bromamide reaction, Schmidt reaction and Gabriel phthalmide synthesis. Chemical properties: Basicity (effect of substituents on the basicity of aliphatic and aromatic amines), 35arbylamines reaction, conversion of amine to alkene (Hofmann's elimination with mechanism and stereochemistry), acylation and reaction with nitrous acid. Electrophilic substitution reactions of aniline: Halogenation, nitration and sulphonation. Preparation and uses sulpha drugs – Structural formula of sulphapyridine, sulphadiazine, sulphathiazole and sulphaguanidine. Separation of amines by Hinsberg's method.

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

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

References

1. R. T. Morrison and R. N. Boyd, *Organic Chemistry*, 6th Edn., Prentice Hall of India.
2. I. L. Finar, *Organic Chemistry*, 6th Edn., Vol.- I, Pearson.
3. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co.
4. K. S. Tewari, N. K. Vishnoi, *Organic Chemistry*, 3rd Edn., Vikas Publishing House.
5. B. S. Bahl, *Advanced organic Chemistry*, S. Chand.

Further Reading

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

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

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

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

References

1. R. T. Morrison and R. N. Boyd, *Organic Chemistry*, 6th Edn., Prentice Hall of India.
2. I. L. Finar, *Organic Chemistry*, 6th Edn., Vol.- I, Pearson.
3. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co.
4. K. S. Tewari, N. K. Vishnoi, *Organic Chemistry*, 3rd Edn., Vikas Publishing House.

Further reading

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

SEMESTER V

Course Code: CHE5B08

Core Course VIII: PHYSICAL CHEMISTRY – II

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

CHE5B08	PHYSICAL CHEMISTRY – II	L	T	P	C
		3	0	0	3
Objective (s)	To make the student understand the concept of kinetics, catalysis and photochemistry and to familiarize the applications of molecular spectroscopy and phase equilibrium.				
Course outcome (s)					
CO1	To apply the concept of kinetics, catalysis and photochemistry to various chemical and physical processes				
CO2	To characterize different molecules using spectral methods				
CO3	To understand various phase transitions and its applications				

Module I: Kinetics (10 hrs)

[Prerequisites: Fundamentals of Kinetics –Introduction – Derivation of rate constants for first, second (with same and different reactants), third (with same reactants only) and zero order reactions with examples (graphical representations needed) – Half life period (derivation for first and n^{th} order reactions)].

Factors affecting the rate of reactions- Methods to determine the order of a reaction – Steady state approximation – Parallel reactions, opposing reactions, consecutive reactions and chain reactions with examples (elementary idea only) – Arrhenius equation – Effect of temperature on reaction rates Determination and significance of Arrhenius parameters (work out problems) – Theories of reaction rates – Collision theory – Derivation of rate equation for bimolecular reactions using collision theory – Transition state theory – Expression for rate constant based on equilibrium constant and thermodynamic aspects (derivation not required) – Unimolecular reactions – Lindemann mechanism.

Module II: Adsorption and Catalysis (6 hrs)

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

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

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

References

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

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

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

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

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

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

Further reading

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

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

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

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

Module III: Phase Equilibria (10 hrs)

[Prerequisites: Concept of phase- solid, liquid and gas-homogeneous and heterogeneous phase- component and degree of freedom].

Gibbs phase rule and its derivation. Clausius-Clapeyron equation and its applications to solid-liquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems, with applications. One component systems: Water and sulphur systems. Two component systems: Simple eutectic system (lead- silver system) – Pattinson's process – Two component systems involving formation of compounds with congruent melting points (zinc-magnesium system and ferric chloride-water system) – Two component systems involving formation of compounds with incongruent melting points (sodium sulphate-water system). Freezing mixtures – Thermal analysis – Cooling curve method – Deliquescence and efflorescence.

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

References

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

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

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

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

Further reading

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

Module IV: Molecular Spectroscopy I (12 hrs)

[Prerequisites: Electromagnetic spectrum- wavelength, frequency, wavenumber].

Interaction of electromagnetic radiation with matter – Qualitative aspects, Einstein, absorption-emission and factors affecting line width and intensity of signal (elementary idea)- Energy levels in molecules – Born-Oppenheimer approximation.

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

Vibrational Spectroscopy: Simple harmonic oscillator – Energy levels – Force constant – Selection rules

Anharmonicity – Fundamental frequencies – Overtones – Fingerprint region – Group frequency concept – Degree of freedom for polyatomic molecules – Modes of vibrations of CO_2 and H_2O.

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

Electronic Spectroscopy: Basic principles – Frank-Condon principle – Electronic transitions – Beer Lamberts law- Dissociation energy of diatomic molecules – Chromophore and auxochrome – Bathochromic and hypsochromic shifts.

Module V: Molecular Spectroscopy II (4 hrs)

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

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

References

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

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

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

4. C. N. Banwell, *Fundamentals of molecular spectroscopy*, McGraw-Hill, 1994.

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

Further reading

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

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

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

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

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

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

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

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

Module VI: Photochemistry (6 hrs)

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

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

References

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

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

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

4. K. K. Rohatgi-Mukherjee, *Fundamentals of Photochemistry*, New Age International, 1978.

Further reading

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

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

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

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

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

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

SEMESTER VI

Course Code: CHE6B09

Core Course IX: INORGANIC CHEMISTRY – IV

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

CHE6B09	**INORGANIC CHEMISTRY – IV**	L	T	P	C
		3	0	0	3
Objective (s)	To gain detailed knowledge of the electronic configuration and properties of transition and inner transition elements and their role in biological systems. To understand the importance of different instruments used in analysis.				
Course outcome (s)					
CO1	To understand the principles behind different instrumental methods				
CO2	To distinguish between lanthanides and actinides				
CO3	To appreciate the importance of CFT				
CO4	To understand the importance of metals in living systems				
CO5	To distinguish geometries of coordination compounds				

Module I: Instrumental Methods of Analysis (8 hrs)

[Prerequisites: Beer- Lambert's law]

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

References

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

Further reading

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

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

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

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

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

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

References

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

Further reading

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

Module III: Coordination Chemistry (16 hrs)

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

Molecular orbital theory for octahedral complexes (with sigma bonds only). Stability of complexes: Inert and labile complexes – Factors influencing stability. Application of complexes in qualitative and quantitative analysis.

References

1. R. Gopalan, V. Ramalingam, *Concise Coordination Chemistry*, 1st Edn., Vikas Publishing House, New Delhi, 2001.

2. R. Puri, L. R. Sharma, K. C. Kalia, *Principles of Inorganic Chemistry*, 31st Edn., Milestone Publishers, New Delhi 2010.
3. J. D. Lee, *Concise Inorganic Chemistry*, 5th Edn., Wiley India Pvt. Ltd.2008.

Further reading

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

Module IV: Organometallic Compounds (8 hrs)

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

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

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

References

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

Further reading

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

Module V: Bioinorganic Chemistry (8 hrs)

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

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

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

References

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

Further reading

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

SEMESTER VI

Course Code: CHE6B10

Core Course X: ORGANIC CHEMISTRY – III

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

CHE6B10	**ORGANIC CHEMISTRY – III**	L	T	P	C
		3	0	0	3
Objective(s)	To gain detailed knowledge of the chemistry of different bio molecules. To give a basic understanding of different spectral techniques and to apply them in simple molecules. To differentiate diverse pericyclic reactions.				
Course outcome (s)					
CO1	To elucidate structure of simple organic compounds using spectral techniques				
CO2	To understand the basic structure and tests for carbohydrates				
CO3	To understand the basic components and importance of DNA				
CO4	To understand the basic structure and applications of alkaloids and terpenes				
CO5	To distinguish different pericyclic reactions				

Module I: Structure Elucidation Using Spectral Data (11 hrs)

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

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

UV-Visible Spectroscopy: Electronic transitions in molecules ($\sigma\rightarrow\sigma^*$, $n\rightarrow\sigma^*$, $\pi\rightarrow\pi^*$ and $n\rightarrow\pi^*$) – Chromophore and auxochrome. Study of the UV spectra of butadiene, acetone, methyl vinyl ketone and benzene. λ_{max} calculation for dienes and α,β-unsaturated carbonyl compounds.

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

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

Structure elucidation of simple organic compounds using UV, IR and ^{1}H NMR spectroscopic, techniques (ethanol, acetone, acetophenone, acetaldehyde, acetic acid, propanoic acid and ethyl acetate only).

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

References

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

2. Y. R. Sharma, *Elementary Organic Spectroscopy*, 4th Edn., S. Chand & Company Ltd., New Delhi.

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

4. Paula Y. Bruice, *Organic Chemistry*, 3rd Edn. Pearson Education, Asia.

Further reading

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

Module II: Carbohydrates (8 hrs)

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

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

References

1. I. L. Finar, *Organic Chemistry* – Volume I & II – Pearson Education.
2. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co.
3. K. S. Tewari, N. K. Vishnoi, *Organic Chemistry*, 3rd Edn., Vikas Publishing House.
4. R. T. Morrison, R.N. Boyd, *Organic Chemistry*, 6th Edn. – Prentice Hall of India.

Further reading

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

Module III: Proteins and Nucleic acids (11 hrs)

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

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

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

References

1. I. L.Finar, *Organic Chemistry* – Volume I & II – Pearson Education.

2. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co.
3. K. S. Tewari, N. K. Vishnoi, *Organic Chemistry*, 3rd Edn., Vikas Publishing House.
4. R. T. Morrison, R. N. Boyd, *Organic Chemistry*, 6th Edn. – Prentice Hall of India.

Further reading

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

Module IV: Biomolecules (5 hrs)

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

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

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

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

Note: Structural elucidation not expected in any case.

References

1. I. L. Finar, *Organic Chemistry* – Volume I & II - Pearson Education.
2. M. K. Jain and S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co.
3. K. S. Tewari, N. K. Vishnoi, *Organic Chemistry*, 3rd Edn., Vikas Publishing House.

Further reading

1. John McMurry, *Organic Chemistry*, 5th Edn., Thompson Asia Pvt Ltd.
2. C. N. Pillai, *Organic Chemistry*, Universities Press.
3. S. P. Bhutani, *Chemistry of Biomolecules*, Ane Books Pvt Ltd.
4. O. P. Agarwal, *Chemistry of Natural Products*, Goel Publication.
5. R. T. Morrison, R. N. Boyd, *Organic Chemistry*, 6th Edn., Prentice Hall of India.

Module V: Natural products (5 hrs)

[Prerequisites: Heterocyclic systems- nitrogen heterocycles.]

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

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

Note: Structural elucidation not expected in any case.

References

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

3. K. S. Tewari, N. K. Vishnoi, *Organic Chemistry*, 3rd Edn., Vikas Publishing House.
4. R. T. Morrison, R.N. Boyd, *Organic Chemistry*, 6th Edn., Prentice Hall of India.

Further reading

1. S. P. Bhutani, *Chemistry of Biomolecules*, Ane Books Pvt Ltd.
2. O. P. Agarwal, *Chemistry of Natural Products*, Goel Publications.

Module VI: Pericyclic Reactions (8 hrs)

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

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

References

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

Further Reading

1. R. Bruckner, *Advanced Organic Chemistry*, Elsevier.
2. J. March, *Advanced Organic Chemistry*, 4th Edn, John Wiley & Sons, NY.
3. S. H. Pine, *Organic Chemistry*, McGraw Hill.
4. J. Clayden, N. Greeves, S. Warren, P. Wothers, *Organic Chemistry*, Oxford University Press.

SEMESTER VI

Course Code: CHE6B11

Core Course XI: PHYSICAL CHEMISTRY – III

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

CHE6B11	**PHYSICAL CHEMISTRY – III**	L	T	P	C
		3	0	0	3
Objective (s)	To get a thorough knowledge of electrochemistry, colligative properties and solid state				
Course outcome (s)					
CO1	To understand the basic concepts of electrochemistry				
CO2	To realize the importance of colligative properties				
CO3	To relate the properties of material/solids to the geometrical properties and chemical compositions				

Module I: Electrochemistry – I (12 hrs)

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

Module II: Electrochemistry – II (10 hrs)

[Prerequisites: Module I – Electrochemistry. Basics of thermodynamics.]
Introduction – types of cell and electrodes (Reversible- SHE, calomel and quinhydrone electrode) – Standard electrode potential – Electrochemical series – Nernst equation for electrode potential and EMF of a cell (Review) – Relationship between free energy and electrical energy (work out problems).

Gibbs Helmholtz equation to galvanic cells. Concentration cells: Concentration cells with and without transference – Liquid junction potential. Application of EMF measurements: Solubility of sparingly soluble salts – Determination of pH – pH measurement using glass electrode – Potentiometric titrations – Hydrogen-oxygen fuel cell – Electrochemical theory of corrosion of metals.

References

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

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

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

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

Further reading

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

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

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

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

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

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

Module III: Solutions (10 hrs)

[**Prerequisites:** Fundamentals of solutions. Solute, solvent, kinds of solutions – Vapour pressure- Solubility of gases in liquids – Henry's law and its applications – Raoult's law – Ideal and non ideal solutions – Dilute solutions.]

Colligative properties – Qualitative treatment of colligative properties – Relative lowering of vapour pressure – Elevation of boiling point – Depression in freezing point – Osmotic pressure – Reverse osmosis and its applications – Application of colligative properties in finding molecular weights (thermodynamic derivation not needed) – Abnormal molecular mass – Van't Hoff factor. Surface tension: Explanation and its determination. Viscosity: Determination of molecular mass from viscosity measurements. Refraction: Refractive index – Molar refraction and optical exaltation – Application.

References

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

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

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

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

Further reading

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

Module IV: Ionic Equilibria (3 hrs)

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

References

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

Further reading

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

Module V: Solid State – I (10 hrs)

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

Module V: Solid State – II (3 hrs)

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

References

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

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

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

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

Further reading

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

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

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

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

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

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

SEMESTER VI

Course Code: CHE6B12

Core Course XII: Advanced and Applied Chemistry

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

CHE6B12	Advanced and Applied Chemistry	L	T	P	C
		3	0	0	3
Objective (s)	Student will be able to 54olymer the role and opportunities of chemistry as a discipline in modern civilization.				
Course outcome (s)					
CO1	To understand the importance of nanomaterials				
CO2	To appreciate the importance of green approach in chemistry				
CO3	To understand the uses and importance of computational calculations in molecular design				
CO4	To realize the extent of chemistry in happiness index and life expectancy				

Module I: Colloids and Nanomaterials (6 hrs)

[Prerequisites: Colloids: Definition – classification- Synthesis – nanometer, micrometer.]

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

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

Characterization of nanomaterials.

Applications of nanomaterials (general idea only).

References

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

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

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

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

Further reading

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

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

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

Module II: New vistas in chemistry (8 hrs)

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

Supramolecular chemistry: Introduction—types of non- covalent interactions – Molecular recognition – Host-guest interactions.

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

References

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

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

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

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

Further reading

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

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

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

Module III: Introduction to Computational Chemistry (6 hours)

Classification of Computational Chemistry methods – Molecular mechanics methods (basic idea of force field) and Electronic Structure methods (basic idea of ab initio and semi empirical methods), potential energy surface – local minima, global minima, saddle point and transition states, Elementary idea of basis functions – Slater type and Gaussian type orbitals.

Reference

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

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

3. C. J. Cramer, *Essentials of Computational Chemistry: Theories and models*, John Wiley & Sons 2002.
4. P. W. Atkins, *Molecular Quantum Mechanics*, Oxford University Press, New York, 2005.
5. R. K. Prasad, *Quantum Chemistry*, Oscar Publications, New Delhi, 2000.

Further reading

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

Module IV: Synthetic polymers (4 hrs)

Classification – Tacticity –Synthesis and applications of addition polymers (polythene, polystyrene, 56olyme and PMMA) and condensation polymers (nylon 6, nylon 66, and terylene) – thermosets – 56olymeri. Zeigler Natta 56olymerization—advantages. Plastic identification codes. Biodegradable polymers: PLA, PGA and PHBV.

References

1. V. R. Gowarikar, *Polymer Chemistry*, New Age International (P) Ltd., New Delhi, 2010.
2. Fred. W. Billmeyer, *Textbook of Polymer Science*, 3rd Edn., Wiley India, Delhi, 2008.
3. Jeol R. Fried, *Polymer Science and Technology*, Prentice Hall of India Private Limited, New Delhi, 1999.

Further reading

1. Premamoy Ghosh, *Polymer Science and Technology: Plastics, Rubbers, Blends and Composites*, 3rd Edn., McGraw Hill Education (India) Private Limited, 2011.

Module V: Applied inorganic chemistry (8 hrs)

Cement: Manufacture, composition and setting.

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

Refractory materials: borides and carbides.

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

Rocket propellants: Classification with examples

Tooth paste and Talcum powder: Composition and health effects.

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

References

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

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

Further reading

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

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

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

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

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

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

Module VI: Applied organic chemistry – I (8 hrs)

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

Pharmaceuticals: Medicinal chemistry – Drugs (chemical, generic and trade names with examples).

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

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

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

References

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

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

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

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

Further reading

1. K. H. Buchel, *Chemistry of Pesticides*, John Wiley & Sons, New York, 1983.

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

Module VII: Applied organic chemistry – II (8 hrs)

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

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

Food additives: Food preservatives, artificial sweeteners and antioxidants (definition and examples, structures not required) – Structure of BHT, BHA and Ajinomoto – Common permitted and non-permitted food colours (structures not required) – Artificial ripening of fruits.

Modern food: Definition of fast foods, instant foods, dehydrated foods, junk foods and condiments – Composition of chocolate, milk powder and soft drinks.

References

1. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edn., Vikas Publishing House (Pvt.) Ltd., New Delhi, 2004.

2. B. Srilakshmi, *Food Science*, 5nd Edn., New Age Publishers, New Delhi, 2010.

Further reading

1. B. Sivasankar, *Food processing and preservation*, Prentice – Hall of India Pvt. Ltd. New Delhi, 2002.

2. Srinivasan Damodaran, Kirk L. Parkin, Owen R. Fennema, *Food Chemistry*, 4nd Edn., CRC Press, New York, 2007.

3. K. Singh, *Chemistry in Daily Life*; Prentice Hall of India, New Delhi, 2008.

SEMESTER VI

Course Code: CHE6B13(E1)

Core Course XIII: Elective 1. INDUSTRIAL CHEMISTRY

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

CHE6B13(E1)	**INDUSTRIAL CHEMISTRY**	L	T	P	C
		3	0	0	2
Objective (s)	Student will be able to 59ealize the role and opportunities of chemistry as a discipline in modern civilization. To make awareness among the students on different chemical industries.				
Course outcome (s)					
CO1	To understand the importance of petrochemicals				
CO2	To appreciate the importance and to 59ealize the opportunities of pharmaceutical, leather and sugar industries.				
CO3	To analyse the role of catalysts in industrial processes.				

Module I: Introduction (4 hrs)

Requirements of an industry – Location – Water – Industrial water treatment – Safety measures – Pilot plants – ISO certification.

References

1. B. K. Sharma, *Industrial chemistry*, 11th Edn., Goel publishing House, Meerut, 2000.

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

Further reading

1. Marshal Sittig, M. Gopala Rao, *Outlines of Chemical Technology for the 21st Century*, 3rd Edn., East-West Press Pvt. Ltd., New Delhi, 2010.

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

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

Module II: Petrochemical Industry (12 hrs)

Introduction. Natural gas – CNG, LNG and LPG.

Coal: Classification based on carbon content – Carbonisation of coal – Composition and uses of various fractions.

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

Catalysts used in Petroleum Industries: Structure, selectivity and applications.
Synthetic Petrol: Manufacture by Bergius and Fischer-Tropsch processes.
Manufacture of petrochemicals: Ethylene glycol, glycerine, acetone, phenol, vinyl acetate, toluene, linear alkyl benzenes and their sulphonates.
Usage and depletion of petroleum products – Need for alternative fuel – Hydrogen as the future fuel.

References

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

Further reading

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

Module III: Pharmaceutical Industry (8 hrs)

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

References

1. G. L. Patrick, *Introduction to Medicinal Chemistry*, Oxford University Press, UK.
2. Hakishan Singh, V.K. Kapoor, *Medicinal and Pharmaceutical Chemistry*, Vallabh Prakashan, Pitampura, New Delhi.
3. W. O. Foye, L. Thomas, Lemke, David A. William, *Principles of Medicinal Chemistry*, B.I. Waverly Pvt. Ltd. New Delhi.
4. Jayashree Ghosh, *A Text Book of Pharmaceutical Chemistry*, S. Chand and Co. Ltd, 1999.
5. O. Le. Roy, *Natural and synthetic organic medicinal compounds*, Ealemi, 1976.

Further reading

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

Module IV: Industrial Catalysis (6 hrs)

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

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

References

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

Further reading

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

Module V: Leather and Sugar Industries (8 hrs)

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

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

References

1. *Fundamental of Leather Science* – Woodroffe Publications of CLRI – Chennai.
2. J. Partridge Noyes, N. J. Park Ridge, *Chemical treatment of hides a leather*.

Further reading

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

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

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

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

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

References

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

SEMESTER VI

Course Code: CHE6B13(E2)

Core Course XIII: Elective 2. POLYMER CHEMISTRY

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

CHE6B13(E2)	**POLYMER CHEMISTRY**	L	T	P	C
		3	0	0	2
Objective (s)	To gain detailed knowledge about classification of polymers and various mechanisms and technology adopted for 62evlar62ization. To give a basic understanding of properties of polymers like glass transition temperature, molecular weight and degradation of polymers. To give detailed idea about different commercial polymers.				
Course outcome (s)					
CO1	To understand various classification of polymers and types of 62evlar62ization methods.				
CO2	To understand the important characteristics of polymers such as average molecular weight, glass transition temperature, viscoelasticity and degradation				
CO3	To appreciate the importance of processing techniques				
CO4	To 62evlar62iz different commercial polymers and to understand the significance of recycling				

Module I: Introduction (4 hrs)

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

Module II: Types of Polymerisation (10 hrs)

Chain and step growth polymerizations – Free radical, ionic and coordination polymerizations with mechanism – Zeigler-Natta polymerization (mechanism expected) and its advantages – Ring-opening & group transfer 62evlar62izations (Mechanism not needed).

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

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

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

Visco elasticity of polymers (Basic Concepts only)

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

Module IV: Polymerisation Techniques (6 hrs)

Polymerisation Techniques: Bulk, solution, suspension, emulsion, melt condensation and interfacial polycondensation 63evlar63izations.

Module V: Polymer Processing (6)

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

Module VI: Commercial Polymers (12 hrs)

Preparation, Structure , properties and applications of- Polyolefins (HDPE, LDPE, PP and PS); Vinyl polymers (PVC, PVP and EVA, Saran); fluoro polymers (Teflon); Acrylic polymers (PAN and PMMA); Aliphatic polyamides (nylon6,6 and nylon 6); Aromatic polyamides (63evlar); Polyester (terylene); Polycarbonate (lexan); Polyurethanes; Resins- Glyptal and formaldehyde resins (UF, MF and PF); Rubbers (NR- Vulcanisation, EPDM, BR, SBR, nitrile rubber, Neoprene, Butyl rubber and silicone rubber); Conducting polymers- Dopping (Conduction mechanism not required).

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

References

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

Further reading

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

SEMESTER VI

Course Code: CHE6B13(E3)

Core Course XIII: Elective 3. MEDICINAL AND ENVIRONMENTAL CHEMISTRY

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

CHE6B13(E3)	**MEDICINAL AND ENVIRONMENTAL CHEMISTRY**	L	T	P	C
		3	0	0	2
Objective (s)	Student will be able to realise the importance of chemistry in medicinal field and to get ideas about various diseases. It will also help to get information about various toxic substances in environment and their control.				
Course outcome (s)					
CO1	To understand the importance of drugs in human health				
CO2	To understand the facts about common diseases and treatment				
CO3	To recognize the presence of toxic substances in atmosphere				
CO4	To realize the extent of chemistry in treatment of water and sewage				

Module I: Health and Biochemical Analysis (6 hrs)

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

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

Module II: Drugs (4 hrs)

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

Module III: Common Diseases and Treatment (10 hrs)

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

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

Module IV: Environmental Toxicology (6 hrs)

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

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

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

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

Module VI: Water Treatment Processes (10 hrs)

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

References

1. G. Thomas, *Fundamentals of Medicinal Chemistry*, John Wiley & Sons Ltd., London, 2003.
2. Arthur C. Guyton, John E. Hall, Textbook of Medical Physiology, 12th Edition, Saunders, US, 2010.
3. D. J. Abraham, *Burger's Medicinal Chemistry and Drug Discovery*, Vol.1-6, WileyInterscience, Hoboken, NJ, 2003.
4. B. L. Oser, *Hawk's Physiological Chemistry*, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 1979.
5. S. C. Rastogi, *Biochemistry*, 2nd Edn., Tata McGraw Hill Publishing Co., New Delhi, 2007.
6. Gurdeep R. Chatwal, *Synthetic Drugs*, Himalaya Publishing House, Bombay, 1995.
7. Jayashree Ghosh, *A Textbook of Pharmaceutical Chemistry*, 3rd Edn., S. Chand and Company Ltd., New Delhi, 1999.
8. Rasheeduz Zafar, *Medicinal Plants of India*, 1st Edn., CBS Publishers & Distributors Pvt. Ltd., New Delhi, 2009.
9. A. K. De, *Environmental Chemistry*, 6th Edn., New Age International (P) Ltd., New Delhi, 2006.
10. M. L. Davis, D. A. Cornwell, *Introduction to Environmental Engineering*, 3rd Edn., McGraw Hill, New Delhi, 1998.
11. S. E. Manahan, *Environmental Chemistry*, 8th Edn., CRC Press, Florida, 2004.
12. G.M. Masters, *Introduction to Environmental Engineering and Science*, 3rd Edn., Prentice-Hall Inc., New Delhi, 2007.
13. A. K. Ahluwalia, *Environmental Chemistry*, Ane Books India, New Delhi, 2008.
14. B. K. Sharma, H. Kaur, *Environmental Chemistry*, Goel Publishing House, Meerut, 1996.

SEMESTER VI

Course Code: CHE6B14(P)

Core Course XIV: PHYSICAL CHEMISTRY PRACTICAL

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

CHE6B14(P)	**PHYSICAL CHEMISTRY PRACTICAL**	L	T	P	C
		0	0	5	4
Objective (s)	The relation between physical properties and chemical composition is used for analysis. Get an idea of designing experimental methods to analyze the physical properties of molecules or materials.				
Course outcome (s)					
CO1	To enable the students to develop analytical skills in determining the physical properties (Physical constants)				
CO2	To develop skill in setting up a experimental methods to determine the physical properties				
CO3	To understand the principles of Refractometry, Potentiometry and Conductometry				

General Instructions

1. For weighing, either electronic balance may be used.

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

3. A minimum number of 10 experiments must be done, covering at least six modules, to appear for the examination.

4. The practical must be completed in the 5^{th} semester. Practical examination will be conducted at the end of 6^{th}semester.

Module I: Viscosity and Surface tension

1. Determination of viscosity of various liquids using Ostwald's viscometer.
2. Study of glycerine-water system and determination of percentage of glycerine using viscometer (plot composition against time of flow x density of the solution).
3. Determination of the surface tension of a liquid or a dilute solution (NaCl / surfactant) using a stalagmometer (drop number method).

Module II: Colligative properties (Cooling curve method)

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

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

Module III: Transition Temperature

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

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

Module IV: Phase Equilibria

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

Module V: Spectroscopy

1. Determination of composition of glycerine-water mixture by refractive index method.
2. Determination of refractive indices of KCl solutions of different concentration and concentrations of unknown KCl solution.
3. Verify Lambert-Beer's law and determine molar extinction coefficient, concentration of any one, $CuSO_4$ / Ferric alum / $KmnO_4$ / $K_2Cr_2O_7$ in a solution. Find out the unknown concentration of the given solution. (Five standards may be prepared).

Module VI: Conductometry and Potentiometry

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

Module VII: pH metry

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

Module VIII: Kinetics

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

References

1. A. Findlay, *Findlay's Practical Physical Chemistry*, 9th Edn., John Wiley and Sons, New York, 1972.

2. J. B. Yadav, *Advanced Practical Physical Chemistry*, Goel Publications, Meerut, 2008.

3. D. P. Shoemaker, C. W. Garland, *Experiments in Physical Chemistry*, McGraw-Hill Book Company, New York, 1962.

4. W. G. Palmer, *Experimental Physical Chemistry*, Cambridge University Press, Cambridge, 2009.

5. R. C. Das, B. Behra, *Experiments in Physical Chemistry*, Tata McGraw Hill, New Delhi, 1983.

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

7. P. S. Sindhu, *Practicals in Physical Chemistry A Modern Approach*, Macmillan India Ltd. 2006.

SEMESTER VI

Course Code: CHE6B15(P)

Core Course XV: ORGANIC CHEMISTRY PRACTICAL

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

CHE6B15(P)	ORGANIC CHEMISTRY PRACTICAL	L	T	P	C
		0	0	5	4
Objective (s)	Empower the student to prepare different compounds without compromising yield. Characterisation and analysis of different organic compounds based on functional groups. Develop skill in separation and purification of mixtures.				
Course outcome (s)					
CO1	To enable the students to develop analytical skills in organic qualitative analysis				
CO2	To develop talent in organic preparations to ensure maximum yield				
CO3	To apply the concept of melting or boiling points to check the purity of compounds				
CO4	To analyze and characterize simple organic functional groups				
CO5	To analyse individual amino acids from a mixture using paper chromatography				

General Instructions

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

Module I: Reagent Preparation

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

Module II: Determination of Physical Constants

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

Module III: Recrystallisation Techniques

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

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

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

Module V: Reactions of Organic Compounds

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

1. Phenols (phenol, α-naphthol).
2. Nitro compounds (nitrobenzene, o-nitrotoluene).
3. Amines (aniline, N,N-dimethyl aniline).
4. Halogen compounds (chlorobenzene, benzyl chloride, p-dichlorobenzene).
5. Aldehydes and ketones (benzaldehyde, benzophenone).
6. Carboxylic acid (benzoic acid, cinnamic acid, phthalic acid, salicylic acid).
7. Carbohydrates (glucose, sucrose).
8. Amides (benzamide, urea).
9. Esters (ethyl benzoate, methyl salicylate).
10. Hydrocarbons (naphthalene, anthracene)

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

Module VI: Organic Preparations

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

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

Module VII: Chromatography

Paper chromatographic separation of mixture of two amino acids.

References

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

SEMESTER VI

Course Code: CHE6B16 (P)

Core Course XVI: INORGANIC CHEMISTRY PRACTCAL-II

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

CHE6B16 (P)	**INORGANIC CHEMISTRY PRACTCAL-II**	L	T	P	C
		0	0	5	4
Objective (s)	To develop skill in quantitative analysis using gravimetric and colorimetric methods.				
Course outcome (s)					
CO1	To enable the students to develop analytical skills in inorganic quantitative analysis				
CO2	To understand the principles behind gravimetry and to apply it in quantitative analysis.				
CO3	To understand the principles behind colorimetry and to apply it in quantitative analysis.				

General Instructions

1. For weighing, electronic balance should be used.

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

3. A minimum number of 10 experiments must be done, covering the three modules, to appear for the examination.

4. The report of industrial visit must be submitted, along with the practical record, to appear for the examination.

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

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

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

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

Module III: Colorimetry

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

References

1. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Edn., Pearson Education, Noida, 2013.
2. D. N Bajpai, O. P. Pandey, S. Giri, *Practical Chemistry for I, II & III B. Sc. Students*, S. Chand & Company Ltd., New Delhi, 2012.
3. V. K. Ahluwalia, Sunita Dhingra, Adarsh Gulati, *College Practical Chemistry*, Universities Press (India) Pvt. Ltd., Hyderabad, 2008.
4. D. A. Skoog, D. M. West, F. J. Holler, S. R. Crouch, *Fundamentals of Analytical Chemistry*, 8th Edn., Brooks/Cole, Thomson Learning, Inc., USA, 2004.

SEMESTER VI

Course Code: CHE6B17(P)

Core Course XVII: INORGANIC CHEMISTRY PRACTCAL-III

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

CHE6B17 (P)	**INORGANIC CHEMISTRY PRACTCAL-III**	L	T	P	C
		0	0	5	4
Objective (s)	To develop skill in quanlitative analysis of inorganic compounds				
Course outcome (s)					
CO1	To enable the students to develop skills in inorganic quanlitative analysis.				
CO2	To understand the principles behind inorganic mixture analysis and to apply it in quanlitative analysis.				
CO3	To analyse systematically mixtures containing two cations and two anions.				

General Instructions

1. Semimicro analysis must be adopted for inorganic qualitative analysis.

2. Mixtures containing more than one interfering anions must be avoided.

3. If interfering anions are not present, cations may be given from the same group.

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

5. A minimum of 8 inorganic mixtures must be done to appear for the examination.

Module I: Inorganic Qualitative Analysis

1. Study of the reactions of following ions. *Anions:* Carbonate, sulphate, fluoride, chloride, bromide, iodide, acetate, borate, oxalate, phosphate and nitrate. *Cations:* Lead, bismuth, copper, cadmium, iron, aluminium, cobalt, nickel, manganese, zinc, barium, calcium, strontium, magnesium and ammonium.

2. Systematic analysis of mixtures containing two cations and two anions from the above list.

3. Na_2CO_3 extract procedure may be adopted.

References

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

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

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

SEMESTER VI

Course Code: CHE6B18(Pr)

Core Course XVIII: PROJECT WORK

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

CHE6B18(Pr)	**PROJECT WORK**	L	T	P	C
		0	0	2	2
Objective (s)	To develop skill in scientific research, critical thinking and reasoning.				
Course outcome (s)					
CO1	To understand the scientific methods of research project.				
CO2	To apply the scientific method in life situations.				
CO3	To analyse scientific problems systematically.				

Guidelines

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

CORE COURSE THEORY: EVALUATION SCHEME

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

1. INTERNAL EVALUATION

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

Table 1: Components of Evaluation

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

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

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

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

Table 3: Pattern of Test Papers

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

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

2. EXTERNAL EVALUATION

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

Table 1: Pattern of Question Paper

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

CORE COURSE PRACTICAL: EVALUATION SCHEME

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

1. INTERNAL EVALUATION

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

Table 1: Components of Evaluation

Sl. No.	*Components*	*Marks*
1	Record (60%)	12
2	Lab involvement (40%)	8
Total Marks		20

Table 2: Lab involvement

Viva	4
Performance	2
Punctuality	2
Total	8

Table 3: Number of Experiments and Marks for Practical Records

Number of Experiments (Marks in brackets)						
Inorganic Chemistry Practical-I		*Physical Chemistry Practical*	*Organic Chemistry Practical*		*Inorganic Chemistry Practical –II*	*Inorganic Chemistry Practical –III*
Volumetry	*Preparation*		*Analysis*	*Preparation*		*Mixture*
19-20 (9)	6 (3)	14 (12)	10 (8)	8 (4)	13-14 (12)	11-12 (12)
18 (8)	5 (2)	13 (11)	9 (7)	7 (3)	12 (11)	10 (11)
17 (7)	4 (1)	12 (10)	8 (6)	6 (2)	11 (10)	9 (10)
16 (6)		11 (9)	7 (5)		10 (9)	8 (9)
15 (5)		10 (8)				

2. EXTERNAL EVALUATION

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

PATTERN OF QUESTION PAPERS

Table 1: Inorganic Chemistry Practical – I

Duration	*Pattern*	*Marks*	*Total Marks*
3 Hours	Question on volumetric analysis	8	80
	Procedure for volumetry	8	
	Procedure for inorganic preparation	4	
	Inorganic preparation	5	
	Result	35	
	Calculation	4	
	Record	8	
	Viva-Voce	8	

Guidelines

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

2. *Marks for Result:* For calculating the error percentage both theoretical value and skilled value are considered. The reported values (RV) of the students are compared with theoretical value (TV) and skilled value (SV) to calculate the error percentage. Up to 1.5% error: 35 marks; between 1.51 – 2%: 30 marks; between 2.1 – 2.5%: 25 marks; between 2.51– 3%: 15 marks; greater than 3%: 4 marks.

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

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

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

Table 2: Physical Chemistry Practical

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

Guidelines

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

2. *Marks for Result:* The mark distribution may vary for different experiments.

Table 3: Organic Chemistry Practical

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

Guidelines

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

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

3. *Organic Analysis:* Aliphatic/aromatic: 2 marks, saturated/unsaturated: 2 marks, detection of elements: 3 marks, identification test of functional group: 5 marks, chemistry of identification test: 3 marks, confirmation test of functional group: 5 marks, chemistry of confirmation test: 3 marks, suggestion of derivative: 1 mark, method of preparation of the derivative: 2 marks, preparation of derivative suggested by the examiner: 3 marks, chemistry of the derivative preparation: 3 marks, systematic procedure: 4 marks.

Table 4: Inorganic Chemistry Practical – II

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

Guidelines

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

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

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

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

Table 5: Inorganic Chemistry Practical – III

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

Guidelines

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

Table 6: Evaluation of Records

Number of Experiments (Marks in brackets)						
Inorganic Chemistry Practical – I		*Physical Chemistry Practical*	*Organic Chemistry Practical*		*Inorganic Chemistry Practical –II*	*Inorganic Chemistry Practical –III*
Volumetry	Preparation		*Analysis*	*Preparation*		*Mixture*
19-20 (6)	6 (2)	13-14 (8)	9-10 (4)	8 (4)	13-14 (8)	12 (8)
18 (5)	5 (1)	12 (7)	8 (3)	7 (3)	12 (7)	11 (7)
17 (4)		11 (6)	7 (2)	6 (2)	11 (6)	10 (6)
16 (3)		10 (5)			10 (5)	9 (5)
						8 (4)

CORE COURSE PROJECT: EVALUATION SCHEME

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

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

b) External evaluation by examiner appointed by university

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

Table 1: Internal Evaluation

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

Table 2: External Evaluation

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

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

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

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

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

CHEMISTRY COMPLEMENTARY COURSE STRUCTURE

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

Semester	*Code No*	*Course Title*	*Hrs/ Week*	*Total Hrs*	*Credit*	*Marks*
I	CHE1C01	Complementary Course I: General Chemistry	2	32	2	75
	-	Complementary Course V: Chemistry Practical	2	32	-*	-
II	CHE2C02	Complementary Course II: Physical Chemistry	2	32	2	75
	-	Complementary Course V: Chemistry Practical	2	32	-*	-
III	CHE3C03	Complementary Course III: Organic Chemistry	3	48	2	75
	-	Complementary Course V: Chemistry Practical	2	32	-*	-
IV	CHE4C04	Complementary Course IV: Physical and Applied Chemistry	3	48	2	75
	CHE4C05(P)	Complementary Course V: Chemistry Practical	2	32	4*	80
Total					**12**	380

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

CHEMISTRY COMPLEMENTARY COURSE STRUCTURE

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

Semester	Code No	Course Title	Hrs/ Week	Total Hrs	Credit	Marks
I	CHE1C01	Complementary Course I: General Chemistry	2	32	2	75
	-	Complementary Course V: Chemistry Practical	2	32	-*	-
II	CHE2C02	Complementary Course II: Physical Chemistry	2	32	2	75
	-	Complementary Course V: Chemistry Practical	2	32	-*	-
III	CHE3C03	Complementary Course III: Organic Chemistry	3	48	2	75
	-	Complementary Course V: Chemistry Practical	2	32	-*	-
IV	CHE4C04	Complementary Course IV: Physical and Applied Chemistry	3	48	2	75
	CHE4C05(P)	Complementary Course V: Chemistry Practical	2	32	4*	80
Total					**12**	**380**

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

SEMESTER I

Course Code: CHE1C01

Complementary Course I:

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

CHE1C01	**GENERAL CHEMISTRY**	L	T	P	C
		2	0	0	2
Objective(s)	To provide the students a thorough knowledge about the chemistry of quantitative and qualitative analysis and the theories behind chemical bonding. It will also impart the ideas behind atomic nucleus and the importance of metals in biological systems.				
Course outcome (s)					
CO1	To understand and to apply the theories behind quantitative and qualitative analysis				
CO2	To understand the theories behind chemical bonding				
CO3	To appreciate the uses of radioactive isotopes				
CO4	To understand the importance of metals in biological systems				

Module I: Analytical Chemistry (10 hrs)

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

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

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

Accuracy & Precision (mention only).

References

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

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

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

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

Chemical Bonding: Introduction – Type of bonds.

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

Covalent bond: Lewis theory – Coordinate bond.

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

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

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

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

References

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

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

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

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

Module III: Nuclear Chemistry (6 hrs)

Natural radioactivity – Modes of decay – Group displacement law.
Nuclear forces - n/p ratio - Nuclear stability - Mass Defect - Binding energy. Isotopes, isobars and isotones with examples.
Nuclear fission - Atom bomb - Nuclear fusion – Hydrogen bomb - Nuclear reactors
Application of radioactive isotopes – ^{14}C dating, Rock dating, Isotopes as tracers, Radio diagnosis, radiotherapy.

References

1. H. J. Arnikar, *Essentials of Nuclear Chemistry*, 4th Edn., New Age International (P) Ltd., New Delhi, 1995 (Reprint 2005).
2. R. Gopalan, *Elements of Nuclear Chemistry*, Vikas Publ. House

Module IV: Bioinorganic Chemistry (6 hrs)

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

References

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

SEMESTER II

Course Code: CHE2C02

Complementary Course II: PHYSICAL CHEMISTRY

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

CHE2C02	**PHYSICAL CHEMISTRY**	L	T	P	C
		2	0	0	2
Objective(s)	To provide the students a thorough knowledge about different terminologies in thermodynamics and the continuity between different states of matter. It will also impart an idea behind basic principles of electrochemistry.				
Course outcome (s)					
CO1	To understand the importance of free energy in defining spontaneity				
CO2	To realize the theories behind different states of matter and their implication				
CO3	To understand the basic principles of electrochemistry				

Module I: Thermodynamics (6 hrs)

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

References

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

Module II: Gaseous and Solid States (10 hrs)

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

References

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

Module III: Liquid State and Solutions (6 hrs)

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

References

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

Module IV: Electrochemistry (10 hrs)

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

References

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

SEMESTER III

Course Code: CHE3C03

Complementary Course III: ORGANIC CHEMISTRY

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

CHE3C03	**ORGANIC CHEMISTRY**	L	T	P	C
		3	0	0	2
Objective(s)	To provide the students a thorough knowledge about basic theory and concepts of organic chemistry.				
Course outcome (s)					
CO1	To understand the basic concepts behind reaction intermediates				
CO2	To realize the importance of optical activity and chirality				
CO3	To appreciate the importance of functional groups and aromatic stability				
CO4	To understand the basic structure and importance of carbohydrates, nucleic acids, alkaloids and terpenes				

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

Introduction: Homolysis and heterolysis of bonds – Electrophiles and nucleophiles.
Reaction Intermediates: Carbocations, carbanions and free radicals (types, hybridization and stability).
Types of organic reactions: Addition,elimination,substitution and rearrangement reactions(definition and one example each)
Electron Displacement Effects: Inductive effect: Definition – Characteristics - +I and –I groups.
Applications: Explanation of substituent effect on the acidity of aliphatic carboxylic acids. Mesomeric effect: Definition – Characteristics - +M and –M groups. Applications: Comparison of electron density in benzene, nitrobenzene and aniline. Hyperconjugation: Definition – Characteristics. Example: Propene.
Applications: Comparison of stability of 1-butene & 2-butene. Electromeric effect: Definition – Characteristics - +E effect (addition of H^+ to 86isulp) and –E effect (addition of CN^- to acetaldehyde). Steric effect (causes and simple examples).

References

1. Peter Sykes, *A Guide book to Mechanism in Organic Chemistry*, 6th Edn., Pearson Education.
2. P. S. Kalsi, *Organic Reactions and their Mechanisms*, New Age International Publishers.
3. K. S. Tewari, N. K. Vishnoi, *Organic Chemistry*, 3rd Edn., Vikas Publishing House.
4. M. K. Jain, S.C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co.
5. R. T. Morrison, R. N. Boyd, *Organic Chemistry*, 6th Edn., Prentice Hall of India.
6. I. L. Finar, *Organic Chemistry*, 6th Edn., Vol.- I, Pearson.

Module II: Stereochemistry (6 hrs)

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

References

1. R. T. Morrison, R. N. Boyd, *Organic Chemistry*, 6th Edn., Prentice Hall of India.
2. I. L. Finar, *Organic Chemistry* – Vol. 1, 6th Edn., Pearson Education.
3. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co.
4. K. S. Tewari, N. K. Vishnoi, *Organic Chemistry*, 3rd Edn., Vikas Publishing House.

Module III: Aromatic Hydrocarbons (5 hrs)

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

References

1. R. T. Morrison, R. N Boyd, *Organic Chemistry*, 6th Edn., Prentice Hall of India.
2. I. L. Finar, *Organic Chemistry* – Vol.1, 6th Edn., Pearson Education.
3. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co.
4. K. S. Tewari, N. K. Vishnoi, *Organic Chemistry*, 3rd Edn., Vikas Publishing House.

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

Halogen Compounds: Preparation of alkyl halides from alkanes and alkenes – Wurtz reaction and Fittig's reaction – Mechanism of S_N1 and S_N2 reactions of alkyl halides – Effect of substrate and stereochemistry.
Alcohols: Preparation from Grignard reagent – Preparation of ethanol from molasses – Wash, rectified spirit, absolute alcohol, denatured spirit, proof spirit and power alcohol (mention only) – Comparison of acidity of ethanol, isopropyl alcohol and *tert*-butyl alcohol – Haloform reaction and iodoform test – Luca's test – Chemistry of methanol poisoning – Harmful effects of ethanol in the human body.
Phenols: Preparation from chlorobenzene – Comparison of acidity of phenol, *p*-nitrophenol and *p*-methoxyphenol – Preparation and uses of phenolphthalein.

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

Aldehydes & Ketones: Preparation from alcohols – Nucleophilic addition reactions (HCN and 88isulphate) – Comparison of nucleophilic addition rate of aliphatic aldehydes and ketones.
Carboxylic Acids: Preparation from Grignard reagent – Decarboxylation – Kolbe electrolysis.
Amines: Preparation from nitro compounds – Hofmann's bromamide reaction – Hofmann's carbylamines reaction. Basicity: Comparison of basicity of ammonia, methyl amine and aniline
Diazonium Salts: Preparation and synthetic applications of benzene diazonium chloride – Preparation and uses of methyl orange.

References

1. R. T. Morrison, R. N Boyd, *Organic Chemistry*, 6th Edn., Prentice Hall of India.
2. I. L. Finar, *Organic Chemistry* – Vol.1, 6th Edn., Pearson Education.
3. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co.
4. K. S. Tewari, N. K. Vishnoi, *Organic Chemistry*, 3rd Edn., Vikas Publishing House.

Module VI: Biomolecules (8 hrs)

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

References

1. R. T. Morrison, R. N Boyd, *Organic Chemistry*, 6th Edn., Prentice Hall of India.
2. I. L. Finar, *Organic Chemistry* – Vol.1, 6th Edn., Pearson Education.
3. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co.
4. K. S. Tewari, N. K. Vishnoi, *Organic Chemistry*, 3rd Edn., Vikas Publishing House.

Moldule VII: Alkaloids and Terpenes (3 hrs)

Alkaloids: Classification – Source, structure and physiological functions of nicotine, coniine and piperine.
Terpenes: Classification with examples – Isoprene rule – Isolation of essential oils by steam distillation – Uses of lemongrass oil, eucalyptus oil and sandalwood oil – Source, structure and uses of citral and menthol – Natural rubber – Vulcanization and its advantages.
Note: Structural elucidation not expected in any case.

References

1. R. T. Morrison, R. N Boyd, *Organic Chemistry*, 6th Edn., Prentice Hall of India.
2. I. L. Finar, *Organic Chemistry* – Vol.1, 6th Edn., Pearson Education.
3. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co.
4. K. S. Tewari, N. K. Vishnoi, *Organic Chemistry*, 3rd Edn., Vikas Publishing House.

SEMESTER IV

Course Code: CHE4C04

Complementary Course IV: PHYSICAL AND APPLIED CHEMISTRY

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

CHE4C04	**PHYSICAL AND APPLIED CHEMISTRY**	L	T	P	C
		3	0	0	2
Objective (s)	To provide the students a thorough knowledge about colloidal chemistry, nanochemistry and the importance of chemistry in daily life. It also provides a basic idea behind separation and spectral techniques. It also imparts the idea of green processes with an importance for environment.				
Course outcome (s)					
CO1	To understand the basic concepts behind colloidal state and nanochemistry				
CO2	To realize the importance of green chemistry and pollution prevention				
CO3	To appreciate the importance of different separation methods and spectral techniques				
CO4	To realize the extent of chemistry in daily life				

Module I: Colloidal Chemistry (6 hrs)

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

References

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

Module II: New Vistas in Chemistry (6 hrs)

Nanochemistry: Introduction – classification of nanomaterials (0D, 1D, 2D) - size dependence of material properties (optical, electrical and catalytic) - surface to volume ratio and its significance, - application of nanomaterials in electronics, optics, catalysis and medicine (detailed discussion not expected).
Green Chemistry: Definition and need of green chemistry- principles (detailed discussion not expected) - atom economy- green solvents- green synthesis of Ibuprofen.

References

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

Module III: Chromatography (6 hrs)

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

References

1. R. A. Day Junior, A. L. Underwood, *Quantitative Analysis*, 5th Edn., Prentice Hall of India Pvt. Ltd. New Delhi, 1988.
2. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, *Vogel's Text Book of Quantitative Chemical Analysis*, 6th Edn., Pearson Education, 2003.
3. R. Gopalan, *Analytical Chemistry*, S. Chand and Co., New Delhi.

Module IV: Spectroscopy (10 hrs)

Origin of spectra - Interaction of electromagnetic radiation with matter. Different types of energy levels in molecules: Rotational, vibrational and electronic levels. Statement of Born-Oppenheimer approximation - Fundamental laws of spectroscopy and selection rules (derivations not required).
IR Spectroscopy: Introduction - Group frequency concept - Characteristic stretching frequencies of O-H, N-H, C-H, C=C, C=N and C=O functional groups - Fingerprint region in IR spectra.
UV-Visible Spectroscopy: Introduction - Beer-Lambert's law - Electronic transitions in molecules ($\sigma\rightarrow\sigma^*$, $n\rightarrow\sigma^*$, $\pi\rightarrow\pi^*$ and $n\rightarrow\pi^*$) - Chromophore and auxochrome - Red shift and blue shift.
NMR Spectroscopy: Introduction - Chemical shift and spin-spin coupling - Application in elucidating the structure of ethanol, dimethyl ether, propanal and acetone (detailed study not required).

References

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

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

Module V: Polymers (4 hrs)

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

References

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

Module VI: Environmental Pollution (6 hrs)

Definition – Types of pollution.

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

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

Soil pollution – Pollution due to plastics.

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

References

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

Module VII: Chemistry in Daily Life (10 hrs)

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

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

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

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

Cement: Manufacture, composition and setting.

Glass: Types of glasses and uses.

References

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

SEMESTER IV

Course Code: CHE4C05(P)

Complementary Course V: CHEMISTRY PRACTICAL

Total Hours: 128; Credits: 4; Hours/Week: 2 (I, II, III & IV Semesters); Total Marks 80 (Internal 16 & External 64)

CHE4C05(P)	**CHEMISTRY PRACTICAL**	L	T	P	C
		0	0	2	4
Objective (s)	Develop proficiency in quantitative and qualitative analysis and expertise in organic preparation and determination of physical constants.				
Course outcome (s)					
CO1	To understand the basic concepts behind inter group separation				
CO2	To enable the students to develop analytical and preparation skills				

General Instructions

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

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

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

Module II: Volumetric Analysis

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

Permanganometry:

(i) Estimation of oxalic acid.

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

Dichrometry:

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

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

Iodimetry and Iodometry:

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

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

Module III: Gravimetric Analysis

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

Module IV: Inorganic Qualitative Analysis

(a) Reactions of Cations: Study of the reactions of the following cations with a view of their identification and confirmation. Pb^{2+}, Bi^{3+}, Cu^{2+}, Cd^{2+}, Fe^{2+}, Fe^{3+}, Al^{3+}, Ni^{2+}, Co^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+} and NH^{4+}. (b) Systematic qualitative analysis of a solution containing any two cations from the above list.

Module V: Determination of Physical Constants

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

Module VI: Organic Preparations

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

References

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

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

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

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

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

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

COMPLEMENTARY COURSE THEORY: EVALUATION SCHEME

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

1. INTERNAL EVALUATION

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

Table 1: Components of Evaluation

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

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

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

Table 3: Pattern of Test Papers

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

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

2. EXTERNAL EVALUATION

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

Table 1: Pattern of Question Papers

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

COMPLEMENTARY COURSE PRACTICAL: EVALUATION SCHEME

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

1. INTERNAL EVALUATION

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

Table 1: Components of Evaluation

Sl. No.	*Components*	*Marks*
1	Record	10
2	Lab involvement (viva – 3 and punctuality – 3)	6
Total Marks		16

Table 2: Number of Experiments and Marks for Practical Records

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

2. EXTERNAL EVALUATION

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

Table 1: Pattern of Question Paper

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

Guidelines

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

2. *Marks for Result:* The reported values (RV) of the students are compared with theoretical value (TV) and skilled value (SV) and calculate error percentage. Up to 1.5% error: 20 marks; between 1.51 – 2%: 16 marks; between 2.1– 2.5%: 12 marks; between 2.51– 3%: 8 marks; greater than 3%: 4 marks.

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

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

Table 2: Evaluation of Records

Number of Experiments (Marks in brackets)	
Volumetric Analysis Max. Marks: 3	*Mixture Analysis Max. Marks: 3*
11-12 (3)	9-10 (3)
10 (2)	8 (2)
9 (1)	7 (1)

OPEN COURSE STRUCTURE

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

Semester	*Code No*	*Course Title*	*Hrs/ Week*	*Total Hrs*	*Marks*
V	CHE5D01	Open Course 1: Environmental Chemistry	3	48	75
	CHE5D02	Open Course 2: Chemistry in Daily Life			
	CHE5D03	Open Course 3: Food Science and Medicinal Chemistry			

SEMESTER V

Course Code: CHE5D01

Open Course 1: ENVIRONMENTAL CHEMISTRY

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

Course outcomes

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

CO 1: Recall the terms involved in pollution.

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

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

CO 4: Describe water quality parameters

CO 5: Know Soil, Noise, Thermal and Radioactive Pollutions and their effects.

CO 6: Study various pollution control measures.

CO 7: Understand the basics of green chemistry.

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

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

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

References

1. A. K. De., *Environmental Chemistry*, 6th Edn., New Age International.
2. A. K. Ahluwalia, *Environmental Chemistry*, The Energy and Resources Institute, 2017.

3. Balram Pani, *Textbook of Environmental Chemistry*, I. K. International Pvt Ltd, 2010.

Module II: Air Pollution (8 hrs)

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

References

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

Module III: Water Pollution (10 hrs)

Impurities in water – Cause of pollution – natural and anthropologenic – Marine water pollution – Underground water pollution.

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

Types of water pollutants: Biological agents, physical agents and chemical agents – Eutrophication-biomagnifications and bioaccumulations.

Water quality parameters: DO, BOD, COD, alkalianity, hardness, chloride, fluoride and nitrate. Toxic metals in water and their effects: Cadmium, lead and mercury – Minamata disaster (a brief study). International Standards for Drinking Water.

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

References

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

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

Soil pollution: Sources by industrial and urban wastes Pollution due to plastics, pesticides, biomedical waste and E-waste (source, effects and control measures) – Control of soil pollution.- Solid waste Management – Open dumping, Landfilling, Incineration, Re – use, reclamation, recycle, Composting.

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

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

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

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

References

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

Module V: Pollution Control Measures (12 hrs)

Air pollution control measures – Gravitational settling chamber, fabric filter, wet scrubber, catalytic converters, stacks and chimneys, cyclone collectors, Cottrell electrostatic precipitator, extraction ventilator, zoning and green belt.

References

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

Module VI: Green Chemistry (6 hrs)

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

References

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

Scheme of Examinations:

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

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

The students can answer all the questions in Sections A & B. But there shall be Ceiling in each section.

Mark Distribution

Module I	4 Marks
Module II	10 Marks
Module III	14 Marks
Module IV	10 Marks
Module V	14 Marks
Module VI	8 Marks

SEMESTER V

Course Code: CHE5D02

Open Course 2: CHEMISTRY IN DAILY LIFE

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

Course outcomes

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

CO 1: Understand the basics of polymer chemistry.

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

CO 3: Describe food additives and the food habits.

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

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

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

CO 7: Understand the basic concepts and processes in petroleum industry.

Module I: Polymers (8 hrs)

Classification of polymer: Origin, structure, synthesis, Molecular forces. Commercially important polymers: Application of polyethylene, polystyrene, polyhaloolefines, Nylon-6, Nylon-66, Melamine, Terylene, Bakelite, Natural and synthetic rubber, vulcanization,

Advantages of vulcanized rubber, Natural silk and artificial silk, inorganic polymer: (Examples Only).— Plastic identification codes – Applications of biodegradable polymers (PGA, PLA and PHBV) – Importance of plastic recycling.

References

1. B. K. Sharma, *Industrial Chemistry*, 11th Edn., Goel publishing House, Meerut, 2000.
2. K. S. Tewari, N.K. Vishnoi, S.N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edn., Vikas Publishing House (Pvt.) Ltd., New Delhi, 2004.
3. V. R. Gowarikar, *Polymer Chemistry*, New Age International Pvt. Ltd., New Delhi, 2010.
4. B. K. Sharma, *Polymer Chemistry*, Goel Publishing House, Meerut, 1989.
5. M. G. Arora, M. Singh, M. S. Yadav, *Polymer Chemistry*, 2nd Revised Edn., Anmol Publications Private Ltd., New Delhi, 1989.
6. Raju Francis , *Recycling of Polymers: Methods, Characterization and Applications*, John Wiley & Sons, 2016.
7. Catia Bastioli, *Handbook of Biodegradable Polymers*, Smithers Rapra Publishing, 2005.

Module II: Chemistry in Biological Systems (8 hrs)

Vitamins: Name, Source, Function and deficiency diseases. Enzymes- Classifications, characteristics, role, examples. Hormones- Sex hormones- Androgens, oestrogens, progesterone, Example, function. Cortical hormones- A few examples with function. Nucleic acid- RNA, DNA: Introduction- role in life process (No structure or chemical reactions needed).

References

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

Module III: Food Chemistry (8 hrs)

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

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

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

Importance of milk, coconut water and Neera.

References

1. Lillian Hoagland Meyer, *Food Chemistry*, 1st Edn., CBS Publishers & Distributors, New Delhi, 2004.

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

Module IV: Agriculture (4 hrs)

Fertilizers: Essential nutrients for plants – NPK value – Natural and synthetic fertilizers – Nitrogenous, phosphatic and potash fertilizers (examples) – Impact of excessive use of fertilizers on environment – Bio fertilizers.
Pesticides: Classification – Insecticides, herbicides, rodenticides and fungicides (definition and examples only) – Non-degradable pesticides – Pesticide pollution and its impact on environment – Endosulfan disaster in Kerala (brief study). Pheromones.

References

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

Module V: Cleansing Agents and Cosmetics (6 hrs)

Cleansing Agents: Soaps – Hard and soft soaps – Alkali content – TFM – Detergents (classification) – Cleaning action – Advantages and disadvantages of soaps and detergents – Shaving creams. Shampoos: Ingredients and functions – Different kinds of shampoos (Anti-dandruff, anti-lice, herbal and baby shampoos). Tooth paste: Composition and health effects.
Cosmetics: Hair dye: Chemicals used and its harmful effects. Face and skin powders: Types, ingredients and functions. Cleansing creams: Cold creams, vanishing creams and bleach creams. Perfumes, antiperspirants, sun screen preparations, nail polishes, lipsticks, rouges, eyebrow pencils and eye liners (ingredients and functions) – Harmful effects of cosmetics.

References

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

Module VI: Pharmaceuticals and Dyes (8 hrs)

Drug: Chemical name, generic name and trade names with examples. Terminology: Prodrug, pharmacy, pharmacology, pharmacophore, pharmacognosy, pharmacodynamics and

pharmacokinetics (elementary idea only). Antipyretics, analgesics, antacids, antihistamines, antibiotics, antiseptics, disinfectants, anaesthetics, tranquilizers, narcotics, antidepressants and psychedelic drugs (definition and examples).
Dyes: classification based on constitution, application, examples, uses.
Dyes: Requirements of a dye – Classification based on mode of application to the fabric – Applications of dyes (general study). Ancient and modern colours – Mention of indigo and alizarin.

References

1. B. K. Sharma, *Industrial Chemistry*, Krishna Prakashan Media, 1991.
2. Gurdeep R. Chatwal, *Synthetic Drugs*, Himalaya Publishing House, Bombay, 1995.
3. Jayashree Ghosh, *A Textbook of Pharmaceutical Chemistry*, 3rd Edn., S. Chand and Company Ltd., New Delhi, 1999.

Module VII: Fuels (6 hrs)

Definition and classification of fuels – Characteristics of a good fuel – Combustion – Calorific value – Wood.
Coal: Classification based on carbon content – Fractional distillation products of coal and uses of various fractions.
Petroleum: Origin – Fractional distillation – Different fractions, their composition and uses. Petrol: Knocking – Octane number – Aviation fuel. Diesel: Cetane number. Flash point. Natural gas, biogas and LPG: Composition and uses.
Pollution due to burning of fossil fuels.
Solar energy and solar cells (applications only).

References

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

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

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

The students can answer all the questions in Sections A & B. But there shall be Ceiling in each section.

Mark Distribution	
Module I	12 Marks
Module II	10 Marks
Module III	10 Marks
Module IV	5 Marks
Module V	7 Marks
Module VI	9 Marks
Module VII	7 Marks

SEMESTER V

Course Code: CHE5D03

Open Course 3: FOOD SCIENCE AND MEDICINAL CHEMISTRY

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

Course outcomes

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

CO 1: Understand the food adulteration and preservation methods.

CO 2: Understand the food additives.

CO 3: Compare the modern food with natural food.

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

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

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

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

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

CO 9: Illustrate the first aids and safety steps to be taken for the common illness.

Module I: Food Adulteration and Preservation (6 hrs)

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

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

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

References

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

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

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

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

Module II: Chemistry of Food (10 hrs)

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

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

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

References

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

Module III: Beverages (4 hrs)

Definition and examples - Classification of beverages - Fruit beverages - Milk based beverages - malted beverages - Alcoholic and non alcoholic beverages - examples. Appetizers - definition - classification – examples.

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

References

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

Module IV: Biochemistry (5 hrs)

Vitamins (name, source, function and deficiency diseases). Enzymes (classification,

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

References

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

Module V: Medicinal Chemistry – I (5 hrs)

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

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

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

References

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

Module VI: Medicinal Chemistry – II (12 hrs)

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

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

Avenues for the treatment of terminal cancer.

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

References

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

Module VII: Clinical chemistry (6 hrs)

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

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

References

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

Scheme of Examinations:

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

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

The students can answer all the questions in Sections A & B. But there shall be Ceiling in each section.

Mark Distribution	
Module I	7 Marks
Module II	12 Marks
Module III	4 Marks
Module IV	8 Marks
Module V	7 Marks
Module VI	15 Marks
Module VII	7

OPEN COURSE: EVALUATION SCHEME

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

1. INTERNAL EVALUATION

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

Table 1: Components of Evaluation

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

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

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

Table 3: Pattern of Test Papers

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

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

2. EXTERNAL EVALUATION

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

Table 1: Pattern of Question Paper

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