



UNIVERSITY OF CALICUT

**Abstract**

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

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**G & A - IV - J**

U.O.No. 8846/2019/Admn

Dated, Calicut University.P.O, 05.07.2019

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

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

3. Item No. I.33 of the minutes of the meeting of Faculty of Science held on 27.06.2019

**ORDER**

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

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

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

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

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

Orders are issued accordingly. (Syllabus appended).

Biju George K

Assistant Registrar

To

The Principals of all Affiliated Colleges

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Section Officer



# UNIVERSITY OF CALICUT

**B.Sc. DEGREE PROGRAMME**

**IN**

**INDUSTRIAL CHEMISTRY**

**(LRP Pattern)**

(CBCSSUG 2019)

**UNDER CHOICE BASED CREDIT AND SEMESTER SYSTEM**

**SCHEME AND SYLLABI**

**2019 ADMISSION ONWARDS**

*CORE COURSES*

*OPEN COURSES*

*MODEL QUESTION PAPERS*

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## UNDERGRADUATE PROGRAMME – AN OVERVIEW

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

**Course** means a segment of subject matter to be covered in a semester. The undergraduate programme includes 5 types of courses, viz., common courses, core courses, complementary courses, open course and audit courses. **Common course** means a course that comes under the category of courses, including compulsory English and additional language courses and a set of general courses applicable for **Language Reduced Pattern (LRP)** programmes, the selection of which is compulsory for all students undergoing UG programmes. **Core courses** comprise compulsory course in a subject related to a particular degree programme offered by the parent department. There are 18 core courses including a project work. **Complementary courses** cover two disciplines that are related to the core subject and are distributed in the first four semesters. There shall be one **open course** in the 5<sup>th</sup> semester. Students can opt one open course of their choice offered by any department in the institution other than their parent department. **Audit courses** are courses which are mandatory for a programme but not conducted for the calculation of SGPA or CGPA. There shall be one audit course each in the first 4 semesters. Audit courses are not meant for class room study. The students can attain only pass (Grade P) for these courses. At the end of each semester there shall be examination conducted by the college from a pool of questions (Question Bank).

Each course shall have certain credits. **Credit** is a unit of academic input measured in terms of weekly contact hours/course contents assigned to a course. A student is required to acquire a minimum of 140 credits for the completion of the UG programme, of which 120 credits are to be acquired from class room study and shall only be counted for SGPA and CGPA. Out of the 120 credits, 38 credits shall be from common courses, 55 credits for core courses (including 2 credits each for project work and Elective), 24 credits for complementary courses (12 credits each) and 3 credits for the open course. Audit courses shall have 4 credits per course and a total of 16 credits in the entire programme. In the case of LRP Programmes 14 credits are given for common courses (English), 8 credits for additional language courses and 16 credits for General courses.

**Extra credits** are mandatory for the programme. Extra credits will be awarded to students who participate in activities like NCC, NSS and Swachh Bharat. Those students who could not join in any of the above activities have to undergo Calicut University Social Service Programme

(CUSSP). Extra credits are not counted for SGPA or CGPA. The maximum credits acquired under extra credits shall be 4. If more Extra credit activities are done by a student that may be mentioned in the Grade card.

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

## **UNDERGRADUATE PROGRAMME IN INDUSTRIAL CHEMISTRY**

### **PREAMBLE**

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

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

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

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

The units of the syllabus are well defined. The number of contact hours required for each unit is given which excludes pre-requisites. The pre-requisites provided at the beginning of the units guides the students to what he/she should know before exploring the topic. This can be assessed by the teacher either before delivering the particular topic or as a bridge course at the beginning of each semester. **These shall not be considered for the external evaluation for the calculation of SGPA or CGPA.** A list of references and further readings are provided at the end of each unit.

## **AIMS**

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

## **BROAD OBJECTIVES**

To enable the students

- To understand basic facts and concepts in chemistry.
- To apply the principles of chemistry.
- To appreciate the achievements in chemistry and to know the role of chemistry in nature and in society.
- To familiarize with the emerging areas of chemistry and their applications in various spheres of chemical sciences and to apprise the students of its relevance in future studies.
- To develop skills in the proper handling of instruments and chemicals.

- To familiarize with the different processes used in industries and their applications.
- To develop an eco-friendly attitude by creating a sense of environmental awareness.
- To be conversant with the applications of chemistry in day-to-day life and in various industrial processes

## Course Structure

### Credit Distribution

Semester	Common course			Core course	Complementary course		Open course	Total
	English	Additional Language	General Course		Mathematics	Computer Science		
<b>I</b>	4+3	4		2	3	2		<b>18</b>
<b>II</b>	4+3	4		2	3	2		<b>18</b>
<b>III</b>			4 + 4	3	3	2		<b>16</b>
<b>IV</b>			4 + 4	3+4*	3	2+4*		<b>24</b>
<b>V</b>				3+3+3			3	<b>12</b>
<b>VI</b>				3+3+3+3+2 <sup>#</sup> +4* +4* +4* + 4* +2**				<b>32</b>
<b>Total</b>	<b>14</b>	<b>8</b>	<b>16</b>	<b>55</b>	<b>12</b>	<b>12</b>	<b>3</b>	<b>120</b>

\*Practicals    \*\*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<sup>+</sup>, A, B<sup>+</sup>, B, C, P, F, I or Ab) to that course by the method of indirect grading.



### Mark Distribution

<i>Sl. No.</i>	<i>Course</i>	<i>Marks</i>
1	English	350
2	Additional Language	200
3	General Courses	400
4	Core course: Chemistry and Industrial Chemistry	1475
5	Complementary course: Mathematics	300
6	Complementary course: Computer science	400
7	Open Course	75
	<b>Total Marks</b>	3200

### Ten point Indirect Grading System

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

## CREDITS AND MARKS DISTRIBUTION IN EACH SEMESTER

**Total Credits: 120**

<i>Semester</i>	<i>Course</i>	<i>Credits</i>	<i>Marks</i>
<b>I</b>	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: Computer Science	2	75
	<b>Total</b>	<b>18</b>	<b>500</b>
<b>II</b>	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: Computer Science	2	75
	<b>Total</b>	<b>18</b>	<b>500</b>
<b>III</b>	General course I	4	100
	General course II	4	100
	Core Course III: Physical Chemistry-I	3	75
	Complementary course: Mathematics	3	75
	Complementary course: Computer Science	2	75
	<b>Total</b>	<b>16</b>	<b>425</b>
<b>IV</b>	General course III	4	100
	General course IV	4	100
	Core Course IV: Organic Chemistry-I	3	75
	Core Course V: Inorganic Chemistry Practicals-I	4	100
	Complementary course: Mathematics	3	75
	Complementary course: Computer Science	2	75
	Complementary course: Computer Science Practicals	4	100
	<b>Total</b>	<b>24</b>	<b>625</b>
<b>V</b>	Core Course VI: Industrial Chemistry-I	3	75
	Core Course VII: Organic Chemistry-II	3	75
	Core Course VIII: Physical Chemistry-II	3	75
	Open course	3	75
	<b>Total</b>	<b>12</b>	<b>300</b>
<b>VI</b>	Core Course IX: Industrial Chemistry-II	3	75
	Core Course X: Inorganic 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: Industrial Chemistry Practicals - I	4	100
	Core Course XV: Organic Chemistry Practicals	4	100
	Core Course XVI: Industrial Chemistry Practicals-II	4	100
	Core Course XVII: Inorganic Chemistry Practicals-II	4	100
	Core Course XVIII: Project Work	2	75
	<b>Total</b>	<b>32</b>	<b>850</b>

**SYLLABUS**

**FOR**

**CORE COURSES**

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

Semester	Code No	Course Title	Hrs/	Total	Credits	Marks		
			Week	Hrs				
I	CHE1B01	Core Course I: Theoretical and Inorganic Chemistry-I	2	32	2	75		
	-	Core Course V : Inorganic Chemistry Practicals-I	2	32	-*	-		
II	CHE2B02	Core Course II: Theoretical and Inorganic Chemistry-II	2	32	2	75		
	-	Core Course V : Inorganic Chemistry Practicals-I	2	32	-*	-		
III	CHE3B03	Core Course III: Physical Chemistry-I	3	48	3	75		
	-	Core Course V : Inorganic Chemistry Practicals-I	2	32	-*	-		
IV	CHE4B04	Core Course IV: Organic Chemistry-I	3	48	3	75		
	CHE4B05(P)	Core Course V : Inorganic Chemistry Practicals-I	2	32	4	100		
V	ICH5B01	Core Course VI: Industrial Chemistry-I	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: Industrial Chemistry Practicals - I	5	80	-**	-		
	-	Core Course XV: Organic Chemistry Practicals	5	80	-**	-		
	-	Core Course XVIII: Project Work	2	32	-**	-		
VI	ICH6B02	Core Course IX: Industrial Chemistry-II	3	48	3	75		
	ICH6B03	Core Course X: Inorganic Chemistry-III	3	48	3	75		
	CHE6B11	Core Course XI: Physical Chemistry-III	3	48	3	75		
	ICH6B04	Core Course XII: Advanced and Applied Chemistry	3	48	3	75		
	ICH6B05 (E1)	Core Course XIII: Elective ***	1. Medicinal Chemistry and Drug development		3	48	2	75
	ICH6B05 (E2)		2. Introduction to Cheminformatics					
	ICH6B05 (E3)		3. Analytical Methods in Chemistry					
	ICH6B06(P)	Core Course XIV: Industrial Chemistry Practicals - I	-	-	4**	100		
	ICH6B07(P)	Core Course XV: Organic Chemistry Practicals	-	-	4**	100		
	ICH6B08(P)	Core Course XVI Industrial Chemistry Practicals - II #	5	80	4	100		
	ICH6B09(P)	Core Course XVII: Inorganic Chemistry Practicals-II	5	80	4	100		
ICH6B10 (Pr)	Core Course XVIII: Project Work	-	-	2**	75			
<b>Total</b>					<b>55</b>	<b>1475</b>		

\* Exam will be held at the end of 4<sup>th</sup> semester

\*\* Exam will be held at the end of 6<sup>th</sup> semester

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

# Includes industrial visit also. Marks: 85 (Inorganic Chemistry Practicals–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 <i>s</i> and <i>p</i> block elements. To provide the basic groundwork for a research project. Students will be able to analyse basic theory of acid base concept.				
Course outcome (s)					
CO1	To apply the methods of a research project.				
CO2	To understand the principles behind volumetry.				
CO3	To analyse the characteristics of different elements.				
CO4	To distinguish between different acid base concepts.				
CO5	To analyse the stability of different nuclei.				

\*Lecture, \*\*Tutorial, \*\*\*Practicals, #Credit

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

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

What is science? Scientific statements - scientific methods - observation - posing a question - formulation of hypothesis - experiment - theory - law - revision of scientific theories and laws. Scientific research: selecting a topic for research, design of an experiment, sampling, use of controls, experimental bias, analysis, results and discussion of results, statistical analysis of experimental data, preparation of seminar papers, major publishers in chemical science, author citation, reviews and keywords.

Publishing a research work: Introduction, review of literature, scope, materials and methods, results and discussion, conclusions and bibliography.

#### References

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

2. C. N. R. Rao, *Understanding Chemistry*, Universities Press India Ltd., Hyderabad, 1999.
3. George Gamow, *One, Two, Three...Infinity: Facts and Speculations of Science*, Dover Publications, 1988.
4. *Resonance – Journal of Science Education*, Indian Academy of Sciences.
5. *Nature Chemistry*, Nature Publishing Group.
6. *Chemistry: A Volatile History*, BBC documentary.
7. <http://www.vlab.co.in>
8. <http://nptel.iitm.ac.in/>

### Further reading

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

### Module II: Analytical Principles – I (10 hrs)

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

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

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

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

*Volumetric Analysis:* Introduction - Primary and secondary standards – Standard solutions - Theory of titrations involving acids and bases,  $\text{KMnO}_4$ ,  $\text{K}_2\text{Cr}_2\text{O}_7$ ,  $\text{I}_2$  and liberated  $\text{I}_2$  - Complexometric titrations. Indicators: Theory of acid-base, redox, adsorption and complexometric indicators. Double burette method of titration: Principle and advantages.

## References

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

## Further reading

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

## Module III: Periodic Properties (3 hrs)

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

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

## Module IV: Representative Elements (6 hrs)

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

Standard electrode potential, flame colour of *s* block elements, diagonal relationships - Inert pair effect.

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

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

Comparison of Lewis acidity of boron halides - Preparation, properties, structure and uses of Diborane, Boric acid, Borazine and Boron nitride - Structure of  $\text{AlCl}_3$ .

Structures of oxides of N and P, oxy acids of N and P, structure of  $\text{SO}_2$  and  $\text{SO}_3$ . Structure and acidic strength of oxy and peroxy acids of sulphur, oxy acids of chlorine. Preparation, properties and uses of ammonia, nitric acid, ozone, hydrogen peroxide, sulphuric acid and hydrochloric acid.

### References

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

### Further reading

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

### Module V: Acid Base Concepts (3 hrs)

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

Lux-Flood, Solvent System and Usanovich concepts, Metal and nonmetal hydroxy compounds, acid anhydrides, amphoteric oxides and hydroxides, Hard and soft acids and bases: Classification of acids and bases as Hard and Soft. Applications of HSAB concept, limitations of HSAB concept.

### References



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

### Further reading

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

### Module VI: Nuclear Chemistry (5 hrs)

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

Nuclear forces – Exchange theory and nuclear fluid theory – Nuclear reactors. Decay series – group displacement law - Isotopes: Detection – Aston's mass spectrograph – Separation of isotopes by gaseous diffusion method and thermal diffusion method – Application of radioactive isotopes – <sup>14</sup>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*, 4<sup>th</sup> Edn., New Age International (P) Ltd., New Delhi, 1995.

### Further reading

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

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

## SEMESTER II

Course Code: CHE2B02

### Core Course II: Theoretical and Inorganic Chemistry- II

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

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

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

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

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

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

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

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

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

Application of Schrödinger wave equation to hydrogen atom. The wave equation in spherical polar coordinates. Separation of variables. Wave functions or atomic orbitals, radial and angular parts of atomic orbitals. Quantum numbers ( $n, l, m$ ). Radial functions, Radial distribution functions and their plots, Angular functions and their plots (1s, 2s and 2p<sub>z</sub> 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<sub>2</sub> molecule (derivation not required). Molecular orbital theory of H<sub>2</sub><sup>+</sup> ion H<sub>2</sub> molecule - linear combination of atomic orbitals (LCAO) and coefficients in the linear combination (derivation not required). Potential energy diagram of H<sub>2</sub> molecule formation – equilibrium geometry. Bonding and antibonding molecular orbitals, bond order. MO diagrams of homonuclear and heteronuclear diatomic molecules – He<sub>2</sub>, Li<sub>2</sub>, Be<sub>2</sub>, B<sub>2</sub>, C<sub>2</sub>, N<sub>2</sub>, O<sub>2</sub>, F<sub>2</sub>, CO and NO. Comparison of VB and MO theories.

## **Module IV: Bonding in polyatomic molecules (6 hrs)**

[Prerequisites: VSEPR theory: Postulates – applications.]

Concept of Hybridization: Need of hybridization, Definition (mixing of wave functions of the same atom), LCAO of the central atom – coefficients of atomic orbitals in the linear combination of sp (BeH<sub>2</sub>), sp<sup>2</sup> (BH<sub>3</sub>) and sp<sup>3</sup> (CH<sub>4</sub>) hybridization (derivation not required). Other examples of hybridization – Geometry of molecules like PCl<sub>5</sub>, SF<sub>6</sub> and IF<sub>7</sub>.

## **References**

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

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

3. R. K. Prasad, *Quantum Chemistry*, 3<sup>rd</sup> Edn., New Age International, 2006.

**Further reading**

1. N. Levine, *Quantum Chemistry*, 6<sup>th</sup> Edn., Pearson Education Inc., 2009.

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

<b>Mark Distribution</b>	
Module I	15 Marks
Module II	25 Marks
Module III	24 Marks
Module IV	15 Marks

## SEMESTER III

Course Code: CHE3B03

### Core Course III: PHYSICAL CHEMISTRY - I

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

CHE3B03	PHYSICAL CHEMISTRY - I	L	T	P	C
		3	0	0	3
Objective (s)	To introduce the concepts of chemical thermodynamics, equilibria and group theory.				
Course outcome (s)					
CO1	To understand the properties of gaseous state and how it links to thermodynamic systems.				
CO2	To understand the concepts of thermodynamics and its 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*, 46<sup>th</sup> Edn., Vishal Publishing Company, New Delhi, 2013.
2. P. W. Atkins, J. de Paula, *Atkin's Physical Chemistry*, 8<sup>th</sup> Edn., Oxford University Press, 2006.
3. D. A. McQuarrie, J. D. Simon, *Physical Chemistry: A Molecular Approach*, University Science Books: Sausalito, CA, 1997.
4. K. L. Kapoor, *Physical Chemistry*, Vol. II and III, Macmillan Publishers, Noida, 2004.

#### Further reading

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

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

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

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

### **Module II: Chemical Thermodynamics – I (16 hrs)**

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

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

Thermochemistry: Heat changes during physicochemical processes. Kirchoff's relations. Bond dissociation energies. Resonance energy from thermochemical data. Changes of thermodynamic properties with respect to different chemical changes.

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

### **Module III: Chemical Thermodynamics – II (8 hrs)**

[Prerequisites: Module II: Chemical Thermodynamics - I, idea of permutation and combination] Gibbs-Helmholtz equation - Partial molar free energy - Concept of chemical potential - Gibbs-Duhem equation. Maxwell relations.

Fundamental concepts of Statistical Thermodynamics - Probability - Partition function - ensembles - Boltzmann distribution derivation - Relation between entropy and probability -

Stirling's approximation - Residual entropy and absolute entropy. Third law of thermodynamics  
- Nernst heat theorem - Statement of third law.

### References

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

### Further reading

1. G. M. Barrow, *Physical Chemistry*, 5<sup>th</sup> Edn., Tata McGraw Hill Education, New Delhi, 2006.
2. S. Glasstone, D. H. Lewis, *Elements of Physical Chemistry*, 2<sup>nd</sup> Edn., Macmillan & Company, UK, 1962.
3. F. Daniels, R. A. Alberty, *Physical Chemistry*, 5<sup>th</sup> Edn., John Wiley and Sons, Canada, 1980.
4. P.W. Atkins, J. de Paul, *The Elements of Physical Chemistry*, 7<sup>th</sup> 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  $K_p$ ,  $K_c$  and  $K_x$  (using chemical potential). Van't Hoff's equation - Le Chatelier principle (quantitative treatment). Homogeneous and heterogenous equilibria.

### References

1. B. R. Puri, L. R. Sharma, M. S. Pathania, *Principles of Physical Chemistry*, 46<sup>th</sup> Edn., Vishal Publishing Company, New Delhi, 2013.
2. P. W. Atkins, J. de Paula, *Atkin's Physical Chemistry*, 8<sup>th</sup> Edn., Oxford University Press, 2006.
3. D. A. McQuarrie, J. D. Simon, *Physical Chemistry: A Molecular Approach*, University Science Books: Sausalito, CA; 1997.

#### **Further reading**

1. G. M. Barrow, *Physical Chemistry*, 5<sup>th</sup> Edn., Tata McGraw Hill Education, New Delhi, 2006.
2. K. L. Kapoor, *Physical Chemistry*, Vol. II and III, Macmillan Publishers, Noida, 2004.
3. S. Glasstone, D. H. Lewis, *Elements of Physical Chemistry*, 2<sup>nd</sup> Edn., Macmillan & Company, UK, 1962.
4. F. Daniels, R. A. Alberty, *Physical Chemistry*, 5<sup>th</sup> Edn., John Wiley and Sons, Canada, 1980.
5. P. W. Atkins, J. de Paula, *The Elements of Physical Chemistry*, 7<sup>th</sup> Edn., Oxford University Press, Oxford, 2016.
6. J. Rajaram, J. C. Kuriacose, *Chemical Thermodynamics*, Pearson Education, New Delhi, 2013.

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

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

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

#### **References**

1. B. R. Puri, L. R. Sharma, M. S. Pathania, *Principles of Physical Chemistry*, 46<sup>th</sup> Edn., Vishal Publishing Company, New Delhi, 2013.
2. P. W. Atkins, J. de Paula, *Atkin's Physical Chemistry*, 8<sup>th</sup> Edn., Oxford University Press 2006.
3. D. A. McQuarrie, J. D. Simon, *Physical Chemistry: A Molecular Approach*, University Science Books: Sausalito, CA; 1997.



4. K. L. Kapoor, *Physical Chemistry*, Vol. II and III, Macmillan Publishers, Noida, 2004.
5. B. S. Garg, *Chemical Applications of Molecular Symmetry and Group Theory*, Macmillan Publishers India Ltd., 2012.

### Further reading

1. G. M. Barrow, *Physical Chemistry*, 5<sup>th</sup> Edn., Tata McGraw Hill Education, New Delhi, 2006.
2. S. Glasstone, D. H. Lewis, *Elements of Physical Chemistry*, 2<sup>nd</sup> Edn., Macmillan & Company, UK, 1962.
3. F. Daniels, R. A. Alberty, *Physical Chemistry*, 5<sup>th</sup> Edn., John Wiley and Sons, Canada, 1980.
4. P. W. Atkins, J. de Paula, *The Elements of Physical Chemistry*, 7<sup>th</sup> 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*, 3<sup>rd</sup> Edn., John Wiley & Sons, New York, 1990.

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

## SEMESTER IV

Course Code: CHE4B04

### Core Course IV: ORGANIC CHEMISTRY– I

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

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

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

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

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

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

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

## References

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

## Further Reading

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

## Module II: Stereochemistry (13 hrs)

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

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

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

Configurational isomerism: Optical isomerism and Geometrical isomerism.

*Optical Isomerism*: Optical activity – Concept of chirality – Chirality in organic molecules: Enantiomers, Diastereomers and Meso compounds. Optical isomerism in glyceraldehyde, lactic acid and tartaric acid. Relative and absolute configuration - DL system, RS system of

nomenclature for acyclic optical isomers with one and two asymmetric carbon atoms – sequence rules. Erythro and threo representations (basic idea only). Racemic mixture – Resolution methods – Enantiomeric excess. Asymmetric synthesis (partial and absolute).

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

#### References:

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

#### Further Reading

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

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

[Prerequisites: Nomenclature of hydrocarbons and alkyl halides.]

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

Alkenes: Preparation: dehalogenation of dihalides (stereochemistry expected) and dehydration of alcohols. Dehydrohalogenation of alkyl halides (Saytzeff's rule). Chemical reactions: Addition of halogens (electrophilic addition with mechanism), addition of hydrogen halides (Markownikov and Anti-Markownikov addition with mechanism) and addition of water (mechanism expected) – conversion to alcohol (oxymmercuration-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  $\text{KMnO}_4$ ). 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 –  $\text{S}_{\text{N}}1$  and  $\text{S}_{\text{N}}2$  mechanisms with stereochemical aspects and effects of substrate structure, solvent, nucleophile and leaving group. Elimination reactions:  $\text{E}1$  &  $\text{E}2$  mechanisms.

### References

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

### Further Reading

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

### Module IV: Aromaticity (3 hrs)

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

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

**References:**

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

**Further Reading**

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

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

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

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

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

**References:**

1. R. T. Morrison, R. N. Boyd, *Organic Chemistry*, 7<sup>th</sup> Edn., Pearson Education, New Delhi, 2013.
2. I. L. Finar, *Organic Chemistry*, Vol. I, 5<sup>th</sup> Edn., Pearson Education, New Delhi, 2013.
3. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3<sup>rd</sup> Edn., Vishal Publishing Company Co., 2010.

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

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

### Further Reading

1. P. S. Kalsi, *Organic Reactions and their Mechanisms*, New Age International Publishers, 2009.

2. S. H. Pine, *Organic Chemistry*, 5<sup>th</sup> Edn., McGraw Hill, 1987.

3. Jerry March, *Advanced Organic Chemistry*, 5<sup>th</sup> Edn., John Wiley & Sons, New York, 2004.

4. P. Y. Bruice, *Essential Organic Chemistry*, 3<sup>rd</sup> Edn., Pearson Education, 2015.

5. J. Clayden, N. Greeves, S. Warren, P. Wothers, *Organic Chemistry*, 2<sup>nd</sup> Edn., Oxford University Press, New York, 2012.

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

## SEMESTER IV

Course Code: CHE4B05 (P)

### Core Course V: INORGANIC CHEMISTRY PRACTICALS – 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 PRACTICALS –I	L	T	P	C
		0	0	2	4
Objective (s)	To enable the students to gain skills in preparation of standard solutions and quantitative volumetric analysis.				
Course outcome (s)					
CO1	To enable the students to develop skills in quantitative analysis and preparing inorganic complexes.				
CO2	To understand the principles behind quantitative analysis.				
CO3	To apply appropriate techniques of volumetric quantitative analysis in estimations.				
CO4	To analyse the strength of different solutions.				

#### General Instructions

1. Use safety coat, goggles, shoes and gloves in the laboratory.
2. For weighing electronic balance may be used.
3. Double burette titration method may be used for acid base titrations in Module III. Single burette method can be followed for other titrations (Module IV- VII).
4. Experiments may be selected in such a way that preference may be given for Modules from IV to VII.
5. A minimum number of, 1 experiment from module III, 14 experiments covering Modules IV to VII and 4 inorganic preparations must be done to appear for the examination.
6. Practical examination will be conducted at the end of semester IV.

#### Module I: Introduction to Volumetric Analysis

1. Weighing using electronic balance.
2. Preparation of standard solutions.

#### Module II: Technique of Quantitative Dilution

1. Preparation of 100 mL 0.2 M H<sub>2</sub>SO<sub>4</sub> 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<sub>3</sub> by indirect method.
5. Titration of HCl + CH<sub>3</sub>COOH 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  $\text{Fe}^{2+}/\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ /Mohr's salt.
3. Estimation of hydrogen peroxide.
4. Estimation of calcium.

##### ***b) Dichrometry***

1. Estimation of  $\text{Fe}^{2+}/\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ /Mohr's salt using internal indicator.
2. Estimation of  $\text{Fe}^{2+}/\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ /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*, 6<sup>th</sup> Edn., Pearson Education, Noida, 2013.
2. D. A. Skoog, D. M. West, F.J. Holler, S. R. Crouch, *Fundamentals of Analytical Chemistry*, 8<sup>th</sup> Edn., Brooks/Cole, Thomson Learning, USA, 2004.
3. G. D. Christian, *Analytical Chemistry*, 7<sup>th</sup> Edn., John Wiley and Sons, New York, 2013.
4. A. L. Underwood, *Quantitative Analysis*, 6<sup>th</sup> 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: ICH5B01

### Core Course VI: INDUSTRIAL CHEMISTRY - I

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

ICH5B01	INDUSTRIAL CHEMISTRY - I	L	T	P	C
		3	0	0	3
Objective (s)	To create awareness among the students about the role of chemistry in industries				
Course outcome (s)					
CO1	To understand the importance of inorganic materials in industry				
CO2	To understand the process of manufacture of glass, cement and fertilizers				
CO3	To understand the pollution caused from fertilizers and pesticides				
CO4	To understand the basic idea on the industrial importance of catalysis and fuels.				

#### Module I: Inorganic materials of industrial importance (10 hrs)

Classification, characteristics and applications of silicates, alumina, clay, zeolites borides and carbides . Molecular sieves, NASICON. Fullerides (Basic concept only).

#### References

1. B.K Sharma, *Industrial Chemistry*, Krishna Prakashan Media. 2005
2. Mark Anthony Benvenuto, *Industrial Inorganic Chemistry*, Walter de Gruyter GmbH & Co KG, 2015

#### Module II: Glass (9 hrs)

Glass-physical and Chemical properties, characteristics of glass,manufacture of glass-raw materials chemical reactions reactions in the furnace, Annealing, types of glass Ceramics – General properties, structure and bonding

#### Reference

1. O. P. Vermani, *Industrial Chemistry*, Galgotia Publications
2. B.K Sharma, *Industrial Chemistry*, Krishna Prakashan Media. 2005

#### Module III: Cement (6 hrs)

Cement-portland cement,raw materials, manufacture, concrete. gypsum and plaster of paris

#### Reference

1. H. F. W. Taylor, *Cement Chemistry*, Thomas Telford, 1997
2. B.K Sharma, *Industrial Chemistry*, Krishna Prakashan Media. 2005

#### Module IV: Catalysts (7 hrs)

Catalysis—General characteristics of catalytic reactions, Homogeneous and heterogeneous catalysis, promoters, inhibitors, catalyst poison, Applications of some important catalysts: Wilkinsons catalyst, Zeigler-Natta catalyst

## Reference

1. O. P. Vermani, *Industrial Chemistry*, Galgotia Publications
2. Bruce C. Gates, *Catalytic Chemistry*, Wiley, 1992

## Module V: Fertilizers and pesticides (9 hrs)

Essential requirements of fertilizers, Natural and artificial fertilizers, Manufacture and applications of Nitrogenous, Phosphatic and Potash fertilizers, pollution caused by fertilizers- eutrophication. Pesticides-herbicides, fungicide, insecticides, rodenticide (Basic concepts), Pesticide pollution

## Reference

1. B.K Sharma, *Industrial Chemistry*, Krishna Prakashan Media. 2005
2. Mark Anthony Benvenuto, *Industrial Inorganic Chemistry*, Walter de Gruyter GmbH & Co KG, 2015

## Module VI: Fuels (7 hrs)

Fuels-classification, calorific value, criterion for selection of fuel, Fossil fuels-coal –different grades of coal, synthetic fuels from coal, Bergius process Fischer Tropsch process, Natural gas, Petroleum-Distillation products of petroleum

## Reference

1. Chunsham Song, *Chemistry of Diesel Fuels*, CRC Press, 2000
2. B.K Sharma, *Industrial Chemistry*, Krishna Prakashan Media. 2005

## Further Reading

1. Richard P. Pohanish, *Handbook of Pesticides and Agricultural Chemicals*, William Andrew Publishing, 2015.
2. S S Dara, *Text Book of Environmental chemistry and Pollution*.
3. S.L. Kakani, *Material Science*, New Age International, 2006
4. Stefania Albonetti, Siglinda Perathoner, Elsjé Alessandra Quadrelli, *Horizons in Sustainable Industrial Chemistry and Catalysis*, Elsevier, 2019

Mark Distribution	
Module I	14 Marks
Module II	8 Marks
Module III	10 Marks
Module IV	17 Marks
Module V	16 Marks
Module VI	14 Marks

## SEMESTER V

Course Code: CHE5B07

### Core Course VII: ORGANIC CHEMISTRY – II

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

CHE5B07	ORGANIC CHEMISTRY – II	L	T	P	C
		4	0	0	3
Objective (s)	To give the students a thorough knowledge about the chemistry of selected functional groups and their applications in organic preparations.				
Course outcome (s)					
CO1	To understand the difference between alcohols and phenols.				
CO2	To understand the importance of ethers and epoxides.				
CO3	To apply organometallic compounds in the preparation of different functional groups.				
CO4	To apply different reagents for the interconversion 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  $\text{KMnO}_4$ ) – 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). Riemeier-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*, 7<sup>th</sup> Edn., Pearson Education, New Delhi, 2013.
2. I. L. Finar, *Organic Chemistry*, Vol. I, 5<sup>th</sup> Edn., Pearson Education, New Delhi, 2013.
3. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3<sup>rd</sup> Edn., Vishal Publishing Company Co., 2010.

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

#### **Further reading**

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

#### **Module II: Ethers and Epoxides (5 hrs)**

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

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

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

#### **References**

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

#### **Further reading**

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

#### **Module III: Organometallic Compounds (2 hrs)**

Preparation and synthetic applications of Grignard reagent and organozinc compounds.

#### **References**

1. R. T. Morrison, R. N. Boyd, *Organic Chemistry*, 7<sup>th</sup> Edn., Pearson Education, New Delhi, 2013.
2. I. L. Finar, *Organic Chemistry*, Vol. I, 5<sup>th</sup> Edn., Pearson Education, New Delhi, 2013.
3. M. K. Jain, S. C. Sharma, Modern, *Organic Chemistry*, 3<sup>rd</sup> Edn., Vishal Publishing Company Co., 2010.

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

5. B. S. Bahl, *Advanced organic Chemistry*, 3<sup>rd</sup> Edn., S. Chand, 2002.

#### **Further reading**

1. P. Y. Bruice, *Essential Organic Chemistry*, 3<sup>rd</sup> Edn., Pearson Education, 2015.

2. John McMurry, *Organic Chemistry*, 5<sup>th</sup> Edn., Thompson Asia Pvt Ltd., 2000.

#### **Module IV: Aldehydes and Ketones (11 hrs)**

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

Nucleophilic addition reactions – Carbon nucleophiles (addition of HCN, Wittig reaction), Oxygen nucleophiles (H<sub>2</sub>O, alcohols,), Nitrogen nucleophiles (NH<sub>3</sub>, hydroxyl amine, hydrazine, semicarbazide and DNP reagent) and Sulfur nucleophiles (sodium bisulfate). Oxidation – acidified K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>, KMnO<sub>4</sub>, CrO<sub>3</sub>; Oppenauer oxidation. Distinguishing aldehydes and ketones (Tollen's reagent, Fehling's solution); Reduction – Catalytic hydrogenation, Wolf-Kishner, Clemmensen, metal hydride (LiAlH<sub>4</sub> and NaBH<sub>4</sub>) and MPV reduction. Reactions involving  $\alpha$  carbons of carbonyl compounds – Aldol condensation, Cannizzaro reaction Benzoin condensation and Perkin's reactions. Haloform reaction (mechanism expected). Synthetic utility of Wittig reaction, Reformatsky reaction and Beckmann rearrangement.

#### **References**

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

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

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

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

5. B. S. Bahl, *Advanced organic Chemistry*, 3<sup>rd</sup> Edn., S. Chand, 2002.

#### **Further reading**

1. P. Y. Bruice, *Essential Organic Chemistry*, 3<sup>rd</sup> Edn., Pearson Education, 2015.

2. John McMurry, *Organic Chemistry*, 5<sup>th</sup> Edn., Thompson Asia Pvt Ltd, 2000.

3. C. N. Pillai, *Organic Chemistry*, Universities Press, 2008.

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

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

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

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

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

### References

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

### Further reading

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

### Module VI: Nitrogen Compounds (14 hrs)

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

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

Amines: Nomenclature – Isomerism. Preparation: From alkyl halides, nitro compounds, nitriles, isonitriles and amides – Hofmann's bromamide reaction, Schmidt reaction and Gabriel phthalimide synthesis. Chemical properties: Basicity (effect of substituents on the basicity of aliphatic and aromatic amines), carbylamine reaction, conversion of amine to alkene (Hofmann's elimination with mechanism and stereochemistry), acylation and reaction with



nitrous acid. Electrophilic substitution reactions of aniline: Halogenation, nitration and sulphonation. Preparation and uses sulphadiazine – 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  $p^H$ .

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

### References

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

### Further Reading

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

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

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

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

### References

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

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

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

**Further reading**

1. John McMurry, *Organic Chemistry*, 5<sup>th</sup> Edn., Thompson Asia Pvt Ltd, 2000.

2. C. N. Pillai, *Organic Chemistry*, Universities Press, 2008.

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

## SEMESTER V

Course Code: CHE5B08

### Core Course VIII: PHYSICAL CHEMISTRY – II

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

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

#### Module I: Kinetics (10 hrs)

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

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

#### Module II: Adsorption and Catalysis (6 hrs)

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

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

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

## References

1. B. R. Puri, L. R. Sharma, M. S. Pathania, *Principles of Physical Chemistry*, 46<sup>th</sup> Edn., Vishal Publishing Company, New Delhi, 2013.
2. P. W. Atkins, J. de Paula, *Atkin's Physical Chemistry*, 8<sup>th</sup> 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*, 3<sup>rd</sup> Edn., Pearson Education, New Delhi, 2004.
5. P. L. Soni, O. P. Dharmarha, U. N. Dash, *Textbook of Physical Chemistry*, 23<sup>rd</sup> Edn., Sultan Chand & Sons, New Delhi, 2011.
6. K. L. Kapoor, *Physical Chemistry*, Vol. II and III, Macmillan Publishers, Noida, 2004.

## Further reading

1. Gordon M. Barrow, *Physical Chemistry*, 5<sup>th</sup> Edn., Tata McGraw Hill Education, New Delhi, 2006.
2. S. Glasstone, D. H. Lewis, *Elements of Physical Chemistry*, 2<sup>nd</sup> Edn., Macmillan & Company, UK, 1962.
3. F. Daniels, R. A. Alberty, *Physical Chemistry*, 5<sup>th</sup> Edn., John Wiley and Sons, Canada, 1980.
4. P. W. Atkins, J. de Paula, *The Elements of Physical Chemistry*, 7<sup>th</sup> 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*, 46<sup>th</sup> Edn., Vishal Publishing Company, New Delhi, 2013.
2. P. W. Atkins, J. de Paula, *Atkin's Physical Chemistry*, 8<sup>th</sup> 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*, 23<sup>rd</sup> Edn., Sultan Chand & Sons, New Delhi, 2011.

#### **Further reading**

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

*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 Lambert's law - Dissociation energy of diatomic molecules – Chromophore and auxochrome – Bathochromic and hypsochromic shifts.

#### **Module V: Molecular Spectroscopy II (4 hrs)**

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

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

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

#### **References**

1. B. R. Puri, L. R. Sharma, M. S. Pathania, *Principles of Physical Chemistry*, 46<sup>th</sup> Edn., Vishal Publishing Company, New Delhi, 2013.
2. P. W. Atkins, J. de Paula, *Atkin's Physical Chemistry*, 8<sup>th</sup> Edn., Oxford University Press 2006.
3. Donald A. McQuarrie, John D. Simon, *Physical Chemistry: A Molecular Approach*, University Science Books: Sausalito, CA; 1997.
4. C. N. Banwell, *Fundamentals of molecular spectroscopy*, McGraw-Hill, 1994.
5. G. M. Barrow, *Introduction to Molecular Spectroscopy*, McGraw Hill, London, 1962.

#### **Further reading**

1. G. M. Barrow, *Physical Chemistry*, 5<sup>th</sup> Edn., Tata McGraw Hill Education, New Delhi, 2006.
2. K. L. Kapoor, *Physical Chemistry*, Vol. II and III, Macmillan Publishers, Noida, 2004.
3. S. Glasstone, D. H. Lewis, *Elements of Physical Chemistry*, 2<sup>nd</sup> Edn., Macmillan & Company, UK, 1962.
4. F. Daniels, R. A. Alberty, *Physical Chemistry*, 5<sup>th</sup> Edn., John Wiley and Sons, Canada, 1980.
5. Peter Atkins, J. de Paula, *The Elements of Physical Chemistry*, 7<sup>th</sup> 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*, 3<sup>rd</sup> 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*, 46<sup>th</sup> Edn., Vishal Publishing Company, New Delhi, 2013.
2. P. W. Atkins, J. de Paula, *Atkin’s Physical Chemistry*, 8<sup>th</sup> 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*, 5<sup>th</sup> Edn., Tata McGraw Hill Education, New Delhi, 2006.
2. K. L. Kapoor, *Physical Chemistry*, Vol. II and III, Macmillan Publishers, Noida, 2004.
3. S. Glasstone, D. H. Lewis, *Elements of Physical Chemistry*, 2<sup>nd</sup> Edn., Macmillan & Company, UK, 1962.
4. F. Daniels, R. A. Alberty, *Physical Chemistry*, 5<sup>th</sup> Edn., John Wiley and Sons, Canada, 1980.
5. Peter Atkins, Julio de Paula, *The Elements of Physical Chemistry*, 7<sup>th</sup> Edn., Oxford University Press, Oxford, 2016.
6. K. Laidler, *Chemical Kinetics*, 3<sup>rd</sup> Edn., Pearson Education, New Delhi, 2004.

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

## SEMESTER VI

Course Code: ICH6B02

### Core Course IX: INDUSTRIAL CHEMISTRY - II

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

ICH6B02	INDUSTRIAL CHEMISTRY - II	L	T	P	C
		3	0	0	3
Objective (s)	To introduce some chemicals used in every day life and their industrial practices				
Course outcome (s)					
CO1	To familiarize the materials and processes used in the day to day life				
CO2	To recognise the drugs commonly used in industry and their mode of action				
CO3	To understand food preservation methods and food additives				
CO4	To understand environmental issues facing our society in, health and medicine.				

#### Module I: Synthetic Polymers (8 hrs)

Introduction, Classification of polymers with suitable examples, Degree of polymerisation, Glass transition temperature and concept of average molecular weight. Thermoplastics and Thermosetting Plastics, Types of Polymerisation- Chain growth and step growth polymerisation, Structure, properties and applications of some commercial polymers : PVC, Polyethylene, Polypropylene, Teflon, Nylon, Bakelite, Natural rubber, SBR, Silicone rubber

#### References

1. Gauri Shankar Misra, *Introductory Polymer Chemistry*, New Age International.
2. Vasant R. Gowariker, N. V. Viswanathan, Jayadev Sreedhar, *Polymer Science*, New Age International.

#### Module II: Dyes (8 hrs)

Classification of dyes based on application, Methods of dyeing. Preparation, structure and uses of some synthetic dyes: Methyl orange, Phenolphthalein, Fluorescein, Indigo fluorescent brightening agents, Non textile uses of dyes

#### References

1. B.Ksharma, *Industrial Chemistry*, Krishna Prakashan Media, 2005
2. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2<sup>nd</sup> Edn., Vikas Publishing House, New Delhi, 2004.

#### Module III: Soaps and Detergents (8 hrs)

Saponification, Manufacture of soap, Soft and hard soap, Total fatty matter of soap, Cleansing action of soap. Detergents : Surface action of detergents, Environmental effect of detergents, Biodegradable detergents

#### References

1. O. P. Vermani, *Industrial Chemistry*, Galgotia Publications
2. B.K Sharma, *Industrial Chemistry*, Krishna Prakashan Media. 2005



#### **Module IV: Drugs and pharmaceuticals (8 hrs)**

Basic raw materials, Process of manufacture, mode of action and efficient handling of the following drugs - Sulfa drugs(Sulfamethoxazole) -Anti Tubercular drugs (Isoniacid)- Antipyretic (Paracetamole)- NSAIDS (Mefenamic acid),  $\beta$  - blockers ( propanalol) -Cardio Vascular agents (methyl dopa) - Antihistamines (Cetricene hydrochloride), Anti viral drugs (acilovir )

#### **References**

1. Dr. K. G. Bothara, *Organic Pharmaceutical Chemistry*, Pragathi Books Pvt Ltd, 2008.
2. B.K Sharma, *Industrial Chemistry*, Krishna Prakashan Media. 2005.

#### **Module V: Food chemistry (8 hrs)**

Food additives: Artificial sweeteners – saccharin, cyclamate, asparatame – food flavours – esters, aldehydes and heterocyclic compounds. Antioxidants. Food colours – changes in cooking. Restricted use. Emulsifying agents, preservatives – leavening agents. Baking powder –Yeast. Taste enhancers Food deterioration, methods of preservation and processing

#### **References**

1. B. Srilakshmi, *Food Science*, New Age International, 2007.
2. Richard Owusu-Apen, *Introduction to Food Chemistry*, CRC, 2004.

#### **Module VI: Paints and coatings ( 8 hrs)**

Objectives of coatings surfaces,classification of surface coatings. Paints and pigments- formulation, composition and related properties. Oil paint, Vehicle, modified oils, Pigments, toners and lakes pigments, Fillers, Thinners, Enamels, emulsifying agents. Special paints -Heat retardant, Fire retardant, Eco-friendly paint, Plastic paint(elementary idea).

#### **References**

1. Philip A. Schweitzer, P.E, *Paint and Coatings: Applications and Corrosion Resistance*, CRC 2005.
2. B.K Sharma, *Industrial Chemistry*, Krishna Prakashan Media. 2005

#### **Further Reading**

1. Klaus Weissmelmel, Hans-Jürgen Arpe, *Industrial Organic Chemistry*, Wiley & Sons, 2008.
2. D. Satas, Arthur A. Tracton, *Coatings Technology Handbook, Second Edition*, CRC Press, 2000.
3. S.L. Kakani, *Material Science*, New Age International, 2006.
4. Richard Owusu-Apenten, *Introduction to Food Chemistry*, CRC Press,2004.

<b>Mark Distribution</b>	
Module I	17 Marks
Module II	14 Marks
Module III	12 Marks
Module IV	12 Marks
Module V	14 Marks
Module VI	10 Marks

## SEMESTER VI

### Course Code: ICH6B03

#### Core Course X: INORGANIC CHEMISTRY – III

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

ICH6B03	INORGANIC CHEMISTRY – III	L	T	P	C
		3	0	0	3
Objective (s)	To gain detailed knowledge of the electronic configuration and properties of transition and inner transition elements and their role in biological systems. To introduce the importance of different instruments used in analysis.				
Course outcome (s)					
CO1	To understand the principles behind different instrumental methods.				
CO2	To distinguish between lanthanides and actinides.				
CO3	To appreciate the importance of CFT.				
CO4	To understand the importance of metals in living systems.				
CO5	To distinguish geometries of coordination compounds.				

#### Module I: Instrumental Methods of Analysis (10 hrs)

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

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

#### References

1. D. A. Skoog, F. James Holler, S. R. Crouch, Principles of Instrumental Analysis, 6<sup>th</sup> 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*, 7<sup>th</sup> Edn., Wadsworth Publishing Co. Ltd., Belmont, California, USA, 1988.

#### Further reading

1. D. A. Skoog, D. M. West, F. J. Holler, *Fundamentals of Analytical Chemistry*, 6<sup>th</sup> Edn., Saunders College Publishing, Fort Worth, 1992.
2. D. C. Harris, *Quantitative Chemical Analysis*, 5<sup>th</sup> Edn., W H Free-man and Company, New York, 1999.

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

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

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

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

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

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

### References

1. J. D. Lee, *Concise Inorganic Chemistry*, 5<sup>th</sup> 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*, 6<sup>th</sup> Edn., John Wiley, New York, 1999.
2. D. F. Shriver, P. W. Atkins, *Inorganic Chemistry*, 3<sup>rd</sup> Edn., Oxford University Press, 2009.

### Module III: Coordination Chemistry (16 hrs)

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

Bonding theories: Review of Werner's theory and Sidgwick's concept of coordination – EAN rule – Valence Bond theory – Geometries of coordination numbers 4 and 6 – Limitations of VBT. Crystal field 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*, 1<sup>st</sup> Edn., Vikas Publishing House, New Delhi, 2001.

2. R. Puri, L. R. Sharma, K. C. Kalia, *Principles of Inorganic Chemistry*, 31<sup>st</sup> Edn., Milestone Publishers, New Delhi, 2010.

3. J. D. Lee, *Concise Inorganic Chemistry*, 5<sup>th</sup> Edn., Wiley India Pvt. Ltd. 2008.

#### **Further reading**

1. F. A. Cotton, G. Wilkinson, *Advanced Inorganic Chemistry*, 6<sup>th</sup> 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*, 4<sup>th</sup> Edn., Pearson Education, New Delhi, 2013.

3. D. F. Shriver, P. Atkins, *Inorganic Chemistry*, 5<sup>th</sup> Edn., Oxford University Press, New York, 2010.

4. F. Basolo, R. C. Johnson, *Coordination Chemistry*, 2<sup>nd</sup> Edn., Science Reviews, Wilmington, 1986.

5. G. L. Meissler, D. A. Tarr, *Inorganic Chemistry*, 3<sup>rd</sup> Edn., Pearson Education, 2004.

#### **Module IV: Organometallic Compounds (6 hrs)**

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

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

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

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

#### **References**

1. P. Powell, *Principles of Organometallic Compounds*, 2<sup>nd</sup> Edn., Chapman and Hall, London, 1988.

2. B. R. Puri, L. R. Sharma, K. C. Kalia, *Principles of Inorganic Chemistry*, 31<sup>st</sup> Edn., Milestone Publishers, New Delhi 2010.

3. G. L. Meissler, D. A. Tarr, *Inorganic Chemistry*, 3<sup>rd</sup> 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. Mehrotra, A. Singh, *Organometallic chemistry*, New age publishers, 1991.

#### **Module V: Bioinorganic Chemistry (8 hrs)**

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

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

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

### References

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

### Further reading

1. B. Douglas, D. Mc Daniel, J. Alexander, *Concepts and models of Inorganic Chemistry*, 3<sup>rd</sup> Edn., John Wiley, 1994.
2. I. Bertini, H. B. Gray, S. J. Lippard, J. Selvertone Valentine, *Bioinorganic Chemistry*, Viva Books Pvt. Ltd., 2007.

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

## SEMESTER VI

Course Code: CHE6B11

### Core Course XI: PHYSICAL CHEMISTRY – III

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

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

#### Module I: Electrochemistry – I (12 hrs)

[Prerequisites: Fundamentals of Electrochemistry. Introduction (Faradays law, types of conductance) – Measurement of equivalent conductance – Variation of conductance with dilution – Kohlrausch's law – Arrhenius theory of electrolyte dissociation and its limitations.]

Weak and strong electrolytes – Ostwald's dilution law, its uses and limitations – Debye-Huckel-Onsager's equation for strong electrolytes (elementary treatment only, derivation is not required) – Debye-Falkenhagen and Wien effects – Migration of ions and Transport number and its determination by Hittorf's and moving boundary methods. Applications of conductivity measurements: Determination of degree of dissociation, ionic product of water and solubility product of sparingly soluble salts (work out problems) – Conductometric titrations, strong acid-strong base, weak acid-strong base, strong acid-weak base and weak acid-weak base.

#### Module II: Electrochemistry – II (10 hrs)

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

Nernst equation for electrode potential and EMF of a cell – Relationship between free energy and electrical energy.

Gibbs Helmholtz equation to galvanic cells. Concentration cells: Concentration cells with and without transference – Liquid Junction Potential. 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*, 46<sup>th</sup> Edn., Vishal Publishing Company, New Delhi, 2013.
2. P. W. Atkins, J. de Paula, *Atkin's Physical Chemistry*, 8<sup>th</sup> 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*, 5<sup>th</sup> Edn., Tata McGraw Hill Education, New Delhi, 2006.
2. K. L. Kapoor, *Physical Chemistry*, Vol. II and III, Macmillan Publishers, Noida, 2004.
3. S. Glasstone, D. H. Lewis, *Elements of Physical Chemistry*, 2<sup>nd</sup> Edn., Macmillan & Company, UK, 1962.
4. F. Daniels, R. A. Alberty, *Physical Chemistry*, 5<sup>th</sup> Edn., John Wiley and Sons, Canada, 1980.
5. Peter Atkins, Julio de Paula, *The Elements of Physical Chemistry*, 7<sup>th</sup> Edn., Oxford University Press, Oxford, 2016.
6. J. Bockris, A. K. N. Reddy, *Modern Electrochemistry*, Kluwer Academic/Plenum Publishers, New York, 2000.

### Module III: Solutions (10 hrs)

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

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

Determination of molecular mass from viscosity measurements. Refraction: Refractive index – Molar refraction and optical exaltation – application.

### References

1. B. R. Puri, L. R. Sharma, M. S. Pathania, *Principles of Physical Chemistry*, 46<sup>th</sup> Edn., Vishal Publishing Company, New Delhi, 2013.
2. P. W. Atkins, J. de Paula, *Atkin's Physical Chemistry*, 8<sup>th</sup> 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*, 23<sup>rd</sup> Edn., Sultan Chand & Sons, New Delhi, 2011.

### Further reading

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

### Module IV: Ionic Equilibria (3 hrs)

[Prerequisites: Introduction to acid base theories –  $pK_a$ ,  $pK_b$  and  $p^H$  – Buffer solutions.]

Mechanism of buffer action – Buffer index – Henderson equation – Applications of buffers - Hydrolysis of salts of all types – Degree of hydrolysis – Hydrolysis constant and its relation with  $K_w$  - Solubility product and common ion effect.

### References

1. B. R. Puri, L. R. Sharma, M. S. Pathania, *Principles of Physical Chemistry*, 46<sup>th</sup> Edn., Vishal Publishing Company, New Delhi, 2013.
2. P. W. Atkins, J. de Paula, *Atkin's Physical Chemistry*, 8<sup>th</sup> 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*, 23<sup>rd</sup> Edn., Sultan Chand & Sons, New Delhi, 2011.

#### **Further reading**

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

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

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

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

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

#### **Module V: Solid State – I (10 hrs)**

[Prerequisites: Introduction - Amorphous and crystalline solids – Law of constancy of interfacial angles and rational indices – Space lattice and unit cell.]

Direct and reciprocal lattice (Miller indices) – Seven crystal systems and fourteen Bravais lattices – X-ray diffraction – Bragg's law (derivation required) – Planes - Simple account of rotating crystal method and powder pattern method – Analysis of powder patterns of NaCl, CsCl and KCl – Simple, face centered and body centered cubic systems – Identification of cubic crystals from inter-planar ratio – Close packing of spheres – Structure of simple ionic compounds of the type AB (NaCl and CsCl) and AB<sub>2</sub> (CaF<sub>2</sub>).

#### **Module VI: Solid State – II (3 hrs)**

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

#### **References**

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

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

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

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

**Further reading**

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

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

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

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

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

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

<b>Mark Distribution</b>	
Module I	17 Marks
Module II	14 Marks
Module III	14 Marks
Module IV	8 Marks
Module V	17 Marks
Module VI	9 Marks

## SEMESTER VI

Course Code: ICH6B04

### Core Course XII: ADVANCED AND APPLIED CHEMISTRY

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

ICH6B04	ADVANCED AND APPLIED CHEMISTRY	L	T	P	C
		3	0	0	3
Objective (s)	To obtain the students to 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 apply spectral data for the structure elucidation of molecules				
CO5	To understand the role of chemistry in human happiness index and life expectancy.				

#### Module I: Nanochemistry (6 hrs)

Historical introduction to nanochemistry - Nanosize domain - Classification of nanomaterials (0D, 1D and 2D) - Size dependence of material properties - Surface area to volume ratio and its significance - Variation in electronic and optical properties. Introduction to metal nanoparticles (gold, silver and platinum nanoparticles), semiconductor nanoparticles or quantum dots (CdS and CdSe nanoparticles) and metal oxide nanoparticles (zinc oxide, iron oxide, silica and titania nanoparticles). Carbon nanostructures: Fullerenes, carbon nanotubes and graphene (elementary idea only). Applications of nanomaterials in electronics, optics, catalysis, medicine and in environment related issues (detailed discussion not required).

#### References

1. M.A. Shah and Tokeer Ahmad, *Principles of Nanoscience and Nanotechnology*, Narosa Publishing House, New Delhi, 2010.
2. V.S. Muralidharan and A. Subramania, *Nano Science and Technology*, CRC Press, London, 2008.

#### Module II: New Vistas in Chemistry (6 hrs)

*Green Chemistry*: Introduction - Environmental concern on chemical industry and need for green chemistry – Origin of green chemistry – 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: Aldol condensation, Diels-Alder reaction and Williamson's synthesis. *Supramolecular Chemistry*: Introduction – Concepts of primary and secondary structures with examples (structures of

protein and DNA) - Molecular recognition - Host-guest interactions - Types of noncovalent interactions.

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

#### References

1. V.K. Ahluwalia, *Green Chemistry*, Narosa Publishing House, New Delhi, 2011.
2. P.S. Kalsi and J.P. Kalsi, *Bioorganic, Bioinorganic and Supramolecular Chemistry*, 1st Edition, New Age International Publishers (P) Ltd., New Delhi, 2007.
3. W. Bannwarth and B. Hinzen, *Combinatorial Chemistry - From Theory to Application*, 2<sup>nd</sup> Edition, Wiley-VCH, 2006.

#### Module III: Introduction to Computational Chemistry (8 hrs)

*General Introduction to Computers*: Operating systems and programming languages (basic idea only). *Excel Spread Sheets*: Basic operations, functions, charts and plots - Linear and non-linear regression - Curve fitting. *Conceptual Background of Molecular Modeling*: Molecular mechanic (force field) and molecular orbital (*ab initio* and semi-empirical) methods for molecular geometry optimization and computation of basic molecular properties (elementary idea only).

#### References

1. Andrew R. Leach, *Molecular Modelling: Principles and Applications*, Prentice Hall, 2001.
2. S. Wilson, *Chemistry by Computer: An Overview of the Applications of Computers in Chemistry*, Plenum Publishing, New York, 1986.

#### Module IV: Pericyclic Reactions (8 hrs)

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

#### References

1. Sethuraman Sankararaman, *Pericyclic reactions: a textbook : reactions, applications and theory*, Wiley-VCH, 2005
2. Jonathan Clayden, Nick Greeves, Stuart Warren, *Organic Chemistry.*, OUP Oxford, 2012

### **Module V: Natural products (4 hrs)**

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. G. R. Chatwal. M. Arora, *Organic Chemistry By Natural Products, Volume 2*, Himalaya Publishing House, 2016

2. O. P. Agarwal, *Natural Products, Volume 2*, Krishna Prakashan.

### **Module VI: Structure Elucidation Using Spectral Data (8 hrs)**

Application of spectral techniques in the structural elucidation of organic and inorganic compounds. *UV-Vis*:  $\lambda_{\max}$  calculation for dienes and  $\alpha,\beta$  unsaturated carbonyl compounds - UV spectra of butadiene, acetone, methyl vinyl ketone and benzene. *IR*: Concept of group frequencies - IR spectra of alcohols, phenols, amines, ethers, aldehydes, ketones, carboxylic acids, esters and amides. *<sup>1</sup>H NMR*: Chemical shift – Spin-spin splitting - PMR spectra of  $\text{CHBr}_2\text{CH}_2\text{Br}$ , ethyl alcohol, acetaldehyde, acetone, propanoic acid and toluene

#### **References**

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

2. Y.R. Sharma, *Elementary Organic Spectroscopy*, 4th Edition, S. Chand & Company Ltd., New Delhi, 1012 (Reprint).

### **Module VII: Applied Organic Chemistry – I (8 hrs)**

*Cosmetics*: Chemicals used in and health effects of hair dye, perfumes, antiperspirants, cleansing creams (cold creams, vanishing creams and bleach creams), sun screen preparations, UV absorbers, skin bleaching agents, depilatories, nail polishes, lipsticks and eye liners - Turmeric and Neem preparations - Vitamin oil. Harmful effects of cosmetics.

*Pesticides*: Insecticides, herbicides, rodenticides and fungicides (definition and examples) – Structure of Endosulfan, DDT and BHC - Harmful effects of pesticides. Endosulfan disaster in Kerala (brief study).

*Food Chemistry*: Common food adulterants in various food materials and their identification: Milk, vegetable oils, tea, coffee powder, rice and chilly powder. Methods of preservation:

Drying, pasteurization, refrigeration, vacuum packing, use of salt and pickling. 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 and its health effects. Modern food: Definition and health effects of fast foods, instant foods, dehydrated foods, junk foods and condiments - Composition and health effects of chocolates and soft drinks. Harmful effects of modern food habits. Natural food: Composition and advantages of milk - Importance of regional and seasonal fruits – Composition, importance and medical uses of coconut water and Neera - Advantages of traditional Kerala foods.

### References

- 1.M.S.R. Winter, *A Consumer's Dictionary of Cosmetic Ingredients*, 7th Edition, Three Rivers Press, New York, 2009.
2. H.S. Rathore and L.M.L. Nollet, *Pesticides: Evaluation of Environmental Pollution*, CRC Press, USA, 2012.
3. Food Science. B. Srilakshmi. New Age International.2007

### Further Reading

1. E. Joseph Billo, *Excel for Chemists - A Comprehensive Guide*, 3rd Edition, John Wiley & Sons, Inc., Hoboken, New Jersey, 2011.
2. I.L. Finar, *Organic Chemistry Vol. II*, 5th Edition, Pearson Education, New Delhi, 2013.
3. T. Pradeep, *A Textbook of Nanoscience and Nanotechnology*, McGrawhill, New Delhi, 2012.
4. Andrew P. Dicks, *Green Organic Chemistry in Lecture and Laboratory*, CRC Press, University of Toronto, Ontario, Canada, 2011.
4. M. Kirchhoff and M. Ryan, *Greener Approaches to Undergraduate Chemistry Experiments*, American Chemical Society, Washington, DC, 2002.
5. Helena Dodziuk, *Introduction to Supramolecular Chemistry*, Springer, New York, 2002.
6. A.W. Czarnik and S.H. DeWitt, *A Practical Guide to Combinatorial Chemistry*, 1st Edition, American Chemical Society, 1997.
7. B. Siva Sankar, *Food Processing and Preservation*, Prentice–Hall of India Pvt. Ltd., New Delhi, 2002.

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

## SEMESTER VI

Course Code: ICH6B05 (E1)

### Core Course XIII: Elective 1.MEDICINAL CHEMISTRY AND DRUG DEVELOPMENT

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

ICH6B05 (E1)	MEDICINAL CHEMISTRY AND DRUG DEVELOPMENT	L	T	P	C
		3	0	0	3
Objective (s)	To obtain the basic concepts of drug molecules, their development, action and dosage in different conditions				
Course outcome (s)					
CO1	To understand the importance of lead molecules in drug discovery				
CO2	To understand the theories of Structure-activity relationship in drug development				
CO3	To understand the concepts of drug targets and their metabolism				
CO4	To understand the importance of drug dosage				
CO5	To understand the role of Pharmaceutical excipients				

#### Module I: Drug design and development (24 Hrs)

Concept of drug -discovery of a drug, discovery of Librium, discovery of penicilin – discovery of lead compounds and lead modification. prodrugs and soft drugs; Random Screening –non random screening Structure-activity relationship (SAR), quantitative structure-activity relationship (QSAR); The Hammett equation –Taft equation- The pharmacophore identification modification structural - functional groups structural modification to increase potency. Homologation, chain branching, ring chain transformation – extension of structures –Isosters/ bio – isosters Factors affecting bioactivity – resonance, inductive effect, isosterism, bio-isosterism, spatial considerations; Theories of drug activity – occupancy theory, rate theory, induced fit theory Concept of drug receptors – elementary treatment of drug-receptor interactions; Drug Targets - Receptors –Enzymes- Nucleic Acids - Non-receptor targets Physicochemical parameters – lipophilicity, partition coefficient, electronic ionization constants, steric, Shelton and surface activity parameters and redox potentials; Factors affecting modes of drug administration, absorption, metabolism and elimination; Significance of drug metabolism in medicinal chemistry. Drug designing using QSAR computer assistant design – applications of other modeling techniques.

#### References

1. Ashutosh Kar, *Medicinal Chemistry*, New Age International Publishers

2. S. S. Pandeya & J. R. Dimmock, *Introduction to Drug Design*, New Age International (2000).

### **Module II: Introduction to Pharmacopoeias (16 Hours)**

Dosage Forms: Dosage forms and their classification on the basis of physical state with important characteristics: Solid Dosage forms including powders, capsules, cachets, Pills, tablets and suppositories. Liquid dosage forms including collodions, aromatic waters, inhalations, injections, lotions, mouth washes, nasal drops and ophthalmic drops. Sterilization: Need for sterilization, sterilization by heat processes viz sterilization by dry heat using hot air oven, flaming and I.R. radiations. Moist heat sterilization processes including autoclaving, heating with bactericide, Tantalization or fractional sterilization.

#### **Reference**

1. Goodman & Gilman, *Pharmacological Basis of Therapeutics*, McGraw-Hill (2005).
2. Donald Cairns, *Essentials of Pharmaceutical Chemistry*.

### **Module III: Pharmaceutical excipients (8 hours)**

Glidants, lubricants, diluents, preservatives, antioxidants – emulsifying agents – coating, colouring and flavoring agents – binders viscosity builders – gelatin, use of sorbitol, mannitol and liquid glucose. Surgical dressings sutures, ligatures – pharmaceutical packaging – selection of packaging – packaging material auxiliary materials – packaging machinery quality control of packaging materials.

#### **Reference**

1. Wilson and Gisvold's *Textbook of Organic Medicinal & Pharmaceutical Chemistry*, Block & Beale, Eds., 11th Ed. 2004.
2. Gurdeep R. Chatwal, *Synthetic Drugs*, Himalaya Publishing House, Bombay, 1995.

### **Module IV (4Hrs)**

Legal aspects of drugs: Important FDA , WHO Schedules, IPR, Patents (brief idea only)

#### **References**

1. Nirali Prakashan, *A text book of pharmaceuticals*
2. Gurdeep R. Chatwal, *Synthetic Drugs*, Himalaya Publishing House, Bombay, 1995.



### Further Reading

1. Burge., *Medicinal Chemistry and Drug Discovery*, Vol-1, Ed. M. E. Wolff, John Wiley (1994).
2. D. Lednicer, *Strategies for Organic Drug Synthesis and Design*, John Wiley (1998).
3. Graham & Patrick, *Introduction to Medicinal Chemistry (3<sup>rd</sup> edn.)*, OUP (2005).
4. *Foye's Principles of Medicinal Chemistry*, Williams & Lemke, Eds., 5th Ed. 2002.
5. *Burger's Medicinal Chemistry and Drug Discovery*, Abraham, Ed., 6th Ed., 2003.

Mark Distribution	
Module I	25 Marks
Module II	22 Marks
Module III	18 Marks
Module IV	14 Marks

## SEMESTER VI

Course Code: ICH6B05(E2)

### Core Course XIII: Elective 2. INTRODUCTION TO CHEMINFORMATICS

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

ICH6B05 (E2)	INTRODUCTION TO CHEMINFORMATICS	L	T	P	C
		3	0	0	3
Objective (s)	To get basic knowledge of applying informatics for studying molecular structure, properties, reactions and drug design				
Course outcome (s)					
CO1	To understand the concept of molecular modelling				
CO2	To familiarize with different chemical databases				
CO3	To apply computational methods to predict the properties of molecules				
CO4	To understand the importance of virtual screening				
CO5	To understand the role of informatics in drug design				

#### Module I: Introduction to Cheminformatics (2 hrs)

Introduction to cheminformatics, History and Evolution of cheminformatics, Use of cheminformatics, Prospects of cheminformatics, Molecular Modeling and Structure Elucidation

#### References

1. Jan H Noordik, *Cheminformatics Developments*, IOS Press
2. Beatriz Scaglia, *The Fundamentals : An understanding of Cheminformatics*, BiblioBazaar,

#### Module II: Representation of Molecules and Chemical Reactions (6 hrs)

Representation of Molecules and Chemical Reactions: Nomenclature; Different types of Notations; SMILES coding; Matrix Representations; Structure of Molfiles and Sdfiles; Libraries and toolkits; Different electronic effects; Reaction classification

#### References

1. Andrew R. Leach, Valerie J. Gillet, Cluwer, *Introduction to Cheminformatics*, Academic Publisher, Netherlands, 2003
2. Alexander Varnek, *Tutorials in Cheminformatics*, Wiley & Sons. 2017

#### Module III: Database Design & their Management (8 hrs)

Database Concepts. Structured Query Language. Design of Chemical Databases, Data Abstraction; Data Models; Instances & Schemes; E-R Model - Entity and entity sets; Relations and relationship sets; E-R diagrams; Reducing E-R Diagrams to tables; Network Data Model: Basic concepts; Hierarchical Data Model: Basic Concepts; Metadatabases;

Indexing and Hashing; Basic concepts; Text Databases; Introduction to Distributed Database Processing, Data Security. Intefacing programs with databases; Structure databases; Reaction Databases; Literature Databases; Medline;GenBank; PIR; CAS Registry; NIH and National Cancer Institute (NCI) Database

#### **References**

1. Jan H Noordik, *Cheminformatics Developments*, IOS Press
2. Rajarshi Guha, *Computational Approaches in Cheminformatics and Bioinformatics.*, Andreas Bender. Wiley Sons. 2011.

#### **Module IV: Searching Chemical Structure (8 hrs)**

Full structure search; sub structure search; basic ideas; similarity search; Three dimensional search methods; Basics of Computation of Physical and Chemical Data and structure descriptors; Data visualization.

#### **References**

1. Alexander Varnek, *Tutorials in Cheminformatic*, Wiley & Sons. 2017
2. Rajarshi Guha, *Computational Approaches in Cheminformatics and Bioinformatics.*, Andreas Bender. Wiley Sons. 2011.

#### **Module V: Applications Prediction of Properties of Compounds (8 hrs)**

Prediction of Properties of Compounds; Linear Free Energy Relations; Quantitative Structure- Property Relations; Descriptor Analysis; Model Building; Modeling Toxicity; Structure-Spectra correlations; Prediction of NMR, IR and Mass spectra; Computer Assisted Structure elucidations; Computer Assisted Synthesis Design

#### **References**

1. Alexander Varnek, *Tutorials in Cheminformatics*, Wiley & Sons. 2017.
2. Frank Jensen, *Introduction to Computational Chemistry*, Wiley Publisher, Second Edition, 2006

#### **Module VI: Virtual screening (4 hrs)**

Computer Assisted Virtual screening design: Structure Based Virtual Screening- Protein Ligand Docking, Scoring Functions for Protein Ligand docking, Practical aspects of structure based Virtual Screening; Prediction of ADMET Properties, 2D and 3D data searching, Chemical databases, Role of computers in Chemical Research.

#### **References**

1. Christoph Sotriffer, *Virtual Screening-Principles, Challenges and Practical Guidelines.* Wiley.
2. Juan Alvarez, Brian Shoichet, *Virtual Screening in Drug Discovery*, CRC Press. 2005.

## **Module VII: Application of Cheminformatics in Drug Design (12 hrs)**

Application of Cheminformatics in Drug Design: Quantitative Structure-Property Relations; Descriptor Analysis; Computer Assisted Structure elucidations; Target Identification and Validation; Lead Finding and Optimization; Analysis of HTS data; Design of Combinatorial Libraries; Ligand - Based and Structure - Based Drug design [Assignments will involve practical using free software]

### **References**

1. San Hongmao, *A practical guide to rational drug design*, Woodhead Publishing. 2015
2. Lee Banting, Tim Clerk, *Drug design strategies- Computational techniques and applications*, RSC. 2012.

### **Further Reading**

1. Lisa B. English (Editor), *Combinatorial Library Methods and Protocols*, Humana Press Inc, Volume:201, 2002
2. Jürgen Bajorath, *Cheminformatics for Drug Discovery*, John Wiley & Sons, 2013
3. Barry A. Bunin, Brian Siesel, Guillermo Morales, Jürgen Bajorath, *Cheminformatics: Theory, Practice, & Products*, Springer Science & Business Media, 2006.
4. Thomas Engel, Johann Gasteiger, *Cheminformatics: Basic Concepts and Methods*, John Wiley & Sons, 2018
5. Thomas Engel, Johann Gasteiger, *Applied Cheminformatics: Achievements and Future Opportunities*, John Wiley & Sons, 2018.
6. Vijayakumaran Nair K., Vinod Chandra, *Informatics*. S.S.Phi learning pvt. Ltd., 2014.

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

## SEMESTER VI

Course Code: ICH6B05(E3)

### Core Course XIII: Elective 3. ANALYTICAL METHODS IN CHEMISTRY

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

ICH6B05 (E3)	ANALYTICAL METHODS IN CHEMISTRY	L	T	P	C
		3	0	0	3
Objective (s)	To get detailed knowledge of different analytical techniques used in chemistry				
Course outcome (s)					
CO1	To familiarize separation techniques in chemistry				
CO2	To understand the principle and applications of thermoanalytical, electroanalytical and optical methods				
CO3	To recall the water quality standards				
CO4	To understand the concept of water quality parameters and their measurement				

#### Module I: Separation techniques (16 hrs)

Extraction: Solvent extraction, Soxhlet extraction, Distillation methods-Fractional distillation, Steam distillation, Purification methods – Filtration, Centrifugation, Recrystallisation, precipitation

Chromatographic methods : Principles and characteristics of Paper chromatography, TLC, Column chromatography and GC

#### Reference

1. *Vogel's Quantitative Chemical Analysis*, Mendham. Pearson Education India, 2009
2. *Physical Methods in Chemical Analysis*, Volume 3. Walter G. Berl. Elsevier, 2013

#### Module II Thermo analytical Methods (8 hrs)

Principle, methodology, characteristics and applications of TG, DTA, DSC

Working of dilatometry

#### Reference

1. Dr. B. K. Sharma, *Instrumental Methods of Chemical Analysis*, GPH Meerut
2. A.K.Srivastava, *Instrumental Approach to Chemical Analysis*, S. Chand Publishing, 2009

#### Module III: Electroanalytical Methods (8 hrs)

Basic principle of Electroanalysis, Principle and working of Potentiometry, Coulometry and Cyclic voltametry, Conductometric titrations, Electrogravimetric methods

#### References

1. Gurdeep Chatwal, *Instrumental Methods of Chemical Analysis*, Sham Anand. Himalaya Publishing House, 1984
2. A.K.Srivastava, *Instrumental Approach to Chemical Analysis*, S. Chand Publishing, 2009

**Module IV: Optical methods (12 hrs)**

Basic Principles and applications of the following opto-analytical methods : Flame photometry, Atomic adsorption spectrometry, Fluorimetry, Colourimetry, UV-VIS Spectrophotometry, Refractometry and turbidimetry

**References**

1. Dr. B. K. Sharma, *Instrumental Methods of Chemical Analysis*, GPH Meerut
2. Gurdeep Chatwal, Sham Anand, *Instrumental Methods of Chemical Analysis*, Himalaya Publishing House, 1984

**Module V: Water and waste water analysis (4 hrs)**

Water quality standards, Analysis of physical and chemical characteristics of waste water : Temperature, density, conductivity, Dissolved solids, salinity, BOD, COD, Concentration of nitrogen, phosphorus and chlorine Ion-exchange chromatography and reverse osmosis

**References**

- 1 Dr. B. K. Sharma, *Instrumental Methods of Chemical Analysis*, GPH Meerut
2. Kanwaljit Kaur, *Handbook of Water and Wastewater Analysis*, Atlantic Publishers & Dist, 2007

**Further readings**

1. Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch, *Fundamentals of Analytical Chemistry*, Cengage Learning, 2013.
2. Francis Rouessac, Annick Rouessac, *Chemical Analysis: Modern Instrumentation Methods and Techniques*, Wiley
3. Daniel C. Harris. W. H. Freeman, *Quantitative Chemical Analysis*, 2010.
4. Ana C. F. Ribeiro, Cecilia I. A. V. Santos, Gennady E. Zaikov, *Chemical Analysis: Modern Materials Evaluation and Testing Methods*, CRC Press
5. Leo M.L. Nollet, Leen S. P. De Gelder, *Handbook of Water Analysis, Third Edition*, CRC Press. 2013

Mark Distribution	
Module I	17 Marks
Module II	14 Marks
Module III	16 Marks
Module IV	18 Marks
Module V	14 Marks

## SEMESTER VI

Course Code: ICH6B06(P)

### Core Course XIV: INDUSTRIAL CHEMISTRY PRACTICALS - I

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

ICH6B06(P)	INDUSTRIAL CHEMISTRY PRACTICALS - I	L	T	P	C
		0	0	5	4
Objective (s)	To familiarise the students with the relation between physical properties and chemical composition used for analysis. To provide students an idea of designing experimental methods to analyse the physical properties of molecules or materials.				
Course outcome (s)					
CO1	To enable the students to develop analytical skills in determining the physical properties (physical constants).				
CO2	To develop skill in setting up an experimental method to determine the physical properties.				
CO3	To understand the principles of Refractometry, Potentiometry and Conductometry.				
CO4	To understand the basic concepts in non-aqueous titrations, Latex analysis, Analysis of Oil				

#### General Instructions

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

#### Module I: Viscosity and Surface tension

1. Determination of viscosity of various liquids using Ostwald's viscometer.
2. Study of glycerine-water system and determination of percentage of glycerine using viscometer (plot composition against  $t \times d$ ).
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:  $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ ,  $\text{CH}_3\text{COONa} \cdot 3\text{H}_2\text{O}$ . Solutes: Urea, Glucose*

### **Module IV: Phase Equilibria**

1. Construction of phase diagram & determination of eutectic composition and eutectic temperature: *Naphthalene-biphenyl system, Naphthalene-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,  $\text{CuSO}_4$  / Ferric alum /  $\text{KMnO}_4$  /  $\text{K}_2\text{Cr}_2\text{O}_7$  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.

**Module IX : Non-aqueous titrations**-Sodium benzoate, Isoniazid, diazepam, Mebendasole

**Module X : Latex analysis**- DRC, TSC, Ammonia content

**Module XI : Analysis of Oil** - Iodine value, Saponification value

### **References**

1. A. Findlay, *Findlay's Practical Physical Chemistry*, 9<sup>th</sup> 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*, 8<sup>th</sup> 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: ICH6B07(P)

### Core Course XV: ORGANIC CHEMISTRY PRACTICALS

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

ICH6B07(P)	ORGANIC CHEMISTRY PRACTICALS	L	T	P	C
		0	0	5	4
Objective (s)	To empower the students to prepare different compounds without compromising yield. Characterisation and analysis of different organic compounds based on functional groups. To develop skill in separation and purification of mixtures.				
Course outcome (s)					
CO1	To enable the students to develop analytical skills in organic qualitative analysis.				
CO2	To develop talent in organic preparations to ensure maximum yield.				
CO3	To apply the concept of melting or boiling points to check the purity of compounds.				
CO4	To analyse and characterise simple organic functional groups.				
CO5	To analyse individual amino acids from a mixture using 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 on tiles, wherever possible.
4. A minimum number of 7 organic analysis, 6 organic preparations and 1 chromatographic separation shall be done to appear for the examination.
5. The practicals must be completed in semester V. Practical examination will be conducted at the end of semester VI.

#### Module I: Reagent Preparation

Preparation of Borsche's reagent, Schiff's reagent, Tollen's Reagent, Fehling's solution, phenolphthalein, methyl orange, *N*-Phenylanthranilic acid and neutral  $\text{FeCl}_3$ .

#### 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,  $\alpha$ -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- $\beta$ -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*, 5<sup>th</sup> Edn., Pearson Education, Noida, 2014.
2. F. G. Mann, B. C. Saunders, *Practical Organic Chemistry*, 4<sup>th</sup> Edn., Pearson Education, Noida, 2011.
3. Arthur I. Vogel, *Elementary Practical Organic Chemistry- Small Scale Preparations*, 2<sup>nd</sup> Edn., Pearson Education, Noida, 2013.
4. V. K. Ahluwalia, S. Dhingra, *Comprehensive Practical Organic Chemistry*, Universities Press, Hyderabad, 2004.

## SEMESTER VI

Course Code: ICH6B08(P)

### Core Course XVI: INDUSTRIAL CHEMISTRY PRACTCAL-II

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

ICH6B08(P)	INDUSTRIAL 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.				
CO4	To apply the knowledge in the analysis of alloys and determination of water quality parameters				

#### General Instructions

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

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

1. Determination of water of hydration in crystalline barium chloride.
2. Determination of water of hydration in crystalline magnesium sulphate.
3. Estimation of  $\text{Ba}^{2+}$  as  $\text{BaSO}_4$
4. Estimation of  $\text{SO}_4^{2-}$  as  $\text{BaSO}_4$
5. Estimation  $\text{Fe}^{3+}$  as  $\text{Fe}_2\text{O}_3$
6. Estimation  $\text{Ca}^{2+}$  as  $\text{CaCO}_3$
7. Estimation  $\text{Al}^{3+}$  as  $\text{Al}_2\text{O}_3$

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

1. Estimation  $\text{Ni}^{2+}$  as nickel dimethyl glyoximate.
2. Estimation  $\text{Cu}^{2+}$  as cuprous thiocyanate.

3. Estimation  $\text{Mg}^{2+}$  as magnesium oxinate.

### **Module III: Colorimetry**

1. Verification of Beer-Lambert law for  $\text{KMnO}_4$  and  $\text{K}_2\text{Cr}_2\text{O}_7$  & determination of concentration of the given solution.

2. Estimation of iron.

3. Estimation of chromium.

4. Estimation of nickel.

### **Module IV: Analysis of Alloys**

Brass, Bronze, Type metal

### **Module V : Water Quality Parameters**

DO,  $\text{pH}$ , Conductivity, Refractive Index, COD, BOD, Total Hardness.

### **References**

1. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6<sup>th</sup> 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*, 8<sup>th</sup> Edn., Brooks/Cole, Thomson Learning, Inc., USA, 2004.

## SEMESTER VI

Course Code: ICH6B09(P)

### Core Course XVII: INORGANIC CHEMISTRY PRACTCAL-II

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

ICH6B09(P)	INORGANIC CHEMISTRY PRACTCAL-II	L	T	P	C
		0	0	5	4
Objective (s)	To develop skill in quanlitative analysis of inorganic compounds.				
Course outcome (s)					
CO1	To enable the students to develop skills in inorganic quanlitative analysis.				
CO2	To understand the principles behind inorganic mixture analysis and to apply it in quanlitative analysis.				
CO3	To analyse systematically mixtures containing two cations and two anions.				

#### General Instructions

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

#### Module I: Inorganic Qualitative Analysis

1. Study of the reactions of following ions. *Anions:* Carbonate, sulphate, fluoride, chloride, bromide, iodide, acetate, borate, oxalate, phosphate and nitrate. *Cations:* Lead, bismuth, copper, cadmium, iron, aluminium, cobalt, nickel, manganese, zinc, barium, calcium, strontium, magnesium and ammonium.
2. Systematic analysis of mixtures containing two cations and two anions from the above list.
3.  $\text{Na}_2\text{CO}_3$  extract procedure may be adopted.

#### References

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

## SEMESTER VI

Course Code: ICH6B10(Pr)

### Core Course XVIII: PROJECT WORK

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

ICH6B10 (Pr)	PROJECT WORK	L	T	P	C
		0	0	2	2
Objective (s)	To develop skill in scientific research, critical thinking and reasoning.				
Course outcome (s)					
CO1	To understand the scientific methods of research project.				
CO2	To apply the scientific method in life situations.				
CO3	To analyse scientific problems systematically.				

#### Guidelines

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

**EVALUATION SCHEME**

**FOR**

**CORE COURSES**



## **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**

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

<i>% of attendance</i>	<i>Marks</i>
85% and above	3
75 - <85%	2
50 - <75%	1

**Table 3: Pattern of Test Papers**

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

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

## **CORE COURSE PRACTICALS: 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**

<i>Sl. No.</i>	<i>Components</i>	<i>Marks</i>
1	Record (60%)	12
2	Lab involvement (40%)	8
<i>Total Marks</i>		20

**Table 2: Lab involvement**

<b>Component</b>	<b>Marks</b>
Viva	4
Performance	2
Punctuality	2
Total	8

**Table 3: Number of Experiments and Marks for Practical Records**

<i>Number of Experiments (Marks in brackets)</i>						
<i>Inorganic Chemistry Practicals-I</i>		<i>Industrial Chemistry Practicals-I</i>	<i>Organic Chemistry Practicals</i>		<i>Industrial Chemistry Practicals –II</i>	<i>Inorganic Chemistry Practicals –II Mixture</i>
<i>Volumetry</i>	<i>Preparation</i>		<i>Analysis</i>	<i>Preparation</i>		
19-20 (9)	6 (3)	16 (12)	10 (8)	8 (4)	16 (12)	10 (12)
18 (8)	5 (2)	15 (11)	9 (7)	7 (3)	15 (11)	9 (11)
17 (7)	4 (1)	14 (10)	8 (6)	6 (2)	14 (10)	8 (10)
16 (6)		13 (9)	7 (5)		13 (9)	7 (9)
15 (5)		12 (8)				

## **2. EXTERNAL EVALUATION**

External evaluation carries 80% marks. Practical examinations along with viva-voce will be conducted at the end of IV<sup>th</sup> and VI<sup>th</sup> semesters.

### ***PATTERN OF QUESTION PAPERS***

**Table 1: Inorganic Chemistry Practicals – I**

<i>Duration</i>	<i>Pattern</i>	<i>Marks</i>	<i>Total Marks</i>
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: Industrial Chemistry Practicals - I**

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

*Guidelines*

1. *Valuation of Principle and procedure:* 8 marks (4 marks for principle and 4 marks for procedure).
2. *Marks for Result:* The mark distribution may vary for different experiments.

**Table 3: Organic Chemistry Practicals**

<i>Duration</i>	<i>Pattern</i>	<i>Marks</i>	<i>Total Marks</i>
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: Industrial Chemistry Practicals – II**

<i>Duration</i>	<i>Pattern</i>	<i>Marks</i>	<i>Total Marks</i>
3 Hours	<b>Gravimetry and Colorimetry</b>		65
	Procedure of colorimetry	4	
	Procedure of gravimetry	8	
	Result	35	
	Calculation	2	
	Record	8	
	Viva-Voce	8	
	<b>Industrial Visit</b>		15
	Report	8	
	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 Practicals – II**

<i>Duration</i>	<i>Pattern</i>	<i>Marks</i>	<i>Total Marks</i>
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**

<i>Number of Experiments (Marks in brackets)</i>						
<i>Inorganic Chemistry Practicals – I</i>		<i>Industrial Chemistry Practicals I</i>	<i>Organic Chemistry Practicals</i>		<i>Industrial Chemistry Practicals –II</i>	<i>Inorganic Chemistry Practicals –II</i>
<i>Volumetry</i>	<i>Preparation</i>		<i>Analysis</i>	<i>Preparation</i>		
19-20 (6)	6 (2)	16 (8)	9-10 (4)	8 (4)	16 (8)	12 (8)
18 (5)	5 (1)	15 (7)	8 (3)	7 (3)	15 (7)	11 (7)
17 (4)		14 (6)	7 (2)	6 (2)	14 (6)	10 (6)
16 (3)		13 (5)			13 (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**

<i>Sl. No</i>	<i>Criteria</i>	<i>Marks</i>
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
<i>Total Marks</i>		15

**Table 2: External Evaluation**

<i>Sl. No</i>	<i>Criteria</i>	<i>Marks</i>
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
<i>Total Marks</i>		60

- 1) Submission of the project report and presence of the student for viva are compulsory for internal evaluation. No marks shall be awarded to a candidate if she/he fails to submit the project report for external evaluation
- 2) The student should get a minimum P grade in aggregate of external and internal.
- 3) There shall be no improvement chance for the marks obtained in the project report.
- 4) In the extent of student failing to obtain a minimum of pass grade, the project work may be re-done and a new internal mark may be submitted by the parent department. External examination may be conducted along with the subsequent batch.

**MODEL QUESTION PAPERS  
FOR  
CORE COURSES**



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

**Time: Two Hours**

**Maximum: 60 Marks**

**Section A (Short answers)**

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

1. Differentiate between scientific theory and law.
2. Write note on S phrase and R phrase?
3. What do the terms absolute error and relative error mean with regard to an analytical determination?
4. Calculate the mole fractions of the components in a solution made up of 1 mole of ethanol and 9 moles of water?
5. Explain a redox titration with example.
6. What is meant by ionization enthalpy?
7. Explain the principles behind hydrogen bomb and atom bomb.
8. How will you prepare nitric acid?
9. Write a note on inert pair effect.
10. Distinguish between hard and soft acids and bases.
11. Write note on radioactive tracer.
12. Draw the structure of boric acid.

**[Ceiling of marks: 20]**

**Section B (Paragraph)**

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

13. Explain the term scientific observation and its role in science.
14. Discuss the Ostwald's theory of acid –base indicators.
15. An item of old wooden furniture shows a C-14 activity which is 45% of the activity found in fresh wood. Calculate the age of the wood.
16. Explain with example the calculation of effective nuclear charge.
17. Describe the structure, properties and applications of diboranes.
18. Explain the principles of Aston's mass spectrograph.
19. Write note on complexometric titration

**[Ceiling of marks: 30]**

**Section C (Essay)**

**(Answer any one. Each question carries 10 marks)**

20. a) Correlate N/P ratio and nuclear stability. b) Write a note on nuclear reactor.
21. a) Compare the electro negativity and ionization energy of s and p block elements. b) Explain the structure of oxides of N and P.

**[1 X 10 = 10]**

**SECOND SEMESTER B.Sc DEGREE EXAMINATION**  
**CBCSSUG – INDUSTRIAL CHEMISTRY**  
**CHE2B02 - Core Course II**  
**THEORETICAL AND INORGANIC CHEMISTRY - II**

**Time: Two Hours**

**Maximum: 60 Marks**

**Section A (Short answers)**

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

1. Predict the hybridization and geometry of SF<sub>4</sub> and IF<sub>7</sub>.
2. Briefly explain Einstein interpretation of photoelectric effect.
3. State Bohr quantization of orbits.
4. What is de-Broglie's wavelength of an electron with speed of 4.12x10<sup>6</sup> m/s? (mass of electron: 9.1x10<sup>-31</sup> Kg).
5. Explain the importance of normalization.
6. Pick the molecule/molecules which exist as stable species: Ne<sub>2</sub>, C<sub>2</sub>, Li<sub>2</sub> and He<sub>2</sub><sup>+</sup>. Give suitable explanation.
7. Describe the importance of Born-Oppenheimer approximation.
8. Explain the term Hermitian operator.
9. Sketch the radial probability plot of 1s and 3s orbital.
10. State Heisenberg's uncertainty principle. Does it have measurable consequence in the macroscopic world?
11. What is an Eigen value? Are the Eigen value of Hamiltonian operator always real?
12. Mention four limitation of Bohr theory. **[Ceiling of marks: 20]**

**Section B (Paragraph)**

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

13. Explain the postulates of quantum mechanics.
14. Write a note on quantum numbers. What are the four quantum numbers that represent an electron in 2p orbital?
15. Draw the molecular orbital diagram of NO. Predict its bond order?
16. Explain the hybridization of BH<sub>3</sub> and CH<sub>4</sub> by applying LCAO treatment.
17. A particle is confined in a 3D box that has side a=b=1.5c, a) Write the expression for wave function and energy, b) Predict its degeneracy for first four energy level.
18. Explain the required qualities of well behaved function with an example.
19. Distinguish VBT and MOT. **[Ceiling of marks: 30]**

**Section C (Essay)**

**(Answer any one. Each question carries 10 marks)**

20. Discuss briefly the concept of particle in 1D box. Using Schrodinger equation predicts its energy and wave function.
21. a) Write a note on atomic spectrum of hydrogen, b) A line of the Lyman series of the spectrum of hydrogen has a wavelength of 9.50 x 10<sup>-8</sup> m. Calculate the n<sub>i</sub> involved in the associated electron transition. **[1 X 10 = 10]**

**THIRD SEMESTER B.Sc DEGREE EXAMINATION**  
**CBCSSUG – INDUSTRIAL CHEMISTRY**  
**CHE3B03 - Core Course III**  
**PHYSICAL CHEMISTRY – I**

**Time: Two Hours**

**Maximum: 60 Marks**

**Section A (Short answers)**

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

1. Calculate the temperature at which O<sub>2</sub> molecule will have the same RMS velocity as CO<sub>2</sub> molecule.
2. Calculate the value of work done when 2g of H<sub>2</sub> expands from a volume of 1 litre to a volume of 10 litres at 27°C.
3. Write Clapeyron - Clausius equation (integrated form) for liquid-vapour equilibrium and explain the terms.
4. Write Gibbs-Duhem equation and explain the terms.
5. Explain the physical significance of entropy.
6. Define third law of thermodynamics.
7. Calculate the entropy of vapourisation of a liquid which boils at 120°C. Given enthalpy of vapourisation is 3600 Jmol<sup>-1</sup>.
8. What is optical exaltation?
9. Give the equation for molar refraction of a liquid and explain the terms.
10. Why chemical equilibrium is termed dynamic?
11. State Le Chatelier's principle.
12. What is homogeneous equilibrium? Give example. **[Ceiling of marks: 20]**

**Section B (Paragraph)**

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

13. Derive the relationship between heat capacity at constant volume and constant pressure for an ideal gas.
14. Derive the expressions for critical constants in terms of vander-Waals constants.
15. Derive the relation between temperature and pressure for an adiabatic process.
16. Calculate the change in freezing point for ice when the pressure is increased by 1 atm. Molar volume of water and ice are 18.0 and 19.6 cm<sup>3</sup> and the enthalpy of fusion for ice is 6008 Jmol<sup>-1</sup>. (IJ = 9.87 x 10<sup>-3</sup> dm<sup>3</sup>.atm.)
17. Discuss the variation of free energy with temperature and pressure.
18. Derive an expression for the relation between entropy and probability?
19. What is Parachor? How is it used for structure elucidation? **[Ceiling of marks: 30]**

**Section C (Essay)**

**(Answer any one. Each question carries 10 marks)**

20. Derive the relationship between K<sub>p</sub> and K<sub>c</sub>.
21. What is Joule-Thomson effect? Describe Linde's method and Claude's method for the liquifaction of gases. **[1 X 10 = 10]**

**FOURTH SEMESTER B.Sc DEGREE EXAMINATION**  
**CBCSSUG – INDUSTRIAL CHEMISTRY**  
**CHE4B04 - Core Course IV**  
**ORGANIC CHEMISTRY – I**

**Time: Two Hours**

**Maximum: 60 Marks**

**Section A (Short answers)**

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

1. Distinguish between chain and position isomerism with an example.
2. Draw the Newman projections of the two extreme conformations of butane.
3. Explain the isomerism exhibited by fumaric and maleic acids.
4. Explain the terms electrophile and nucleophile with examples for each.
5. Compare the basicities of aniline, *p*-nitroaniline and *p*-anisidine.
6. What is the product formed when isopropyl bromide is treated with metallic sodium in ether solvent? Write equation and IUPAC name of the product.
7. State and illustrate Saytzeff's rule of elimination.
8. Why are 1-alkynes acidic?
9. Write two tests to distinguish between alkanes and alkenes.
10. What is Lindlar's catalyst? What is its use in organic synthesis?
11. Write equation to show the Birch reduction of benzene.
12. Write the mechanism of nitration of benzene. **[Ceiling of marks: 20]**

**Section B (Paragraph)**

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

13. What is Huckel's rule of aromaticity. Using it discuss the aromaticity of azulene and annulenes.
14. a) Write any three methods of resolution racemic mixtures. b) Distinguish between absolute and partial asymmetric synthesis
15. What is hyperconjugation? Write the order of stability of propene, 1-butene and 2-butene. Explain why?
16. Write a short note on hybridisation, structure, formation and stability of carbenes.
17. a) What is Corey – House synthesis? b) Write the mechanism of free radical chlorination of methane.
18. What is ozonolysis? One mole of alkene, C<sub>6</sub>H<sub>12</sub> on ozonolysis yields 1 mole each of propanal and propanone. Find the structure of the parent alkene and write equation for the ozonolysis sequence.
19. Explain the postulates of Baeyer's strain theory. **[Ceiling of marks: 30]**

**Section C (Essay)**

**(Answer any one. Each question carries 10 marks)**

20. a) Differentiate between Friedel-Craft's alkylation and acylation reactions. Write the mechanism of each reaction. b) Explain the elimination-addition mechanism (benzyne) of aromatic nucleophilic substitution.

21. a) Explain the Markownikov and Anti-Markownikov addition to alkenes with mechanism. b) Write the  $\text{SN}^1$  and  $\text{SN}^2$  mechanisms of aliphatic nucleophilic substitution reactions with stereochemical aspects. **[1 X 10 = 10]**

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

**Time: 3 Hours**

**Maximum marks: 80**

**Section A**

**Answer the following questions in 10 minutes**

1. Calculate the mass of Mohr's salt required to prepare 500 mL of its 0.5 N solution?
2. Calculate the normality of  $K_2Cr_2O_7$  solution when 0.49 g of it is dissolved in water in a 100 mL standard flask?
3. When 100 mL 1N  $ZnSO_4$  solution is diluted to 500 mL the normality of the resulting solution will be -----
4. Name the indicator used for the titration of  $K_2Cr_2O_7$  against  $FeSO_4$ .
5. Write the balanced chemical equation for the titration of  $I_2$  solution against  $Na_2S_2O_3$ .
6. The titration of  $Fe^{2+}$  solution against  $KMnO_4$  is a ----- titration.
7. What is the role of  $SnCl_2$  in the estimation of  $Fe^{3+}$  during dichrometry?
8. Write the structure of Phenolphthalein. (1x8 = 8  
Marks)

**Section B**

**Answer the following questions in 15 minutes**

9. Give a brief outline of the method for the volumetric estimation of  $Mg^{2+}$  in the whole of the given solution of  $MgSO_4$ , being provided with AR  $ZnSO_4$  crystals. (8 Marks)
10. Write a brief outline of the method for the preparation of ferric alum. (4 Marks)

**Part C**

11. Estimate the weight of  $Fe^{3+}$  in the whole of the given solution of ferric alum, being provided with AR Mohr's salt. (39 Marks)

**Part D**

12. Prepare the inorganic complex ..... Exhibit the crude and recrystallised sample. (5 marks)

**Part E**

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

**FIFTH SEMESTER B.Sc DEGREE EXAMINATION**  
**CBCSSUG - CHEMISTRY**  
**ICH5B01- Core Course V**  
**INDUSTRIAL CHEMISTRY – I**

**Time: Two Hours**

**Maximum: 60 Marks**

**Section A (Short answers)**

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

1. What are silicates?
2. Give the structure of pyro and cyclic silicates.
3. What is Bayer process?
4. What is the general classification of carbides?
5. Write the name and structure of any two industrially important carbides.
6. What are mesoporous materials?
7. How can molecular sieves be regenerated?
8. How are zeolites produced industrially?
9. What is glass?
10. Give the chemical constituents of cement.
11. What are herbicides?
12. What are inhibitors? Give examples.

**[Ceiling of marks: 20]**

**Section B (Paragraph)**

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

13. Write a note on sodium Super Ionic conductor (NASICON).
14. How are silicates classified?
15. Distinguish between homogenous and heterogeneous catalysts.
16. What is eutrophication?
17. What are pesticides? What are the different types of pesticides? Give example for each.
18. What are the essential requirements of a fertilizer?
19. What is Fischer Tropsch process?

**[Ceiling of marks: 30]**

**Section C (Essay)**

**(Answer any one. Each question carries 10 marks)**

20. Describe the industrial method for manufacture of glass.
21. Write a note on manufacture of cement.

**[1 X 10 = 10]**

**FIFTH SEMESTER BSc. DEGREE EXAMINATION**  
**CBCSSUG - CHEMISTRY**  
**CHE5B07 -Core Course VII**  
**ORGANIC CHEMISTRY – II**

**Time: 2 Hrs**

**Max Marks: 60**

**Section A (Short answers)**

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

1. How are alcohols prepared by the hydroboration oxidation?
2. What is Lucas test?
3. How are ethers prepared from alkyl halides?
4. Explain the Zeisel's method of estimation of methoxy groups.
5. What is Etard's reaction?
6. Write two tests to distinguish between aldehydes and ketones.
7. Acetic acid or formic acid, which is more acidic? Why?
8. What is HVZ reaction? Write an example.
9. What is tosylation reaction?
10. What is nitro – aci tautomerism? Explain.
11. What is Hoffmann bromamide reaction?
12. How will you explain the basicity of guanidine?

**[Ceiling of marks: 20]**

**Section B (Paragraph)**

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

13. What is pinacol- pinacolone rearrangement? Explain with mechanism.
14. What are crown ethers? What are their applications in organic synthesis and catalysis?
15. Explain the synthetic utility of Wittig reaction and Beckmann rearrangement.
16. How is citric acid prepared using Reformatsky reaction? What are the uses of it?
17. Explain the separation of primary, secondary and tertiary amines by the Hinsberg's method.
18. How is ethyl acetoacetate prepared by Claisen condensation? Write the mechanism.
19. a) How is methyl orange prepared? How will you explain its colour change with pH?  
b) How is urea estimated by the urease method?

**[Ceiling of marks: 30]**

**Section C (Essay)**

**(Answer any one. Each question carries 10 marks)**

20. a) Explain the important synthetic applications of Grignard's reagent. b) Explain the Aldol and Benzoin condensations.
21. Explain the following reactions with mechanism. a) Riemer – Tiemann reaction. b) Haloform reaction c) Kolbe electrolysis d) Hofmann elimination. **[1 X 10 = 10]**



**FIFTH SEMESTER B.Sc DEGREE EXAMINATION**  
**CBCSSUG - CHEMISTRY**  
**CHE5B08 - Core Course VIII**  
**PHYSICAL CHEMISTRY – II**

**Time: Two Hours**

**Maximum: 60 Marks**

**Section A (Short answers)**

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

1. Order of a reaction need not be whole number always. Account.
2. Give one example each for (i) a parallel reaction; (ii) a consecutive reaction.
3. What is chemiluminescence? Give one example.
4. Explain Bredig's method for the preparation of gold sol.
5. What is meant by Dorn Effect?
6. Name the different symmetry elements implied by  $C_6$  axis.
7. Discuss the principle of gel permeation chromatography.
8. What type of molecules gives rotational Raman spectra?
9. What is Frank – Condon principle?
10. Write any two advantages of Raman spectra over IR spectra.
11. Discuss the ESR spectra of methyl radical.
12. What is proper axis of rotation?

**[Ceiling of marks: 20]**

**Section B (Paragraph)**

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

13. Draw the group multiplication table of  $C_{2v}$  point group.
14. Discuss briefly the activated complex theory of reaction rates.
15. Certain reactions have very high quantum yield whereas others have very low quantum yield. Explain.
16. Draw phase diagram of sulphur system. Explain it.
17. Draw and explain the phase diagram of Zn-Mg system.
18. Explain how rotational spectroscopy can be used to find the bond length.
19. Explain the term chemical shift.

**[Ceiling of marks: 30]**

**Section C (Essay)**

**(Answer any one. Each question carries 10 marks)**

20. (a) Give methods for purification of colloids (b) Derive Langmuir isotherm.
21. (a) Derive an expression for the rate constant of a bimolecular gaseous reaction using collision theory (b)  $E_a$  for a first order reaction is  $250 \text{ KJmol}^{-1}$ . The half life of the reaction is  $6.5 \times 10^6$  second at  $450^\circ\text{C}$ . What will be the half life at  $550^\circ\text{C}$ ? **[1 X 10 = 10]**

**SIXTH SEMESTER BSc. DEGREE EXAMINATION**  
**CBCSSUG - CHEMISTRY**  
**ICH6B02 - Core Course IX**  
**INDUSTRIAL CHEMISTRY – II**

**Time: 2 Hrs**

**Max Marks: 60**

**Section A (Short answers)**

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

1. What is glass transition temperature?
2. Differentiate between soft and hard soap.
3. Mention two non textile uses of dyes.
4. What is total fatty matter of soap?
5. Give two examples for a Biodegradable detergent.
6. What are Antihistamines?
7. What are  $\beta$  – blockers?
8. How does the formulation of tablets differ from capsules?
9. Write two examples for artificial sweeteners.
10. Write the action of any one Anti Tubercular drug.
11. What are emulsifying agents?
12. Give two non textile uses of dyes.

**[Ceiling of marks: 20]**

**Section B (Paragraph)**

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

13. Explain Cleansing action of soap
14. Differentiate between Alkyl sulphates, alkyl sulphonates, aralkyl sulphonates.
15. Explain the mode of action of sulpha drugs.
16. Comment on the mode of action of Mefenamic acid.
17. Explain the significance of Biodegradable detergents.
18. Write short notes on food additives.
19. Explain the role of methyl dopa.

**[Ceiling of marks: 30]**

**Section C (Essay)**

**(Answer any one. Each question carries 10 marks)**

20. Explain different types of polymers with suitable examples.
21. Describe the classification of dyes based on their applications.

**[1 X 10 = 10]**

**SIXTH SEMESTER BSc. DEGREE EXAMINATION**  
**CBCSSUG - CHEMISTRY**  
**ICH6B03 - Core Course X**  
**INORGANIC CHEMISTRY – III**

**Time: 2 Hrs**

**Max Marks: 60**

**Section A (Short answers)**

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

1. Calculate the CFSE in  $[\text{Mn}(\text{H}_2\text{O})_6]^{2+}$ .
2. Explain Bragg's Law.
3. Why do transition metals show catalytic properties?
4. While  $\text{MnSO}_4 \cdot 4\text{H}_2\text{O}$  is pale pink in colour,  $\text{KMnO}_4$  exhibits dark violet colour. Why?
5. The absorbance of an iron thiocyanate solution containing 0.00500 mg Fe/mL was reported as 0.4900 at 540 nm. Calculate the specific absorptivity of iron thiocyanate assuming that a 1.00 cm cuvette was used.
6. What is Spectrochemical series?
7. Distinguish high spin and low spin among  $[\text{Co}(\text{en})_3]^{3+}$  and  $[\text{CoF}_6]^{3-}$ . Give reason [en-ethylenediammine].
8. While  $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$  is pink in colour,  $[\text{CoCl}_4]^{2-}$  is blue in colour. Why?
9. Name the catalyst used for (i) polymerization of alkene and (ii) hydrogenation of alkene.
10. What is Zeise's salt?
11. Explain the significance of zinc in biological systems.
12. Why is lead considered as a toxic metal?

**[Ceiling of marks: 20]**

**Section B (Paragraph)**

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

13. Discuss the structure and oxygen binding mechanism of Haemoglobin.
14. Differentiate between Scanning Electron Microscopy and Transmission Electron Microscopy.
15. Explain the process involved in separation of lanthanides.
16. Discuss any five factors influencing stability of complexes.
17. (i) Explain the hybridization and structure of (a)  $[\text{Ni}(\text{CN})_4]^{2-}$  and (b)  $[\text{NiCl}_4]^{2-}$  based on VBT. (ii) Which of the two is diamagnetic in nature?
18. What is 18- Electron rule? Justify how  $\text{Fe}(\text{CO})_5$  and  $\text{Fe}_2(\text{CO})_9$  obey 18- Electron rule.
19. Explain the principle and working of Atomic Force Microscope. **[Ceiling of marks: 30]**

**Section C (Essay)**

**(Answer any one. Each question carries 10 marks)**

20. Write an account on the MOT of octahedral complexes containing only sigma bonds?
21. (i) Discuss the structure and significance of *Cis*-platin. (ii) Explain the preparation and properties of Ferrocene.

**[1 X 10 = 10]**

**SIXTH SEMESTER B.Sc DEGREE EXAMINATION**  
**CBCSSUG - CHEMISTRY**  
**CHE6B11 - Core Course XI**  
**PHYSICAL CHEMISTRY – III**

**Time: Two Hours**

**Maximum: 60**

**Marks**

**Section A (Short answers)**

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

1. What is the molality of a solution prepared by dissolving 5.0g of toluene in 225 g of benzene?
2. How does band theory distinguish semiconductors from insulators and conductors?
3. 0.0654 g of a metal was deposited by the passage of a current of 0.4 amperes for 30 minutes through its salt solution. Calculate the equivalent mass of the metal.
4. Explain the term electrophoretic effect based on Debye –Huckel theory of strong electrolytes.
5. Explain leveling effect of a solvent with a suitable example.
6. State Henry's law and explain one of its applications.
7. Explain the principle behind the purification of sea water by reverse osmosis method.
8. 2% solution of an organic solute A is found to be isotonic with a 3% solution of sucrose. Calculate the molar mass of A.
9. Distinguish between an electrode concentration cell and electrolyte concentration cell.
10. Explain the principle behind the conductometric titration of a weak acid against a strong base.
11. Discuss the effect of dilution on molar conductivity of an electrolytic solution
12. What is an ideal solution? **[Ceiling of marks: 20]**

**Section B (Paragraph)**

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

13. State and explain Kohlrausch's law. Based on it determine the molar conductivity at infinite dilution of acetic acid.
14. What is meant by salt hydrolysis? Explain why an aqueous solution of sodium carbonate is basic while that of ammonium nitrate is acidic.
15. The emf of the cell  $\text{Ag} \mid \text{AgI} \text{ in } 0.045 \text{ M KI} \parallel 0.045 \text{ M AgNO}_3 \mid \text{Ag}$  is 0.788 at 25°C. Calculate (i) the solubility product of AgI and the (ii) solubility of AgI in water at 25°C.
16. Explain the electrochemical theory of corrosion with a suitable example
17. (a) Explain the term buffer index with regard to buffer solutions. (b) Derive the Henderson equation for the pH of an acidic buffer.
18. (a) Explain common ion effect with an example (b) Calculate the degree of hydrolysis

of deci molar solution of ammonium acetate at 28°C. Dissociation constants of acetic acid and ammonium hydroxide are  $1.75 \times 10^{-5}$  and  $1.85 \times 10^{-5}$  respectively and  $K_w = 1.008 \times 10^{-14}$  at 28°C.

19. (a) Discuss H<sub>2</sub>-O<sub>2</sub> fuel cell (b) How can you determine pH of a solution using standard hydrogen electrode (SHE)?

[Ceiling of marks: 30]

**Section C (Essay)**

**(Answer any one. Each question carries 10 marks)**

20. (a) Calomel electrode is used as a reference electrode. Describe its construction and working. (b) Differentiate between hexagonal close packing and cubic close packing of uniform spheres.

21. (a) Discuss the structures of two AB type compounds (b) Discuss the salient features of different types of liquid crystals.

[1 X 10 = 10]

**SIXTH SEMESTER BSc.DEGREE EXAMINATION**  
**CBCSSUG – CHEMISTRY**  
**ICH6B04 - Core Course XII**  
**ADVANCED AND APPLIED CHEMISTRY**

**Time: 2 Hrs**

**Max Marks: 60**

**Section A (Short answers)**

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

1. Explain the term global minimum in computational chemistry.
2. Describe the change melting point when the particle size of a material approaches nanoscale rang.
3. What are the advantages of microwave assisted organic synthesis?
4. Explain any two principles of green chemistry.
5. Draw the structure of endosulphan and DDT.
6. Explain the uses of nanomaterials.
7. Distinguish ethanol and acetone using NMR spectroscopy.
8. Explain the physiological action of nicotine and quinine.
9. Name two software used in computational chemistry.
10. Draw the structure of cholesterol
11. Name one nitrogenous fertilizer and one potash fertilizer.
12. Explain the importance of combinatorial synthesis. **[Ceiling of marks: 20]**

**Section B (Paragraph)**

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

13. Distinguish between the bottom up and top down methods of nanoscale synthesis.
14. Explain different host-guest interactions in supramolecules.
15. Explain with example the difference between percentage yield and atom economy.
16. Distinguish between molecular mechanics method and electronic structure method in computational chemistry.
17. How will you distinguish ethyl acetate and propanoic acid by IR and  $^1\text{H}$  NMR spectroscopy?
18. Write note on structure and uses of citral, geraniol and menthol
19. Explain the theories behind color of dyeing compounds.

**[Ceiling of marks: 30]**

**Section C (Essay)**

**(Answer any one. Each question carries 10 marks)**

20. a) Sketch the MO diagram of 1,3-butadiene and show the HOMO and LUMO in the ground state (b) Using the Frontier orbital diagram show the mode of cyclisation of 1,3-butadiene under thermal and photochemical conditions.
- 21) Explain the twelve principles of green chemistry **[1 X 10 = 10]**

**SIXTH SEMESTER BSc.DEGREE EXAMINATION**  
**CBCSSUG – CHEMISTRY**  
**ICH6B05(E1) - Core Course XIII**  
**MEDICINAL CHEMISTRY AND DRUG DEVELOPMENT**

**Time: 2 Hrs**

**Max Marks: 60**

**Section A (Short answers)**

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

1. Define a drug molecule
2. What is meant by a lead compound ?
3. What are prodrugs and soft drugs
4. What are Isosters ?
5. What is the principle of lipophilicity of drugs?
6. Name any four Solid Dosage forms
7. Comment about the flavoring agents in drugs
8. What is the Need for sterilization ?
9. What are aromatic waters ?
10. Mention the advantage of suppositories.
11. What are the use of use of sorbitol and mannitol in pharmaceutical field?
12. What are Glidants

**[Ceiling of marks: 20]**

**Section B (Paragraph)**

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

13. Explain the importance of the discovery of librium
14. Describe the Hammet equation –Taft equation
15. Explain Homologation, chain branching, ring chain transformation in drug development
16. What is the principle of Drug Targets and Receptors
17. Comment about the Significance of drug meta-bolism in medicinal chemistry
18. Describe the important FDA and WHO Schedules
19. Comment about the inhalations, injections, nasal drops and ophthalmic drops

**[Ceiling of marks: 30]**

**Section C (Essay)**

**(Answer any one. Each question carries 10 marks)**

20. Explain the Factors affecting modes of drug administration, absorption, metabolism and elimination
21. Discuss the characteristics of different Sterilization methods

**[1 X 10 = 10]**

**SIXTH SEMESTER BSc.DEGREE EXAMINATION**  
**CBCSSUG – CHEMISTRY**  
**ICH6B05(E2) - Core Course XIII**  
**INTRODUCTION TO CHEMINFORMATICS**

**Time: 2 Hrs**

**Max Marks: 60**

**Section A (Short answers)**

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

22. Comment about the history of cheminformatics
23. What is meant by SMILES coding
24. Explain the Matrix Representations
25. What are important Data Models
26. What is the principle of lipophilicity of drugs?
27. What is meant by Data Security.
28. Comment about Database Concepts
29. What is the CAS Registry. Comment.
30. What are the major Reaction Databases
31. Mention the methods of Searching Chemical Structure
32. What is meant by virtual screening
33. What is meant by docking ?

**[Ceiling of marks: 20]**

**Section B (Paragraph)**

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

34. Explain the characteristics of any two chemical data bases
35. Describe the Structure of Molfiles and Sdfiles
36. Explain the Basics of Computation of Physical and Chemical Data
37. What is the principle of Linear Free Energy Relationship
38. Comment about the Literature Databases
39. Describe the Protein -Ligand Docking
40. Illustrate the Prediction of ADMET Properties

**[Ceiling of marks: 30]**

**Section C (Essay)**

**(Answer any one. Each question carries 10 marks)**

41. What is the Role of computers in Chemical Research ? Explain
42. Discuss the Quantitative Structure- Property Relations with special reference to drug molecules

**[1 X 10 = 10]**



**SIXTH SEMESTER BSc.DEGREE EXAMINATION**  
**CBCSSUG – CHEMISTRY**  
**ICH6B05(E3) - Core Course XIII**  
**ANALYTICAL METHODS IN CHEMISTRY**

**Time: 2 Hrs**

**Max Marks: 60**

**Section A (Short answers)**

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

43. What is the principle of recrystallisation ?
44. What are the important purification methods ?
45. Explain the principle of dilatometry
46. What is electrogravimetry ?
47. What is the principle of Coulometry ?
48. Name any four opto-analytical methods
49. Comment about the salinity of water
50. What is the principle of turbidimetry ?
51. What are the important Chromatographic methods ?
52. Mention the uses of Coulometry
53. What are the advantages of Conductometric titrations ?
54. What are the merits of TLC

**[Ceiling of marks: 20]**

**Section B (Paragraph)**

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

55. Explain the methodology of Soxhlet extraction
56. Describe the principle of paper chromatography
57. Explain the technique Atomic adsorption spectrometry.
58. What is the principle of Refractometry ? Explain.
59. Comment about the Water quality standards.
60. How will you determine the following : Concentration of nitrogen, phosphorus and chlorine of water.
61. What is the principle of reverse osmosis

**[Ceiling of marks: 30]**

**Section C (Essay)**

**(Answer any one. Each question carries 10 marks)**

62. Explain the principles of Fractional distillation, Steam distillation.
63. Discuss the Principle, methodology, characteristics and applications of TG and DTA.

**[1 X 10 = 10]**

**SIXTH SEMESTER B. Sc. DEGREE EXAMINATION**  
**CBCSSUG - CHEMISTRY**  
**ICH6B06(P) - Core Course XIV**  
**INDUSTRIAL CHEMISTRY PRACTICALS-I**

**Time: 3 Hours**

**Maximum marks: 80**

**Section A**

A. Write in the first ten minutes the principle and procedure for the question marked in Section B (4 + 4 Marks)

**Section B**

B. Conduct the experiment for the question marked below and records the data and results neatly and systematically. (56 Marks)

1. Determine the cryoscopic constant ( $K_f$ ) of the given solid solvent 1A---. Solute 1B---- of molecular mass----- is given. Conduct a duplicate experiment. Draw cooling curves for the solvent and the two trials. Report two  $K_f$  values. Weight of pure solvent given is ----- g.
2. Determine the molecular mass (M) of the given solute 2B-- by Rast method.  $K_f$  of the solvent 2A— is------. Conduct a duplicate experiment. Draw cooling curves for the solvent and the two trials. Report two M values. Weight of pure solvent given is ----- g.
3. Determine the transition temperature constant ( $K_t$ ) of crystalline 3A----. Solute 3B-- of molecular mass----- is given. Draw cooling curves for the solvent and the two trials. Report two  $K_t$  values. Weight of pure solvent is given is ----- g.
4. Determine the molecular mass (M) of the given solute 4B-- by measuring the depression in transition temperature of the solvent 4A---. Transition temperature constant ( $K_t$ ) of crystalline 4A --- is------. Draw cooling curves for the solvent and two trials. Report two M values. Weight of pure solvent given is ----- g.
5. Determine the composition of the given binary mixture of 5A----- & 5B----- viscometrically using at least five mixtures of known composition.
6. Determine the miscibility temperatures of at least five mixtures of standard aqueous solutions of sodium chloride and phenol & determine the concentration of the given sodium chloride solution 6A----- graphically.
7. Determine the composition of the given mixture 7A--- of glycerol and water by refractometric method, using five standard mixtures of the two components.
8. By potentiometric titration, standardize the given HCl solution 8A--- with the given standard KOH solution of normality -----.
9. By conductometric titration, standardize the given HCl solution 9A---- with the given standard KOH solution of normality -----.

**Section C**

Viva-Voce

(8 marks)

Record

(8 marks)

**SIXTH SEMESTER B. Sc. DEGREE EXAMINATION**  
**CBCSSUG - CHEMISTRY**  
**ICH6B07(P) - Core Course XV**  
**ORGANIC CHEMISTRY PRACTICALS**

**Time: 3 Hours**

**Maximum marks: 80**

**Section A**

**Answer the following questions in 10 minutes**

1. The formula of Prussian blue is -----
2. When cinnamic acid is treated with bromine water the compound formed is -----
3. When naphthalene in benzene is treated with picric acid in benzene, the compound formed has the structural formula -----.
4. When acetophenone is treated with Borsche's reagent, the compound formed is ----.
5. Conversion of aniline into tribromoaniline is a/an ----- reaction.
6. Diazotisation of sulphanilic acid followed by coupling with N,N-dimethyl aniline yield -  
---
7. The structural formula of the compound formed by the acetylation of salicylic acid is ----
8. The electrophile during nitration is ----- (1x8 = 8 Marks)

**Section B**

**Answer the following question in 10 minutes**

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

**Section C**

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

**Section D**

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

**SIXTH SEMESTER B. Sc. DEGREE EXAMINATION**  
**CBCSSUG - CHEMISTRY**  
**ICH6B08(P) - Core Course XVI**  
**INDUSTRIAL CHEMISTRY PRACTCAL - II**

**Time: 3 Hours**

**Maximum marks: 80**

**Section A**

**Answer the following question in 15 minutes**

1. Write a brief outline of the method used for the colorimetric estimation of chromium in the whole of the given solution of  $K_2Cr_2O_7$ . (4 Marks)
2. Write a brief outline of the method used for the gravimetric estimation of nickel in the whole of the given solution of nickel chloride. (8 Marks)

**Section B**

3. Estimate gravimetrically the mass of barium present in the whole of the given solution of barium chloride. (37 Marks)

**Section C**

- Viva-Voce based on colorimetry and gravimetry (8 marks)  
Record (8 marks)

**Section D**

- Report of industrial visit (8 marks)  
Viva-Voce based on industrial visit (7 marks)

**SIXTH SEMESTER B. Sc. DEGREE EXAMINATION**  
**CBCSSUG - CHEMISTRY**  
**ICH6B09(P) - Core Course XVII**  
**INORGANIC CHEMISTRY PRACTICALS - II**

**Time: 3 Hours**

**Maximum marks: 80**

**Section A**

**Answer the following questions in 10 minutes**

1. The reddish brown precipitate in the confirmatory test for  $\text{Cu}^{2+}$  ion is due to the formation of -----
2. The yellow precipitate formed in the identification test for phosphate, on adding conc.  $\text{HNO}_3$  and ammonium molybdate, has the formula -----
3. The compound responsible for the green edged flame in the ethyl borate test is -----
4. The chemical compound formed in the ash test for zinc is ----- (4x1 = 4 Marks)

**Section B**

5. Analyse qualitatively the given mixture by semimicro method to identify and confirm the two cations and two anions present in it. Record the data systematically including chemistry of identification tests and confirmation tests  
(60 Marks)

**Section C**

Viva-Voce

(8 marks)

Record

(8 marks)

**SYLLABUS**

**FOR**

**OPEN COURSES**

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

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

## SEMESTER V

Course Code: CHE5D01

### Open Course 1: ENVIRONMENTAL CHEMISTRY

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

#### Course outcomes

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

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

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

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

CO 4: Describe water quality parameters.

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

CO 6: Study various pollution control measures.

CO 7: Understand the basics of green chemistry.

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

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

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

#### References

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

#### Module II: Air Pollution (8 hrs)

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

#### References

1. S. K. Banergy, *Environmental Chemistry*, 2<sup>nd</sup> 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*, 8<sup>th</sup> Edn., CRC Press, Florida, 2004.
4. A. K. Ahluwalia, *Environmental Chemistry*, The Energy and Resources Institute, 2017.



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

### **Module III: Water Pollution (10 hrs)**

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

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

Types of water pollutants: Biological agents, physical agents and chemical agents – Eutrophication - biomagnification and bioaccumulation.

Water quality parameters: DO, BOD, COD, alkalinity, hardness, chloride, fluoride and nitrate. Toxic metals in water and their effects: Cadmium, lead and mercury – Minamata disaster (a brief study), itai-itai disease, oil pollution in water. International standards for drinking water.

#### **References**

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

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

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

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

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

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

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

#### **References**

1. S. E. Manahan, *Environmental Chemistry*, 8<sup>th</sup> Edn., CRC Press, Florida, 2004.
2. A. K. Ahluwalia, *Environmental Chemistry*, The Energy and Resources Institute, 2017.
3. A. K. De, *Environmental Chemistry*, 6<sup>th</sup> Edn., New Age International.

- Balram Pani, *Textbook of Environmental Chemistry*, I. K. International Pvt Ltd, 2010.
- Anindita Basak, *Environmental Studies*, Pearson Education India, 2009.
- 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**

- N. P Cheremisinoff, *Handbook of Air Pollution Prevention and Control*, 2002.
- M. Senapati, *Advanced Engineering Chemistry*, 2006.
- K. C. Schiffner, *Air Pollution Control Equipment Selection Guide*, CRC Press, 2013.
- 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**

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

**Scheme of Examinations:**

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

**Section A**

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

**Section B**

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

**Section C**

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

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

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

## SEMESTER V

Course Code: CHE5D02

### Open Course 2: CHEMISTRY IN DAILY LIFE

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

#### Course outcomes

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

CO 1: Understand the basics of polymer chemistry.

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

CO 3: Describe food additives and food habits.

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

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

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

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

#### Module I: Polymers (8 hrs)

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

#### References

1. B. K. Sharma, *Industrial Chemistry*, 11<sup>th</sup> Edn., Goel publishing House, Meerut, 2000.
2. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2<sup>nd</sup> 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*, 2<sup>nd</sup> Revised Edn., Anmol Publications Private Ltd., New Delhi, 1989.
6. Catia Bastioli, *Handbook of Biodegradable Polymers*, Smithers Rapra Publishing, 2005.

#### Module II: Chemistry in Biological Systems (8 hrs)

Vitamins: Name, source, function and deficiency diseases. Enzymes - Classifications, characteristics, role, examples. Hormones - Sex hormones - Androgens, oestrogens, progesterone, example, function. Cortical hormones - a few examples with function. Nucleic acid - RNA, DNA: Introduction - role in life process (No structure or chemical reactions needed).

#### References

1. M. V. Kulkarni, *Biochemistry*, Pragati Books Pvt. Ltd., 2008.

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

### **Module IV: Agriculture (4 hrs)**

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

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

### **References**

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

Press, USA, 2012.

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

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

### **Module V: Cleansing Agents and Cosmetics (6 hrs)**

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

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

### **References**

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

2. M. S. R. Winter, *A Consumer's Dictionary of Cosmetic Ingredients*, 7<sup>th</sup> 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*, 3<sup>rd</sup> 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*, 4<sup>th</sup> Edn., Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 2002.
2. B. K. Sharma, *Industrial Chemistry*, Krishna Prakashan Media, 1991.

### Scheme of Examinations:

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

#### Section A

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

#### Section B

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

#### Section C

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

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

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

## SEMESTER V

Course Code: CHE5D03

### Open Course 3: FOOD SCIENCE AND MEDICINAL CHEMISTRY

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

#### Course outcomes

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

CO 1: Understand food adulteration and preservation methods.

CO 2: Understand food additives.

CO 3: Compare modern food with natural food.

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

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

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

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

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

CO 9: Illustrate first aids and the safety steps to be taken for common illnesses.

#### Module I: Food Adulteration and Preservation (6 hrs)

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

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

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

#### References

1. B. Siva Sankar, *Food Processing and Preservation*, Prentice–Hall of India Pvt. Ltd., New Delhi, 2002.
2. Shyam Narayan Jha, *Rapid Detection of Food Adulterants and Contaminants: Theory and Practice*, Academic Press, 2015.
3. *Encyclopedia of Food Chemistry*, Elsevier, 2018.
4. B. Srilakshmi, *Food Science*, 5<sup>th</sup> 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*, 1<sup>st</sup> Edn., CBS Publishers & Distributors, New Delhi, 2004.
3. B. A. Fox, A. G. Cameron, E. Arnold, *Food Science, Nutrition and Health*, 6<sup>th</sup> 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*, 5<sup>th</sup> Edn., New Age Publishers, New Delhi, 2010.
3. Lillian Hoagland Meyer, *Food Chemistry*, 1<sup>st</sup> Edn., CBS Publishers & Distributors, New Delhi, 2004.
4. B. A. Fox, A. G. Cameron, E. Arnold, *Food Science, Nutrition and Health*, 6<sup>th</sup> 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*, 2<sup>nd</sup> Edn., Tata McGraw Hill Publishing Co., New Delhi, 2007.
2. M. V. Kulkarni, *Biochemistry*, Pragati Books Pvt. Ltd., 2008.
3. U. Satyanarayana, U. Chakrapani, *Biochemistry*, Elsevier Health Sciences, 2014.



4. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2<sup>nd</sup> 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*, 12<sup>th</sup> 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*, 2<sup>nd</sup> Edn., Tata McGraw Hill Publishing Co., New Delhi, 2007.
4. Rasheeduz Zafar, *Medicinal Plants of India*, 1<sup>st</sup> Edn., CBS Publishers & Distributors Pvt. Ltd., New Delhi, 2009.
5. <https://en.wikipedia.org>.

### **Module VI: Medicinal Chemistry – II (12 hrs)**

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

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

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

## References

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

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

### Section C

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

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

Mark Distribution	
Module I	13 Marks
Module II	16 Marks
Module III	6 Marks
Module IV	8 Marks
Module V	8 Marks
Module VI	18 Marks
Module VII	10 Marks

**SCHEME OF EVALUATION**

**FOR**

**OPEN COURSES**

## **OPEN COURSE: EVALUATION SCHEME**

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

### **1. INTERNAL EVALUATION**

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

**Table 1: Components of Evaluation**

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

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

<i>% of attendance</i>	<i>Marks</i>
85% and above	3
75 - <85%	2
50 - <75%	1

**Table 3: Pattern of Test Papers**

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

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

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

**Time: 2 Hours**

**Maximum marks: 60**

**Section A (Short answers)**

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

1. Explain why troposphere is a turbulent region.
2. Discuss about the different regions of atmosphere.
3. What are the main sources of particulates?
4. What is meant by photochemical smog?
5. Write a note on alternate refrigerants.
6. What is eutrophication?
7. How can the marine water be polluted?
8. Define thermal pollution.
9. How can we classify the wastes on the basis of their biodegradability?
10. Write a short note on biomedical waste.
11. Define green chemistry.
12. Discuss the working of wet scrubber.

**[Ceiling of marks: 20]**

**Section B (Paragraph)**

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

13. Write the causes and symptoms of any two air-borne diseases.
14. Describe any three water quality parameters.
15. What are the main sources of water pollution
16. Write a note on solid waste management.
17. What is Green house effect? Discuss its causes and consequences.
18. Discuss the depletion of ozone layer.
19. Discuss the basic principles of green chemistry.

**[Ceiling of marks: 30]**

**Section C (Essay)**

**(Answer any one. Each question carries 10 marks)**

20. Discuss the air pollution control by Cottrell electrostatic precipitator and extraction ventilator.
21. (a) Name any two toxic metals in water and explain their harmful effects. (b) What is radioactive pollution? How is it controlled?

**[1 X 10 = 10]**

**FIFTH SEMESTER B. Sc. DEGREE EXAMINATION**  
**CBCSSUG - CHEMISTRY**  
**CHE5D02 - Open Course 2**  
**CHEMISTRY IN DAILY LIFE**

**Time: 2 Hours**

**Maximum marks: 60**

**Section A (Short answers)**

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

1. Explain vulcanization and its advantages.
2. Describe the applications of bakelite?
3. Describe the main functions of vitamin C.
4. Explain the main characteristics of enzymes.
5. What are the common adulterants in tea?
6. Which are the essential nutrients for plants?
7. Define biofertilizers.
8. Discuss the TFM value in soap.
9. Explain the terms pharmacology and pharmacognosy.
10. What is meant by antipyretics? Give one example.
11. How coal is classified based on carbon content?
12. Define the term octane number.

**[Ceiling of marks: 20]**

**Section B (Paragraph)**

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

13. Explain the classification of polymers on the basis of molecular forces.
14. Describe any three water quality parameters.
15. Write a note on the importance of DNA.
16. Give a short note on classification of dyes based on constitution and their applications.
17. Briefly explain the pesticide pollution and its impact on environment.
18. Describe the cleaning action of soaps and detergents.
19. Discuss the health effects of fast food.

**[Ceiling of marks: 30]**

**Section C (Essay)**

**(Answer any one. Each question carries 10 marks)**

20. (a) What are shampoos? How are they classified? Discuss their ingredients and functions. (b) What is radioactive pollution? How is it controlled?
21. (a) Write a note on pollution due to burning of fossil fuels. (b) Discuss the applications of solar energy and solar cells.

**[1 X 10 = 10]**

**FIFTH SEMESTER B. Sc. DEGREE EXAMINATION**  
**CBCSSUG - CHEMISTRY**  
**CHE5D02 - Open Course 3**  
**FOOD SCIENCE AND MEDICINAL CHEMISTRY**

**Time: 2 Hours**

**Maximum marks: 60**

**Section A (Short answers)**

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

1. What is the need for the preservation of food?
2. Which are the main materials used for packaging?
3. What are artificial sweeteners? Give an example.
4. Discuss about the artificial ripening of fruits and its health effects.
5. How can beverages be classified?
6. Define appetizers.
7. What is meant by DNA finger printing?
8. Give a note on blood transfusion.
9. Explain the terms pharmacology and pharmacognosy.
10. What are prescription and non-prescription drugs?
11. Define antacids with an example.
12. Describe the causes and symptoms of food poisoning.

**[Ceiling of marks: 20]**

**Section B (Paragraph)**

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

13. How can food be contaminated by toxic chemicals?
14. Describe the harmful effects of modern food habits.
15. Write a note on the importance of DNA.
16. Give the characteristics of enzymes. Discuss their classification.
17. Explain the source and medicinal uses of eucalyptus oil.
18. Explain the causes, symptoms and drugs used for the treatment of influenza, cholera, bronchial asthma and diabetes.
19. What are the first aids given to prevent bleeding?

**[Ceiling of marks: 30]**

**Section C (Essay)**

**(Answer any one. Each question carries 10 marks)**

20. Name any three Indian medicinal plants. List their major chemical constituents and medicinal uses.
21. Discuss (a) Medical applications of nanomaterials. (b) Applications of radioactive isotopes.

**[1 X 10 = 10]**