SYLLABUS
DIBRUGARH UNIVERSITY
FYUGP 2020

B.Sc. IN CHEMISTRY (NEP)

Approved in the BOS, Chemistry held on 30.05.2024

FOUR-YEARUNDERGRADUATE PROGRAMME (FYUGP) IN CHEMISTRY, DIBRUGARH UNIVERSITY

- **THE PREAMBLE**

Education aims to develop an individual into a human being through moral, spiritual, and cultural development. It also aims to the acquisition of knowledge, skills, and attitudes to adjust properly to one's environment. In a broader sense, it is an instrument to achieve larger societal goals. In addition to these, education has further responsibility of developing core competencies such as communication skills required to articulate thoughts and ideas effectively, using oral and written communication skills, and presenting information and explanations in a well-structured manner.

Change is the law of nature. With the continuously changing society, the nature and scope of education also change and widen. Since education plays a crucial role in the development of social issues all-around, must be up-to-date to address all these problems. Educators and educational practitioners should also change them accordingly.

The main purpose of the Undergraduate Programme in Chemistry is to familiarize students with basic-level to high-level Chemistry which connects the post-graduate program. Significant efforts are given to motivate students to do researchin Chemistry. Due importance is also given to the study of application-oriented topics which is very much relevant and useful to the present scenario.

INTRODUCTION

Undergraduate programmes were traditionally conceived as preparation for post-graduation. The rigidity in choosing subjects through fixed combinations had to be reconsidered. The aspects of all-round development of the students, skill acquisition outside chosen subjects and research were undermined but the National Education Policy-2020 (NEP-2020) has changed all of these in one stroke. The NEP- 2020 recognizes that higher education plays an extremely important role in promoting human as well as societal well-being and in developing India as envisioned in its Constitution. It states that quality higher education must aim to develop good, thoughtful, well-rounded, and creative individuals.

The curriculum at undergraduate and FYUGP therefore, has incorporated certain new components of learning to make it relevant to contemporary society and modern practices by integrating the humanities and arts with Science, Technology, Engineering and Mathematics (STEM). It is expected that it will show positive learning outcomes, including increased creativity and innovation, problem-solving abilities, teamwork, communication skills, more in-depth learning, and increases social and moral awareness besides increased employability.

The prominent features of the NEP framework are:

1. Flexibility in choosing subjects and even disciplines for the graduate programmes
2. Vertical and horizontal mobility across subjects throughout the programme
3. Multiple entry and exit points
4. Main-streaming of skill-based courses
5. Credit-based evaluation system
6. Integration of research into 4th year of the programme leading to an Honours degree.

The Bachelor of Science in Chemistry degree of Dibrugarh University adapted as per the recommendations of NEP 2020 will also be of either a three or four-year duration, with multiple exit options within the period with appropriate certification. After completion of one year a UG certificate, completion of two years a UG diploma, and after completion of three years, a Bachelor's degree in the programme will be provided to the students. The four-year undergraduate programme in chemistry will allow the student an opportunity to experience the full range of holistic and multidisciplinary education, along with the chosen Major and Minor choices of the students.

- **AIMS OF FOUR YEAR UNDER-GRADUATE PROGRAMME (FYUGP) IN CHEMISTRY:**

  The aims of the Four Year Under-Graduate Programme (FYUGP) in Chemistry are:

  1. To equip the students with the potential to contribute to academic and industrial environments.
  2. To impart knowledge in fundamental aspects of various branches of Chemistry.
  3. To apply the key concepts and standard methodologies to solve problems related to Chemistry.
  4. To prepare students for higher education and a career in Chemistry.

5. To develop laboratory skills, *viz*. proper handling of apparatus, chemicals, and experimental techniques.
6. To make students apply chemistry in their day-to-day life.
7. To create the studentsasresponsiblecitizens by creating environmental awareness.

GRADUATE ATTRIBUTES OF THE FYUGP IN CHEMISTRY

Graduate attributes in Chemistry include both Chemistry knowledge and responsibilities and qualities that Chemistry graduates should acquire and demonstrate. Graduate attributes of the FYUGP in Chemistry are:

Attribute 1: Strong grip on fundamental and practical Chemistry knowledge

Attribute 2: Creative and critical thinking, and problem-solving

Attribute 3: Interest in research-based problem

Attribute 4: Digital Fluency

Attribute 5: Teamwork and communication skills

Attribute 6: Professionalism and leadership readiness

Attribute 7: Social responsibility

Attribute 8: Appreciation and adherence to Ethical integrity

PROGRAMME LEARNING OUTCOMES

By the end of the programme an undergraduate student of Chemistry should be able to:

1. Understand the basic principles of various branches of Chemistry.
2. Demonstrate a range of practical skills to conduct and infer experiments independently and in groups.
3. Apply the key concepts and standard methodologies to solve problems related to Chemistry.
4. Apply methodologies to the solution of unfamiliar types of problems.
5. Exhibit skills leading to employability in Chemistry and allied industries.
6. Comprehend the fundamental aspects of research in Chemistry.
7. Possess the level of proficiency in the subject required for post-graduation as well as for pursuing research in Chemistry and related interdisciplinary subjects.
8. Demonstrate teaching competencies required for keeping oneself professionally engaged.

TEACHING LEARNING PROCESS

The programme allows using of varied pedagogical methods and techniques both within the classroom and in laboratories.

- Lecture
- Tutorial
- PowerPoint presentation
- Project Work/Dissertation
- Seminars/workshops/conferences
- IndustryVisits/Field Visits and Report

TEACHING LEARNING TOOLS

- White/Green/Black Board
- LCD projectors/Monitor
- Smart Board
- Model Demonstration
- Learning through lab experiments
- Industry and research visits

ASSESSMENT

- Home assignment
- Project Report
- Seminar Presentation
- Objective /MCQ test
- In semester examinations (Theory and Practical)
- End Semester examinations (Theory and Practical)
- Viva-voce

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FYUGP Structure as per UGC Credit Framework of December, 2022

Year	Semester	Course	Title of the Course	Paper Code	Total Credit
Year 01	1st Semester	C - 01	Chemistry C1: Inorganic + Physical + Organic	CHMC1	**4**
		Minor - 01	Fundamentals of Chemistry-1	MINCHM1	**4**
		GEC - 01	Chemistry in Daily Life- 1	GECCHM1	**3**
		AEC - 01	**Modern Indian Language**	*	**4**
		SEC - 01	Basic Analytical Chemistry	SECCHM1	**3**
		VAC - 01	**Understanding India**	*	**2**
	Total				**20**
	2nd Semester	C - 02	Chemistry C2: Inorganic + Physical + Organic	CHMC2	**4**
		Minor - 02	Fundamentals of Chemistry-2	MINCHM2	**4**
		GEC - 02	Chemistry in Daily Life- 2	GECCHM2	**3**
		AEC - 02	**English Language and Communication Skills**	*	**4**
		SEC - 02	Basic Analytical Chemistry	SECCHM2	**3**
		VAC 02	**Environmental Science**	*	**2**
		Total			**20**
Grand Total(Semester I and II)					**40**

The students on exit shall be awarded an ***Undergraduate Certificate*** (in the Field of Study/Discipline) after securing the requisite ***40 Credits in Semesters 1 and 2*** provided they secure ***4 credits in work based vocational courses*** offered ***during the summer term or internship / Apprenticeship in addition to 6 credits from skill based courses earned during 1st and 2nd Semester***

Year	Semester	Course	Title of the Course	Paper Code	Total Credit
Year 02	3rdSemester	C - 03	Chemistry C3: Inorganic + Physical + Organic	CHMC3	4
		C - 04	Chemistry C4: Inorganic + Physical + Organic	CHMC4	4
		Minor - 03	Fundamentals of Chemistry-3	MINCHM3	4
		GEC - 03	Chemistry in Daily Life- 3	GECCHM3	3
		SEC - 03	Inorganic Materials of Industrial Importance		3
		VAC - 03	Digital Fluency		2
	Total				**20**
	4thSemester	C - 05	Chemistry C5: Inorganic	CHMC5	4
		C - 06	Chemistry C6: Physical	CHMC6	4
		C - 07	Chemistry C7: Organic	CHMC7	4
		C - 08	Chemistry C8: Symmetry & Quantum Chemistry-I	CHMC8	4
		Minor - 04	Fundamentals of Chemistry-4	MINCHM4	4
		Total	**20**		**20**
	Grand Total(Semester I, II, III and IV)				**80**

The students on exit shall be awarded ***Undergraduate Diploma*** (in the Field of Study/Discipline) after securing the requisite ***80 Credits on completion of Semester IV*** provided ***they secure additional 4 credit in skill based vocational courses*** offered ***during First Year or Second Year summer term***

Year	Semester	Course	Title of the Course	Paper Code	Total Credit
Year 03	5thSemester	C - 09	Chemistry C9: Inorganic	CHMC9	4
		C - 10	Chemistry C10: Physical	CHMC10	4
		C - 11	Chemistry C11: Organic	CHMC11	4
		Minor -05	Fundamentals of Chemistry-5	MINCHM5	4
		I/CE	Internship(I)(2)+Community Engagement(CE) (2) Or I(4)/CE(4)	(I/CE)CHM	4
		Total	**20**		**20**
	6thSemester	C - 12	Chemistry C12: Inorganic	CHMC12	4
		C - 13	Chemistry C13: Physical	CHMC13	4
		C - 14	Chemistry C14: Organic	CHMC14	4
		C- 15	Chemistry C15: Spectroscopy	CHMC15	4
		Minor -06	Fundamentals of Chemistry-6	MINCHM6	4
		Total	**20**		**20**
Grand Total ((Semester I, II, III, IV, V and VI)					**120**
The students on exit shall be awarded ***Bachelor's Degree (in the Field of Study/Discipline) (3 years)*** after securing the requisite ***120 Credits on completion of Semester 6***					

Year	Semester	Course	Title of the Course	Paper Code	Total Credit
Year 04	7thSemester	C - 16	Chemistry C16: Inorganic Spectroscopy and photochemistry	CHMC16	4
		C - 17	Chemistry C17: Physical	CHMC17	4
		C - 18	Chemistry C18: Organic	CHMC18	4
		Minor -07	Fundamentals of Chemistry-7	MINCHM7	4
		RM	Research Ethics and Methodology	CHMRM	4
		Total	**207**		**20**
	8thSemester	C - 19	Chemistry C19: Advanced (Inorganic + Physical)	CHMC19	4
		C - 20	Chemistry C20: Advanced (Organic + Group Theory)	CHMC20	4
		Minor -08	Fundamentals of Chemistry-8	MINCHM4	4
		Project (8 credits)/ 2 DSEs of 4 credits each in lieu of Project			8
		Total	**20**		**20**
Grand Total ((Semester I, II, III, IV, V and VI)					**160**
The students on exit shall be awarded ***Bachelor's Degree with Honours (in the Field of Study/Discipline) OR (Honours with Research) (4 years)*** after securing the requisite ***160 Credits on completion of Semester 8***					

Abbreviations Used:

- **C = Core/Major**

- **GEC = Generic Elective Course / Multi Disciplinary Course**
- **AEC = Ability Enhancement Course**
- **SEC = Skill Enhancement Course**
- **VAC = Value Added Course**
- **CHM = Chemistry**
- **MIN = Minor**

Table 1 : Credit Distribution matrix of FYUGP (Single Major)										
Year	**Semester**	**Core**	**Minor**	**GEC**	**AEC**	**SEC**	**Internship/ Community Engagement/ Project**	**VAC**	**Research/ Dissertation/**	**Total**
1	I	4	4	3	4	3		2		20
	II	4	4	3	4	3		2		20
UG Certificate										**40**
2	III	4+4	4	3		3		2		20
	IV	4+4+4+4	4							20
UG Diploma		**32**	**16**	**09**	**08**	**09**		**06**		**80**
3	V	4+4+4	4				2 +2 (I + CE) OR 4 (I) / 4 (CE)			20
	VI	4+4+4+4	4							20
UG Degree		**60**	**24**	**-**	**-**	**-**	**-**	**-**	**-**	**120**
4	VII	4+4+4	4						4 (RM)	20
	VIII	4+4	4						8 (D)/ 4+4 (DSE)	20
Honours Degree		**80**	**32**	**-**	**-**	**-**	**-**	**-**	**12**	**160**
5	IX	4+4+4	4						4(P)/ 4 (DSE)	20
	X	4+4	4						8/4+4 (DSE)	20
PG Degree		**100**	**40**	**-**	**-**	**-**	**-**	**-**	**24**	**200**

FYUGP

DETAILED SYLLABUS OF 1st SEMESTER

Title of the Course : Chemistry C1: Inorganic + Physical + Organic
Course Code : C - 01
Nature of the Course : CHEMISTRY MAJOR
Total Credits : 4
Distribution of Marks : 60 (End Sem) + 40 (In-Sem)

COURSE OBJECTIVES:

- To give idea about the basic knowledge of chemistry in different field of specializations (viz. inorganic, organic and physical chemistry)

UNITS	CONTENTS	L	T	P	Total Hours
I	**Periodic properties:** Effective nuclear charge (screening constant – Slater's rule only), ionic and covalent radii, ionization potential, electron affinity and electro negativity (Pauling, Mulliken's and Allred-Rochow Scales).	**06**	**0**	**-**	**06**
	Bonding and structure: Ionic Bonding: Energy consideration in ionic bonding, lattice Energy. Born - Haber cycle and its application, polarizing power and polarizability. Fajan's rule, Bond moment, dipole moment and percentage ionic character. Hydrogen Bonding. Covalent Bonding: VB Approach-Concept of hybridization (sp, sp^2, sp^3, sp^3d, sp^3d^2 and dsp^2). VSEPR Theory. Resonance and Resonance energy: Study of some inorganic and organic compounds (O_3, NO_3^- , CO_3^{2-}, SO_4^{2-}, $RCOO^-$, C_6 H_6). Co-ordinate or Dative Bond. Bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combination of atomic orbitals non-bonding combination of orbitals, MO treatment of homonuclear diatomic molecules and heteronucear diatomic molecules such as CO, NO and NO^+	**08**	**0**	**-**	**08**
II	**Gas :** Derivation of kinetic gas equation, Maxwell distribution of molecular speed, different types of speeds, collision properties, Mean free path, determination of collision diameter, transport phenomenon in gases, coefficient of viscosity, law of equipartition of energy, degrees of freedom and average energy of a molecule, molecular basis of heat capacity, barometric formula and its uses for determination of Avogadro number. Deviation from	**09**	**0**	**-**	**09**

	ideal behavior, van der Waals and Dieterici's, Virialequation of state, Boyle'stemperature, Critical constants, reduced equation of state, co-efficient of compressibility and thermal expansion. **Liquid:** Qualitative treatment of structure of liquids, physical properties of liquids, vapour pressure, surface tension-Explanation of cleansing action of detergents,parachor-determination and application, viscosity, Newtonian and non-Newtonian liquid, liquid crystals.	**06**	**0**		**06**
III	**Basics of Organic Chemistry:** Organic Compounds: classification and Nomenclature. Hybridization: Shape of molecules, Influence of hybridization on bond properties. Electronic displacements: Inductive, Electromeric, Resonance, Mesomeric effects and Hyper conjugation and their applications. Dipole moment. Organic acids and bases: Their relative strength,Homolytic and Heterolytic fission, Electrophiles and Nucleophiles: Nucleophilicity and basicity. Reactive intermediates: Carbocations, carbanions, free radicals, carbenes, nitrenes, Types, Shape and their relative Stability. Energy profile diagrams of one step, two steps and three steps reactions, Rate limiting steps. Activation Energy. Kinetically and thermodynamically controlled reactions.	**08**	**0**	**-**	**08**
	Stereochemistry: Elements of symmetry and their application in simple organic molecules. Definition and classification of stereoisomerism, Representation of organic molecules in three & two dimension: Fischer Projection, Newman projection, Saw horse and flying wedge projection formula and their interconversions. **Optical isomerism**: Concepts of asymmetry, dissymmetry, optical activity, Specific rotation, Chirality, enantiomers, Diastereomers, racemic mixture, racemization and Resolution, Threo and Erythro forms, Meso structures &Epimers. Relative and absolute configuration: D/L and R/S designations. Walden inversion. **Geometrical Isomerism**: Restricted rotation about C=C bonds, physical and chemical properties of diasteroisomers, determination of configuration of geometrical isomers: cis-trans isomerism, syn-anti and E/Z notation with CIP rules. Geometrical isomerism in oximes and alicyclic compounds.	**08**	**0**	**-**	**08**

IV	**EXPERIMENTAL WORK** Oxidation-Reduction Titrimetry (any one) (i) Estimation of Fe(II) or oxalic acid using standardized KMnO4 solution. (ii) Estimation of Fe(II) with K2Cr2O7 using diphenylamine as internal indicator.	**-**	**0**	**30**	**30**
	Total	**45**	**0**	**30**	**75**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

CO1: Develop a solid understanding of fundamental concepts in periodic properties, bonding, gas and liquid properties, organic chemistry, and stereochemistry.
CO2: Apply theoretical knowledge to solve problems and predict chemical behavior.
CO3: Perform experimental techniques proficiently, analyze data, and draw accurate conclusions.
CO4: Enhance critical thinking, analytical skills, and the ability to communicate scientific information effectively.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual						
Conceptual		CO1	CO2	CO3		
Procedural					CO4	
Metacognitive						

SUGGESTED READINGS:

1. Selected Topics in Inorganic Chemistry--Wahid U. Malik, G. D. Tuli and R. D. Madan. (S. Chand & Co. Ltd.)
2. Advanced Inorganic Chemistry – Satyaprakash, Basu, Tuli
3. Inorganic Chemistry – Puri, Sharma and Kalia
4. Inorganic Chemistry – J.D. Lee
5. General and Inorganic Chemistry (Part-I & II) R. Sarkar
6. Basic Inorganic chemistry – Cotton and Wilkinson
7. Inorganic Chemistry – J.E.Huheey
8. Physical Chemistry-- Atkins, P. W. & Paula, J.

9. A Text Book of Physical Chemistry – Negi& S.C. Anand, Wiley Eastern
10. Physical Chemistry, Castellan G. W., Narosa Publishing
11. Principles of Physical Chemistry, Puri, Sharma, Pathania, ShobanLal, (S. Chand & Co.)
12. Physical Chemistry – P.W. Atkins, Oxford University Press
13. Physical Chemistry – Barrow G.M., Tata-McGraw Hill
14. Advanced Physical Chemistry – J.N. Gurta& H. Snehi, PragatiPrakashan
15. Physical Chemistry – D.S. Pahari
16. Organic Chemistry – B.S. Bahl and A. Bahl (Vol. I & II)
17. Organic Chemistry – M.K. Jain, S.Chand& Co.
18. A Text Book of Organic Chemistry (Vol. I & II) – B.K. Sharma, G.P. Pokhriji and S.K. Sharma, (S. Chand & Co.)
19. Organic Chemistry – I.L. Finar, Vol. I & II, ELBS
20. Organic Chemistry, R.I. Morrison & R.N. Boyd, S.K. Bhattacharjee
21. Organic Chemistry – Vol. I & II, Mukherjee and Kapoor
22. Advanced General Organic Chemistry (Part I and Part II) - S. C.Ghosh
23. Organic Chemistry (Oxford) - Clayden,Warren, Greeves and Wothers.
24. Organic Reactions and their Mechanisms (New Age International Privatr Limited) - P.S.Kalsi.

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DETAILED SYLLABUS OF 1st SEMESTER

Title of the Course	**:**	**Fundamentals of Chemistry-1**
Course Code	**:**	**MINOR-01**
Nature of the Course	**:**	**CHEMISTRY MINOR COURSE-1**
Total Credits	**:**	**4**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

COURSE OBJECTIVES:

- To develop the basic knowledge of chemistry in relation to atomic structure, bonding. To emphasize on different states of matter & their mechanical treatment; to develop preliminary knowledge in basic organic chemistry, hydrocarbons, stereochemistry & conformational analysis etc

UNITS	CONTENTS	L	T	P	Total Hours
I	**Atomic Structure:** (Recapitulation of Bohr's Theory, de Broglie, Theory, Heisenberg Uncertainty Principle) Time independent Schrödinger wave equation (H=E). Significance of Ψ and Ψ^2 Schrodinger equation for Hydrogen atom (qualitative treatment only). Quantum numbers, Electronic configuration of elements based upon electronic configuration in the periodic table, periodic properties-effective nuclear charge, ionization energy, electron affinity, electronegativity (Pauling, Mulliken's and Allred-Rochow scales). Redox potential.	**09**	**0**	**-**	**09**
	Chemical Bonding and Molecular Structure-1: Ionic Bonding: Energy consideration in ionic bonding, Lattice Energy and Solvation Energy and their importance in the context of Stability and Solubility of ionic compounds. Polarizing power and polarizability. Fajan's rule, dipole moment and percentage ionic character. Hydrogen Bonding.	**06**	**0**	**-**	**06**
II	**Kinetic Theory of gases:** Derivation of Kinetic gas equation, Types of molecular velocities, deduction of simple problems on – root mean square speed, most probable speed, collision frequency, collision diameter, mean free path, heat capacity of gases, Deviation from ideal behavior, van der Waals equation, van der Waals constant, critical state of gas, critical constants, continuity of states, law of corresponding states, degree of freedom, law of equipartition of energy	**11**	**0**	**-**	**11**

	(derivation not required), viscosity of gases and effect of temperature and pressure on coefficient of viscosity). **Liquid state**: Qualitative treatment of the structure of liquids, Physical properties of liquids, vapour pressure. Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald Viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment) Parachor - determination and application.	**04**	**0**		**04**
III	**Introduction to Organic Chemistry:** a) Importance of Organic Chemistry & organic systems to human beings & society. Electronic displacements: Inductive effect, Electrometric effect, Resonance and hyperconjugation. b) Mechanism of organic reactions: Cleavage of Bonds- Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules- Nucleophiles and electrophiles. Reactive Intermediates- Carbocations, carbanions, free radicals, carbenes & nitrenes. Strength of organic acids and bases: comparative.	**08**	**0**	**-**	**08**
	Aliphatic Hydrocarbons-1: ***Alkanes*** (upto 5 carbons) Preparation:- Catalytic hydrogenation, Wurtz reaction, Kolbe's Synthesis, from Grignard reagent. Corey-House Synthesis. Reactions: Free radial Substitution: Halogenations.	**07**	**0**	**-**	**07**
IV	**Experimental Work:** **Inorganic Qualitative Analysis** • Analysis of samples containing 4 radicals including interferring radicals, phosphate, borate and fluoride.	**0**	**0**	**30**	**30**
	Total	**45**	**0**	**30**	**75**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

At the end of this course, students will be able to-

CO1: Analyze and apply fundamental principles of atomic structure and chemical bonding to predict the behavior of elements and compounds.

CO2: Apply methods and procedures to solve the Schrödinger wave equation, determine electronic configurations, and analyze periodic properties.

CO3: Explain Schrödinger's wave equation, periodic properties, kinetic gas equation, and the significance of electronic displacements and mechanisms in organic reactions.

CO4: Use principles of ionic bonding, kinetic theory, and organic reaction mechanisms to solve related problems and predict outcomes in practical scenarios.

CO5: Differentiate between various types of molecular interactions, such as ionic bonds, hydrogen bonds, and van der Waals forces, and interpret the behavior of gases and liquids under different conditions.

CO6: Assess the stability and solubility of ionic compounds, the effects of temperature and pressure on physical properties of liquids, and the strength of organic acids and bases.

CO7: Conduct qualitative inorganic analysis, prepare aliphatic hydrocarbons, and utilize laboratory techniques to measure physical properties of liquids and identify various radicals in samples.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual			CO6			
Conceptual		CO3, CO4, CO5		CO1		
Procedural			CO2		CO7	
Metacognitive						

SUGGESTED READINGS:

1. Selected Topics in Inorganic Chemistry--Wahid U. Malik, G. D. Tuli and R. D. Madan. (S. Chand & Co. Ltd.)
2. Inorganic Chemistry – Puri, Sharma and Kalia
3. General and Inorganic Chemistry (Part-I & II) R. Sarkar
4. A Text Book of Physical Chemistry – Negi& S.C. Anand, Wiley Eastern
5. Principles of Physical Chemistry, Puri, Sharma, Pathania, ShobanLal, (S. Chand & Co.)
6. Organic Chemistry – B.S. Bahl and A. Bahl (Vol. I & II)
7. Organic Chemistry – M.K. Jain, S.Chand& Co.
8. A Text Book of Organic Chemistry (Vol. I & II) – B.K. Sharma, G.P. Pokhriji and S.K. Sharma, (S. Chand & Co.)

FYUGP

DETAILED SYLLABUS OF 1st SEMESTER

Title of the Course : Chemistry in Daily Life- 1
Course Code : GEC-01
Nature of the Course : CHEMISTRY GEC-01
Total Credits : 3
Distribution of Marks : 60 (End Sem) + 40 (In-Sem)

COURSE OBJECTIVES:

- The course introduces the students to the fascinating chemistry of some food products. Keeping the importance of food industry in mind this course is aimed to introduce food packaging, processing and preservation.

UNITS	CONTENTS	L	T	P	Total Hours
I	**Dairy Products:** Composition of milk and milk product. Principles of dairy safety; Milk processing.Qualitative analysis of fat content, minerals in milk and butter. Qualitative analysis of caffeine in coffee and tea, detection of chicory in coffee, chloral hydrate in toddy	14	0	-	14
II	**Food additives:** Food preservatives like benzoates, propionates, sorbates, disulphites. Artificial sweeteners: Aspartame, saccharin, dulcin, sucralose, and sodium cyclamate. Flavors: Vanillin, alkyl esters (fruit flavors), and monosodium glutamate.	10	0	-	10
III	**Food adulterants, and contaminants:** Food processing and packaging; Food adulteration: definition and its importance, adulterants present in-coffee, tea, milk, spices, grains and food colour; Difference between food adulteration and contamination.	10	0	-	10
IV	**Artificial food colorants:** Natural and synthetic colors, fake colors, inorganic pigments, application of colors in food industry, flavoring agents, Coal tar dyes and non-permitted colors and metallic salts. Utility of coal tar dyes in food and cosmetics and its harmful effect.	11	0	-	11
	Total	45	0	0	45

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others (Any one) - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

At the end of this course, students will be able to-

CO1: Identify the composition of dairy products and food additives, and recall key concepts in food safety and processing.

CO2: Explain the principles behind dairy safety, milk processing, and the roles of various food preservatives and artificial sweeteners.

CO3: Utilize methods for qualitative analysis of fat, minerals, and caffeine in dairy products and beverages, and detect common adulterants and contaminants in foods.

CO4: Compare and contrast different food additives, artificial colorants, and their applications in the food industry, including their potential health impacts.

CO5: Assess the significance of food adulteration and contamination, and evaluate the harmful effects of synthetic colorants and non-permitted substances.

CO6: Develop methods to detect food adulterants and contaminants, and innovate safer and more effective food processing and packaging techniques.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	CO1					
Conceptual		CO2, CO3	CO4, CO5			
Procedural					CO6	
Metacognitive						

SUGGESTED READINGS:

1. Food Science & Quality Control by SMT. B. Poornima - Centrum Press First edition 2014.
2. Post-Harvest Management of Horticultural crops - S. Saraswathy, T.L. Preethi AGROBIOS (India) 2013.
3. A Handbook of Agn. Food processing and marketing by S.C. Gaur, Agro Bios (India) 2012.
4. Quality Control for value edition in Food processing – by Dev Raj, Rakesh Sharma & V.K. Joshi New India Publishing Agency, 2011.
5. Food processing and preservation – Subbulakshmi, G. Shobha, A. Udipi, New Age International (P) Ltd., 2006.

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DETAILED SYLLABUS OF 1st SEMESTER

Title of the Course : Basic Analytical Chemistry
Course Code : SEC - 01
Nature of the Course : CHEMISTRY SEC-01
Total Credits : 3
Distribution of Marks : 60 (End Sem) + 40 (In-Sem)

COURSE OBJECTIVES:

- To provide a basic understanding of chemical analysis of soil, water, food products, cosmetics and separation techniques (viz. chromatography, ion exchange, etc.)

UNITS	CONTENTS	L	T	P	Total Hours
I	**Introduction:** Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.	**03**	**0**	**-**	**03**
	Analysis of soil: Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators a. Determination of pH of soil samples. b. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.	**05**	**0**	**-**	**05**
II	**Analysis of water:** Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods. a. Determination of pH, acidity and alkalinity of a water sample. b. Determination of dissolved oxygen (DO) of a water sample.	**05**	**0**	**-**	**05**
	Analysis of food products: Nutritional value of foods, idea about food processing and food preservations and adulteration. a. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc. b. Analysis of preservatives and colouring matter.	**05**	**0**	**-**	**05**

III	**Chromatography:** Definition, general introduction on principles of chromatography, paper chromatography, TLC etc. a. Paper chromatographic separation of mixture of metal ion ($Fe^{3+}$and Al^{3+}). b. To compare paint samples by TLC method.	**04**	**0**	**-**	**04**
	Ion-exchange: Column, ion-exchange chromatography etc. Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible).	**04**	**0**	**-**	**04**
	Analysis of cosmetics: Major and minor constituents and their function a. Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate. b. Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration.	**04**	**0**	**-**	**04**
IV	**Any one experiment:** (i) Determination of dissolved oxygen in water. (ii) Determination of Chemical Oxygen Demand (COD) (iii) Determination of Biological Oxygen Demand (BOD) (iv) Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry (v) Spectrophotometric determination of Iron in Vitamin / Dietary Tablets. (vi) Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drinks	**-**	**-**	**30**	**30**
	Total	**30**	**0**	**30**	**60**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others (Any one) - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

At the end of this course, students will be able to-

CO1: Develop a thorough understanding of the principles and practices in analytical chemistry, including sampling, measurement accuracy, and data presentation.

CO2: Gain practical experience in analyzing soil, water, and food products, understanding their composition, and detecting adulterants.

CO3: Learn the techniques in chromatography and ion-exchange, and apply these techniques to real-world samples.

CO4: Acquire skills in analyzing cosmetics and conducting advanced practical experiments to measure various chemical parameters.

CO5: Enhance critical thinking and problem-solving abilities in the context of analytical chemistry applications.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual				CO5		
Conceptual	CO1	CO2	CO3			
Procedural				CO4		
Metacognitive						

SUGGESTED READINGS:

1. Willard, H.H., Merritt, L.L., Dean, J. &Settoe, F.A. *Instrumental Methods of Analysis*, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA,1988.
2. Skoog, D.A., Holler, F.J. & Crouch, S. *Principles of Instrumental Analysis*, Cengage Learning India Edition, 2007.
3. Skoog, D.A.; West, D.M. & Holler, F.J. *Analytical Chemistry: An Introduction 6th Ed.,* Saunders College Publishing, Fort Worth, Philadelphia (1994).
4. Harris, D. C. *Quantitative Chemical Analysis*, 9th ed. Macmillan Education, 2016.
5. Dean, J. A. *Analytical Chemistry Handbook*, McGraw Hill, 2004.
6. Day, R. A. & Underwood, A. L. *Quantitative Analysis*, Prentice Hall of India, 1992.
7. Freifelder, D.M. *Physical Biochemistry 2nd Ed.,* W.H. Freeman & Co., N.Y. USA (1982).
8. Cooper, T.G. *The Tools of Biochemistry,* John Wiley & Sons, N.Y. USA. 16 (1977).
9. Vogel, A. I. *Vogel's Qualitative Inorganic Analysis 7th Ed.,* Prentice Hall, 1996.
10. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.,* Pearson, 2009.
11. Robinson, J.W. *Undergraduate Instrumental Analysis 5th Ed.,* Marcel Dekker, Inc., NewYork (1995).
12. Christian, G.D. *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004
13. Higson, S. P.J. (2003), Analytical Chemistry, Oxford University Press.
14. Fifield, F.W.; Kealey, D. (2000), Principles and Practice of Analytical Chemistry, Wiley.
15. Harris, D. C. (2007), Exploring Chemical Analysis, W.H. Freeman and Co.

FYUGP
DETAILED SYLLABUS OF 2nd SEMESTER

Title of the Course : Chemistry C2: Inorganic + Physical + Organic
Course Code : C - 02
Nature of the Course : CHEMISTRY MAJOR
Total Credits : 4
Distribution of Marks : 60 (End Sem) + 40 (In-Sem)

COURSE OBJECTIVES:

- To give concept about the chemistry of non-transition elements, metallurgy, 1st law of thermodynamics, solid state chemistry and chemistry of aliphatic hydrocarbons.

UNITS	CONTENTS	L	T	P	Total Hours
I	**Non Transition elements:** a) Noble Gas: Compounds of Xenon only b) Boron: wade's rule, nomenclature of closo, nido and arachnoboranes, structure of boron hydrides (B_2H_6), metalloborane and metallocarboranes. borazine, phosphazine, S_4N_4, $(SN)_x$ – preparation, structure and uses. c) Carbon: Fullerenes (C_{60}) d) Silicon: silicones, classifications and structure of silicates. Zeolites, use of Zeolites as catalyst and molecular sieve, aluminosilicates. e) Nitrogen: Hydrazine, hydroxylamine and hydrazoic acid. f) Phosphorus: Phosphines, oxy acids of phosphorus, organophosphorus compounds.	**09**	**0**	**-**	**09**
	Metals: Theory of reduction (Thermodynamic approach), role of carbon and other reducing agents, electrolytic reduction, roasting and calcinations. Method of purification and refining of metals including modern methods like zone refining, vacuum arc process, ion exchange, solvent extraction and electrolytic method, Van- Arkel process andhydrometallurgy. Study of potassium dichromate, manganese dioxide, potassium permanganate, ammonium molybdate, sodium cobaltinitrite, cobalt nitrate, Ni-DMG, vanadium pentoxide).	**06**	**0**	**-**	**06**

II	**Chemical Thermodynamics -I:** Extensive and intensive properties of a system, thermodynamic processes: cyclic, reversible, irreversible processes, thermodynamic function, complete differential, Zeroth law of thermodynamics. First law of thermodynamics-internal energy, enthalpy, molar heat capacities, relation between Cp and Cv, work of expansion in reversible and irreversible process, adiabatic process, relation between P, V, T. Variation in internal energy and enthalpy with temperature, Joule Thomson effect, calculation of Joule Thomson co-efficient for ideal and Vander Waal's gas. Thermo chemistry- Hess's law, Kirchhoff's law relation of reaction enthalpy with internal energy, Bond energy and Bond dissociation energy, calculation from thermo chemical data.	**08**	**0**	**-**	**08**
	Solids: Basic laws of crystallography, crystal system, crystal lattice, Miller indices, and simple face centered and body centered cubic lattice, number of points in a unit cell. X-Ray diffraction study of crystals, Bragg's law, determination of crystal structure- introduction to powder and single crystal methods of structure analysis, crystal structure of NaCl and KCl, packing of crystals, closed packed structure, radius ratio, crystal defect-point defects, conductors, semiconductors and insulators from band theory.	**06**	**0**	**-**	**06**
III	**Carbon- Carbon sigma bonds:** Chemistry of Alkanes: Formation of alkanes with special emphasis on Corey House Synthesis, Wurtz reaction, Wurtz-Fittig reaction. Reactions of alkanes: Free Radical substitution:- Halogenations-relative reactivities and selectivity.	**04**	**0**	**-**	**04**
	Carbon-Carbon pi bonds: Formation of alkenes and alkynes by Elimination: Mechanism of E1., E2, E1cB reactions. Saytzeff and Hoffmann elimination, special emphasis on preparation of alkenes by synelimination:- pyrolysis of esters, Chugaev reaction and Wittig reaction. ***Reaction of alkenes***: Addition Reaction- Electrophilic and free radical additions, their mechanisms. (Markonikoff/ Anti Markonikoff addition) regioselectivity (directional selectivity), and steroselective of addition reactions. Mechanism of	**12**	**0**	**-**	**12**

	oxymercuration–demercuration, Hydroboration-Oxidation, Ozonolysis, reduction (catalytic and chemical). ***Syn and Anti hydroxylation***(oxidation), simple effect of stereo selectivity and stereo specificity. ***Reactions of Alkynes***: Acidity, Electrophilic and Nucleophilic additions, Hydration to form carbonyl compounds. Alkylation of terminal alkynes.				
IV	**EXPERIMENTAL WORK:** **Any one practical** (i) Purification of organic compounds by crystallization using the following solvents: a. Water b. Alcohol c. Alcohol-water And determination of the melting points of above compounds (Kjeldahl method and electrically heated melting point apparatus) (ii) Separation of a mixture of o- and p-nitrophenol or o- and p-aminophenol by thin layer chromatography (TLC)	**-**	**-**	**30**	**30**
	Total	**45**	**0**	**30**	**75**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

At the end of this course, students will be able to-

CO1: Develop a comprehensive understanding of the properties and reactions of non-transition elements and metals.

CO2: Gain in-depth knowledge of chemical thermodynamics and the properties of solids, including crystallography and X-ray diffraction.

CO3: Master the formation and reactions of carbon-carbon sigma and pi bonds, with a focus on alkanes, alkenes, and alkynes.

CO4: Acquire practical laboratory skills in the purification and analysis of organic compounds, enhancing problem-solving abilities and technical expertise in analytical techniques.

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual		CO1				
Conceptual	CO2		CO3			
Procedural					CO4	
Metacognitive						

SUGGESTED READINGS:

1. Selected Topics in Inorganic Chemistry--Wahid U. Malik, G. D. Tuli and R. D. Madan. (S. Chand & Co. Ltd.)
2. Advanced Inorganic Chemistry – Satyaprakash, Basu, Tuli
3. Inorganic Chemistry – Puri, Sharma and Kalia
4. Inorganic Chemistry – J.D. Lee
5. General and Inorganic Chemistry (Part-I & II) R. Sarkar
6. Basic Inorganic chemistry – Cotton and Wilkinson
7. Inorganic Chemistry – J.E.Huheey
8. Physical Chemistry-- Atkins, P. W. & Paula, J.
9. A Text Book of Physical Chemistry – Negi& S.C. Anand, Wiley Eastern
10. Physical Chemistry, Castellan G. W., Narosa Publishing
11. Principles of Physical Chemistry, Puri, Sharma, Pathania, ShobanLal, (S. Chand &Co.)
12. Physical Chemistry – P.W. Atkins, Oxford University Press
13. Physical Chemistry – Barrow G.M., Tata-McGraw Hill
14. Advanced Physical Chemistry – J.N. Gurta& H. Snehi, PragatiPrakashan
15. Physical Chemistry – D.S. Pahari
16. Organic Chemistry – B.S. Bahl and A. Bahl (Vol. I & II)
17. Organic Chemistry – M.K. Jain, S.Chand& Co.
18. A Text Book of Organic Chemistry (Vol. I & II) – B.K. Sharma, G.P. Pokhriji and S.K. Sharma, (S. Chand & Co.)
19. Organic Chemistry – I.L. Finar, Vol. I & II, ELBS
20. Organic Chemistry, R.I. Morrison & R.N. Boyd, S.K. Bhattacharjee
21. Organic Chemistry – Vol. I & II, Mukherjee and Kapoor
22. Advanced General Organic Chemistry (Part I and Part II) - S.C.Ghosh
23. Organic Chemistry (Oxford) - Clayden,Warren,Greeves and Wothers.
24. Organic Reactions and their Mechanisms (New Age International Privatr Limited) - P.S.Kalsi.

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DETAILED SYLLABUS OF 2nd SEMESTER

Title of the Course	**:**	**Fundamentals of Chemistry-2**
Course Code	**:**	**MINOR-02**
Nature of the Course	**:**	**CHEMISTRY MINOR COURSE-2**
Total Credits	**:**	**4**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

COURSE OBJECTIVES:

- To develop the basic knowledge of chemistry in relation to atomic structure, bonding. To emphasize on different states of matter & their mechanical treatment.
- To develop preliminary knowledge in basic organic chemistry, hydrocarbons, stereochemistry & conformational analysis etc.

UNITS	CONTENTS	L	T	P	Total Hours
I	**Coordination Chemistry:** Review of Werner's theory. Types of ligands, monodentate, bidentate ambidentate and polydentate ligands (including _ Acceptor and macrocyclic ligands. IUPAC nomenclature of Co-ordination compounds. Isomerism of 4-and 6- coordinate compounds. Introduction to Valence Bond and Crystal Field theory. Application of dimethyl glyoxime, EDTA, 8-hydroxy quinoline, 2,2-bipyridyl, and ethylenediamine in analysis**.**	**08**	**0**	**-**	**08**
	Chemical Bonding and Molecular Structure-2 Covalent Bonding: VB Approach-Concept of hybridization, sp, sp2 , sp3 , sp3 d, sp3 d 2 and dsp2 VSEPR Theory. Resonance and Resonance energy: Study of some inorganic and organic compounds (O_3, NO_3^-, CO_3^{2-}, SO_4^{2-}, $RCOO^-$, C_6H_6). Molecular Orbital Approach: LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combination of atomic orbitals, non-bonding combination of orbitals, MO treatment of homonuclear diatomic molecules and heteronucear diatomic molecules such as CO, NO and NO^+	**08**	**0**	**-**	**08**
II	**Solids** Forms of solids, unit cells, crystal systems, Bravais lattice, types and identification of lattice planes. Miller and Weiss indices. Laws of crystallography-Law of constancy of interfacial angles. Law of rational indices. X-Ray diffraction by crystals. Bragg's law. Structure of NaCl, KCl and CsCl (qualitative treatment only). Defects in crystals. Liquid crystals.	**09**	**0**	**-**	**09**

	Ionic Equilibria: Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree ofionization, ionization constant and ionic product of water. Ionization of weak acids and bases,pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree ofhydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product ofsparingly soluble salts – applications of solubility product principle.	**06**	**0**	**-**	**06**
III	**Stereochemistry:** Conformation with respect to ethane, butane and cyclohexane. Interconversion of WedgeFormula, Newmann, Sawhorse and Fischer representations. Concept of chirality (uptotwocarbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism,Diastereomerism and Meso Compounds. Threo and erythro; D and L; Cis-trans nomenclature; CIP Rules.	**07**	**0**	**-**	**07**
	Aliphatic Hydrocarbons-2 **Alkenes:** (up to 5 carbons): *Preparation*: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule).*Reactions*: cis-addition (*alk*. KMnO4) and trans-addition (bromine), Addition of HX(Markownikoff's and anti Markownikoff's addition), Hydration, Ozonolysis. **Alkynes:** (up to 5 carbons): *Preparation*: Acetylene from CaC2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinaldihalides. *Reactions*: formation of metal acetylides, addition of bromine and alkaline KMnO4, ozonolysis and oxidation with hot alk. KMnO4.	**07**	**0**	**-**	**07**
IV	**Experimental Work:** **Surface tension/Viscosity/pH -metry (Any one experiment)** (i) Determine the surface tension of various liquids by drop number method. (ii) Determination of viscosity of aqueous solutions at room temperature. (iii) Study the variation of surface tension of detergent solutions with concentration. (iv) Determination of viscosity of aqueous solutions of (a) polymer (b) ethanol and (c) sugar at room	**-**	**-**	**30**	**30**

	(v) pH- metric titration; (a) strong acid vs. strong base (b) weak acid vs. strong base (vi) Preparation of buffer solutions of different pH (a) sodium acetate-acetic acid (b) ammonium chloride-ammonium hydroxide (c) Determination of dissociation constant of weak acid (CH_3COOH)				
	Total	**45**	**0**	**30**	**75**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others (Any one) - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

At the end of this course, students will be able to-

CO1: Apply the concepts of Werner's theory, isomerism in coordination compounds and Valence Bond and Crystal Field theories, to understand and solve problems related to the structure and function of coordination compounds.

CO2: Evaluate the bonding and structural properties of various inorganic and organic compounds by applying concepts of covalent bonding theories, including hybridization, VSEPR, resonance and MO.

CO3: Gain a clear understanding of coordination chemistry, including its theories, naming rules, and types of ligands.

CO4: Learn about chemical bonding, molecular structures, and the basics of solid-state chemistry.

CO5: Understand stereochemistry and the chemistry of aliphatic hydrocarbons, including how to make and react them.

CO6: Develop practical lab skills in measuring surface tension, viscosity, and pH, and in making buffer solutions, which will improve your problem-solving and technical abilities in analytical techniques.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual		CO3				
Conceptual	CO4	CO5	CO1			
Procedural					CO2, CO6	
Metacognitive						

SUGGESTED READINGS:

1. Selected Topics in Inorganic Chemistry--Wahid U. Malik, G. D. Tuli and R. D. Madan. (S. Chand & Co. Ltd.)
2. Inorganic Chemistry – Puri, Sharma and Kalia
3. General and Inorganic Chemistry (Part-I & II) R. Sarkar
4. A Text Book of Physical Chemistry – Negi& S.C. Anand, Wiley Eastern
5. Principles of Physical Chemistry, Puri, Sharma, Pathania, ShobanLal, (S. Chand & Co.)
6. Organic Chemistry – B.S. Bahl and A. Bahl (Vol. I & II)
7. Organic Chemistry – M.K. Jain, S.Chand& Co.
8. A Text Book of Organic Chemistry (Vol. I & II) – B.K. Sharma, G.P. Pokhriji and S.K. Sharma, (S. Chand & Co.)

FYUGP

DETAILED SYLLABUS OF 2nd SEMESTER

Title of the Course : Chemistry in Daily Life- 2
Course Code : GEC-02
Nature of the Course : CHEMISTRY GEC-02
Total Credits : 3
Distribution of Marks : 60 (End Sem) + 40 (In-Sem)

COURSE OBJECTIVES:

- To introduce the students to the chemistry of some biomolecules.
- To familiarized the students with vitamins and their importance in human body.

UNITS	CONTENTS	L	T	P	Total Hours
I	**Vitamins**: Classification and Nomenclature. Sources, deficiency diseases, and structures of Vitamin A, Vitamin B, Vitamin C, Vitamin D, Vitamin E & Vitamin K.	12	0	-	12
II	**Oils and fats:** Composition of edible oils, detection of purity, rancidity of fats and oil. Tests for adulterants like argemone oil and mineral oils. Soaps & Detergents: Definition, classification, manufacturing of soaps and detergents, composition and uses.	10	0	-	10
III	**Proteins:** Sources, Composition and Biological values of protein, Elementary ideas of proteins and amino acids, Essential and Non-essential amino acids. Peptide bonds, Polypeptides, Qualitative ideas of structure of proteins (Primary, secondary, Tertiary and Quaternary structure), Denaturation and coagulation of proteins; Factors contributing to denaturation and coagulation of proteins.	12	0	-	12
IV	**Nucleic Acids:** Nucleic acids and their Chemical composition.Classification, functions and structure of nucleic acids. Concept of DNA fingerprinting and its applications.	11	0	-	11
	Total	45	0	0	45

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others (Any one) - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

At the end of this course, students will be able to-

CO1: Develop a comprehensive understanding of vitamins, including their sources, deficiency diseases, and chemical structures.

CO2: Gain in-depth knowledge of oils and fats, including detection of purity, rancidity, and the manufacturing and uses of soaps and detergents.

CO3: Understand the composition, structure, and biological significance of proteins and amino acids.

CO4: Learn about nucleic acids, their chemical composition, classification, functions, and applications such as DNA fingerprinting.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	CO1, CO2					
Conceptual		CO3, CO4				
Procedural						
Metacognitive						

SUGGESTED READINGS:

1. Berg, J.M.; Tymoczko, J.L.; Stryer, L. (2006), Biochemistry. W.H. Freeman and Co.
2. Nelson, D.L.; Cox, M.M.; Lehninger, A.L.(2009),Principles of Biochemistry. W.H. Freeman and Co.
3. Murray, R.K., Granner, D.K., Mayes, P.A.; Rodwell, V.W.(2009),Harper's Illustrated Biochemistry.Lange Medical Books/McGraw-Hill.
4. Brown,T.A. (2018) Biochemistry, (First Indian addition 2018) Viva Books.
5. Kumar, A.; Garg, S.; Garg, N. (2012), Biochemical Tests: Principles and Protocols. Viva Books.
6. Finar, I. L. (2008), Organic Chemistry, Volume 2, 5th Edition, Pearson Education.

FYUGP

DETAILED SYLLABUS OF 2nd SEMESTER

Title of the Course : Basic Analytical Chemistry-02
Course Code : SEC - 02
Nature of the Course : CHEMISTRY SEC-02
Total Credits : 3
Distribution of Marks : 60 (End Sem) + 40 (In-Sem)

COURSE OBJECTIVES:

- The course aims to provide students with a basic scientific and technical understanding of the production, behaviour and handling of hydrocarbon fuels, petrochemicals and lubricants. This will enable them to be industry ready to contribute effectively in the field of petroleum chemistry and technology.

UNITS	CONTENTS	L	T	P	Total Hours
I	Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value.	03	0	-	03
	Coal: Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal. Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals.	06	0	-	06
II	*Petroleum and Petrochemical Industry*: Composition of crude petroleum; Different types of petroleum products and their applications. Principle and process of fractional distillation, Cracking - Thermal and catalytic cracking; Qualitative treatment of non-petroleum fuels -LPG, CNG, LNG, bio-gas, fuels derived from biomass, fuel from waste; synthetic fuels -gaseous and liquids.	09	0	-	09
	Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene.	06	0	-	06
III	*Lubricants*: Classification of lubricants, lubricating oils (conducting and non-conducting),Solid and semisolid lubricants, synthetic lubricants. Properties of lubricants – viscosity index, cloud point, pore point.	06	0	-	06
IV	**Any one experiment:** (i) To determine the Aniline point of a given lubricating oil. (ii) To determine the acid value of a given oil	-	-	30	30

	(iii) To determine the enthalpy of combustion of liquid fuels using spirit / alcohol burner. (iv) To perform the proximate analysis of coal (v) To perform the ultimate analysis of the coal sample.				
	Total	**30**	**0**	**30**	**60**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others (Any one) - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

At the end of this course, students will be able to-

CO1: Develop a thorough understanding of energy sources, their classification, and the calorific value of fuels.

CO2: Gain comprehensive knowledge of coal, its industrial uses, and the production and applications of its derivatives.

CO3: Learn about the petroleum and petrochemical industry, including the composition and processing of crude petroleum, and the significance of various petrochemicals.

CO4: Understand the classification, properties, and applications of lubricants.

CO5: Acquire hands-on experience in conducting experiments related to lubricants and fuel analysis, enhancing problem-solving and technical skills in analytical techniques.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual		CO1				
Conceptual		CO2, CO3	CO4			
Procedural				CO5		
Metacognitive						

SUGGESTED READINGS:

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

FYUGP

DETAILED SYLLABUS OF 3rd SEMESTER

Title of the Course : Chemistry C3: Inorganic + Physical + Organic
Course Code : C - 03
Nature of the Course : CHEMISTRY MAJOR
Total Credits : 4
Distribution of Marks : 60 (End Sem) + 40 (In-Sem)

COURSE OBJECTIVES:

- To develop the basic knowledge of chemistry in relation to *d* and *f* block elements and coordination compounds
- To develop the basic knowledge of chemistry in relation to chemical thermodynamics and ionic equilibrium
- To develop the basic knowledge of chemistry in relation to cycloalkanes and conformational analysis and chemistry of halogenated hydrocarbons.

UNITS	CONTENTS	L	T	P	Total Hours
I	***d* and *f* block elements**: General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, ability to form complexes. Electronic configuration, oxidation states, colour, spectral and magnetic properties of lanthanides and actinides. Lanthanide contraction, separation of lanthanides (ion-exchange method only).	06	0	-	06
	Coordination compounds: Types of ligands: monodentate, bidentate, ambidentate, polydentate and macro cyclic ligand. Effective atomic number (EAN) rule, valence bond theory (VBT), crystal field theory (CFT), MOT and introduction to ligand field theories and their applications. *Magnetic properties:* paramagnetism, diamagnetism, magnetic properties of octahedral complexes, ferromagnetism, antiferromagnetism and ferrimagnetism.	09	0	-	09
II	**Chemical Thermodynamics II:** Second law of thermodynamics, Carnot's theorem, Carnot cycle, efficiency of heat engines, thermodynamic scale of temperature, concept of entropy, entropy change in a cyclic, reversible, irreversible processes, calculation of entropy changes of an ideal gas with change in P,V,T, entropy change in physical transformation, entropy of mixing. Helmholtz free energy (A) and Gibb's free energy (G),	10	0	-	10

	variation of A and G with P,V,T, criteria for spontaneity and equilibrium, Maxwell's relationship, Gibb's–Helmholtz equation. Nernst heat theorem-consequence of the theorem, third law of thermodynamics, and its verification. Determination of absolute entropies of pure substance. **Ionic equilibrium:** Strong and weak electrolyte with modern classification of electrolytes (true and potential electrolyte), degree of ionization, factors affecting degree of ionization, ionization constant, ionic product of water, ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts, buffer solution, derivation of Henderson equation and its applications, buffer capacity, buffer range, buffer action. Solubility and solubility product of sparingly soluble salts-application of solubility product principle in salt analysis. Qualitative treatment of acid-base titration curves. Theory of acids- base indicators, selection of indicators and their limitations.	**06**	**0**		**06**
III	**Cycloalkanes and conformational analysis:** Synthesis and reactions of three, four, five and six membered cycloalkanes, Their relative stability, Baeyer strain theory. Conformational analysis of Alkanes: (ethane & butane) Relative stability, Energy diagram. Cyclohexane: Chair, Boat and Twist boat forms, Relative stability with energy diagram, axial and equatorial bonds including perspective representation and Newman projections. Conformation & conformational analysis of monosubstituted cyclohexane derivative.	**07**	**0**	**-**	**07**
	Chemistry of Halogenated Hydrocarbons Alkyl halides: Methods of preparation includingHunsdiecker reaction from silver or lead (IV) salts of carboxylic Acid). Nucleophilic substitution reactions: SN_1, SN_2, and SN_i Mechanisms with stereochemical aspects and effect of solvent. Nucleophilic substitution vs elimination. Haloform reaction. Aryl halides: Preparation from diazonium salts. Nucleophilic Aromatic Substitution SNAr, Benzyne intermediates. Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions.	**07**	**0**	**-**	**07**

IV	**EXPERIMENTAL WORK : (Any one)** (i) Determine the surface tension of various liquids by drop number method. (ii) Determination of viscosity of aqueous solutions at room temperature. (iii) Study the variation of surface tension of detergent solutions with concentration. (iv) Determination of viscosity of aqueous solutions of (a) polymer (b) ethanol and (c) sugar at room temperature.	**-**	**-**	**30**	**30**
	Total	**45**	**0**	**30**	**75**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others (Any one) - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

At the end of this programme, students will be able to-

CO1: Develop a solid understanding of the properties and behaviors of d and f block elements and coordination compounds.

CO2: Gain comprehensive knowledge of chemical thermodynamics and ionic equilibrium.

CO3: Learn the concepts and applications of cycloalkanes, conformational analysis, and halogenated hydrocarbons.

CO4: Acquire practical laboratory skills in measuring surface tension and viscosity, enhancing analytical and problem-solving abilities.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual						
Conceptual	CO1	CO2, CO3				
Procedural					CO4	
Metacognitive						

SUGGESTED READINGS:

1. Selected Topics in Inorganic Chemistry--Wahid U. Malik, G. D. Tuli and R. D. Madan. (S. Chand & Co. Ltd.)
2. Advanced Inorganic Chemistry – Satyaprakash, Basu, Tuli
3. Inorganic Chemistry – Puri, Sharma and Kalia
4. Inorganic Chemistry – J.D. Lee
5. General and Inorganic Chemistry (Part-I & II) R. Sarkar
6. Basic Inorganic chemistry – Cotton and Wilkinson

7. Inorganic Chemistry – J.E.Huheey
8. Physical Chemistry-- Atkins, P. W. & Paula, J.
9. A Text Book of Physical Chemistry – Negi& S.C. Anand, Wiley Eastern
10. Physical Chemistry, Castellan G. W., Narosa Publishing
11. Principles of Physical Chemistry, Puri, Sharma, Pathania, ShobanLal, (S. Chand & Co.)
12. Physical Chemistry – P.W. Atkins, Oxford University Press
13. Physical Chemistry – Barrow G.M., Tata-McGraw Hill
14. Advanced Physical Chemistry – J.N. Gurta& H. Snehi, PragatiPrakashan
15. Physical Chemistry – D.S. Pahari
16. Organic Chemistry – B.S. Bahl and A. Bahl (Vol. I & II)
17. Organic Chemistry – M.K. Jain, S.Chand& Co.
18. A Text Book of Organic Chemistry (Vol. I & II) – B.K. Sharma, G.P. Pokhriji and S.K. Sharma, (S. Chand & Co.)
19. Organic Chemistry – I.L. Finar, Vol. I & II, ELBS
20. Organic Chemistry, R.I. Morrison & R.N. Boyd, S.K. Bhattacharjee
21. Organic Chemistry – Vol. I & II, Mukherjee and Kapoor
22. Advanced General Organic Chemistry (Part I and Part II) - S.C.Ghosh
23. Organic Chemistry (Oxford) - Clayden,Warren,Greeves and Wothers.
24. Organic Reactions and their Mechanisms (New Age International Privatr Limited) - P.S.Kalsi.

FYUGP

DETAILED SYLLABUS OF 3rd SEMESTER

Title of the Course : Chemistry C4: Inorganic + Physical + Organic
Course Code : C - 04
Nature of the Course : CHEMISTRY MAJOR
Total Credits : 4
Distribution of Marks : 60 (End Sem) + 40 (In-Sem)

COURSE OBJECTIVES:

- To understand the concepts of acids and bases, including Brönsted-Lowry and Lewis theories, and the application of HSAB principles.
- To learn about inorganic reaction mechanisms, conductance, and electrochemistry, including substitution reactions in complexes, conductometric titrations, and the principles of electrochemical cells.
- To explore aromatic hydrocarbons, electrophilic aromatic substitution, and the chemistry of C-O bonds in alcohols, phenols, ethers, and epoxides,
- To conduct experimental work in conductometry, thermochemistry, and qualitative organic analysis.

UNITS	CONTENTS	L	T	P	Total Hours
I	**Acids and Bases:** Brönsted-Lowry concept of acid-base reactions, solvated proton, relative strength of acids, types of acid-base reactions, levelling solvents, Lewis acid-base concept, classification of Lewis acids, hard and soft acids and bases (HSAB). Application of HSAB principle.	**06**	**0**	**-**	**06**
	Inorganic reaction mechanism: Introduction to inorganic reaction mechanism, inert and labile complexes, association, dissociation and concerted paths. Acid and base hydrolysis (with reference to cobalt complexes only). Substitution reaction in octahedral and square planar complexes. Trans effect, Irving-William series.	**10**	**0**	**-**	**10**
II	**Conductance:** Arrhenius theory of electrolytic dissociation, conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes, molar conductivity at infinite dilution, Kohlrausch law of independent migration of ions, Debye-Huckel - Onsagar equation, Wien effect, Debye-Falkenhagen effect, Walden's rule. Ionic mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf	**06**	**0**	**-**	**06**

	and moving boundary methods (principle only , calculations not required), anomalous transference number, application of conductance measurement: i) degree of dissociation of weak electrolytes ii) ionic product of water iii) solubility and solubility product of sparingly soluble salts iv) Hydrolysis constant of aniline hydrochloride, v) Conductometric titration (Acid-Base and precipitation).				
	Electrochemistry: Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry. Electrochemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells. Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone, glass and SbO/Sb_2O_3 electrodes. Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation)	**07**	**0**		**07**
III	**Aromatic Hydrocarbons Aromaticity:** Huckel's rule, aromatic characters of arenes, benzenoid, non-benzenoid- aromatic compounds and heterocyclic and polynuclear hydrocarbons with suitable examples Synthesis and properties of naphthalene and anthracene. Antiaromaticity and nonaromaticity Electrophilic Aromatic Substitution: Halogenation, nitration, sulphonation and Friedel-craft's alkylation / acylation with their mechanism. Activation/deactivation of aromatic ring and directing effects of groups. Partial rate factor (O/P ratio)	**8**	**0**	**-**	**8**
	Chemistry of C-O Bond Alcohols: Preparation and properties of Glycol: Oxidation by OsO_4, alkaline, KMnO4, periodic acid and lead tetracetate. PinacolPinacolone rearrangement with mechanism. ***Trihydric alcohol:*** Glycerol: preparation & properties. ***Phenols:*** Preparation and properties:- acidity-comparison with alcohol. Substitution reaction,	**8**	**0**	**-**	**8**

	Reimer- Tiemann and Kolbe-Schmidt reaction, Fries rearrangement with mechanism. **Other aromatic Hydroxy compounds:** Cresol, nitrophenols, picric acid, benzyl alcohol, dihydric phenols. Ethers and Epoxides: Preparation and reactions with acids.				
IV	**EXPERIMENTAL WORK:** Inorganic Preparation (Any one) i. Potash alum ii. Chrome alum iii. Potassium trioxalatochromate iv. Potassium trioxalatoferrate	**-**	**-**	**30**	**30**
	Total	**45**	**0**	**30**	**75**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others (Any one) - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

At the end of this programme, students will be able to-

CO1: Develop a solid understanding of the properties and behaviors of acids, bases, and inorganic reaction mechanisms.

CO2: Gain comprehensive knowledge of conductance, electrochemistry, aromatic hydrocarbons, and the chemistry of the C-O bond.

CO3: Learn the concepts and applications of theoretical principles in practical contexts.

CO4: Acquire practical laboratory skills in inorganic synthesis, enhancing analytical and problem-solving abilities.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual						
Conceptual		CO1, CO2		CO3		
Procedural					CO4	
Metacognitive						

SUGGESTED READINGS:

1. Selected Topics in Inorganic Chemistry--Wahid U. Malik, G. D. Tuli and R. D. Madan. (S. Chand & Co. Ltd.)
2. Advanced Inorganic Chemistry – Satyaprakash, Basu, Tuli
3. Inorganic Chemistry – Puri, Sharma and Kalia
4. Inorganic Chemistry – J.D. Lee
5. General and Inorganic Chemistry (Part-I & II) R. Sarkar
6. Basic Inorganic chemistry – Cotton and Wilkinson
7. Inorganic Chemistry – J.E.Huheey
8. Physical Chemistry-- Atkins, P. W. & Paula, J.
9. A Text Book of Physical Chemistry – Negi& S.C. Anand, Wiley Eastern
10. Physical Chemistry, Castellan G. W., Narosa Publishing
11. Principles of Physical Chemistry, Puri, Sharma, Pathania, ShobanLal, (S. Chand & Co.)
12. Physical Chemistry – P.W. Atkins, Oxford University Press
13. Physical Chemistry – Barrow G.M., Tata-McGraw Hill
14. Advanced Physical Chemistry – J.N. Gurta& H. Snehi, PragatiPrakashan
15. Physical Chemistry – D.S. Pahari
16. Organic Chemistry – B.S. Bahl and A. Bahl (Vol. I & II)
17. Organic Chemistry – M.K. Jain, S.Chand& Co.
18. A Text Book of Organic Chemistry (Vol. I & II) – B.K. Sharma, G.P. Pokhriji and S.K. Sharma, (S. Chand & Co.)
19. Organic Chemistry – I.L. Finar, Vol. I & II, ELBS
20. Organic Chemistry, R.I. Morrison & R.N. Boyd, S.K. Bhattacharjee
21. Organic Chemistry – Vol. I & II, Mukherjee and Kapoor
22. Advanced General Organic Chemistry (Part I and Part II) - S.C.Ghosh
23. Organic Chemistry (Oxford) - Clayden,Warren,Greeves and Wothers.
24. Organic Reactions and their Mechanisms (New Age International Privatr Limited) - P.S.Kalsi.

FYUGP

DETAILED SYLLABUS OF 3rd SEMESTER

Title of the Course	**:**	**Fundamentals of Chemistry - 3**
Course Code	**:**	**MINOR-03**
Nature of the Course	**:**	**CHEMISTRY MINOR COURSE-3**
Total Credits	**:**	**4**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

COURSE OBJECTIVES:

- To give the concept of physico-chemical methods involved in metallurgy; first and second law thermodynamics; aromatic hydrocarbons and reactions involved etc.

UNITS	CONTENTS	L	T	P	Total Hours
I	**Chemistry of non-metals:** Boron: Preparation, structure and bonding of diborane Silicon: Structure, properties and use of silicon carbide and silicon polymers (linear). Nitrogen: Hydroxylamine, Hydrazine, Hydrazoic acid;preparation, properties, uses and electronic structure. Rare gases: Xenon compounds. Phosphorous: Structures of oxides and oxyacids.	**08**	**0**	**-**	**08**
	General principles of metallurgy: Physico-Chemical methods involved in metallurgy (concentration, calcinations, reduction, roasting, zone refining, solvent extraction, hydrometallurgy and electrochemical methods) with reference to gold, nickel, thorium uranium and manganese (whichever is applicable).	**07**	**0**	**-**	**07**
II	**a) Chemical Thermodynamics & First law** Thermal equilibrium and zeroth law of thermodynamics- concept of temperature, Mechanical work, SI sign convention.1st law of thermodynamics, internal energy, enthalpy, reversible and irreversible processes,calculation of W,Q, ΔU, ΔH for expansion of ideal gas , isothermal work and enthalpy, relation between enthalpy change, and entropy change, molar heat capacities, relation between Cp and Cv, adiabatic processes- relation between P, V and T, Joule-Thomson effect, liquefication of gases, conversion of heat into work, efficiency of heat engine. Enthalpy of reaction, thermodynamical equation, variation of enthalpy of reaction with temperature-Kirchhoff's	**16**	**0**	**-**	**16**

	equation, enthalpy of different processes. Hess law, calculations based on Hess law. **b) Second law of thermodynamics** Second law of thermodynamics, Spontaneous and Non-Spontaneous processes cyclic process- Carnot cycle, Entropy, Entropy change in reversible and irreversible processes and for ideal gas, concept of work function and free energy.				
III	**Aromatic Hydrocarbons:** Preparation (only benzene) from phenol by decarboxylation, from acetylene, from benzenesulphonic acid. Reactions- Electrophitic substitution in benzene- nitration, halogenations, sulphonation, Fridel-Craft alkylation and acylation with mechanism.	**06**	**0**	**-**	**06**
	Alkyl halides Nucleophilic Substitution Reactions (SN_2, SN_1, &SN_i) Preparation: from alkenes and alcohols Reactions;: Hydrolysis, nitrite and nitro formation, nitrile and isonitrile formation. Williamson's Synthesis: elimination vs Substitution	**08**	**0**	**-**	**08**
IV	**Experimental Work:** **Organic Qualitative Analysis** Detection of elements (nitrogen, sulphur and halogens) and functional groups of organic compound containing one functional group.	**-**	**-**	**30**	**30**
	Total	**45**	**0**	**30**	**75**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others (Any one) - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

At the end of this course, students will be able to-

CO1: Develop a clear and comprehensive understanding of non-metal chemistry, metallurgical principles, thermodynamics, and organic chemistry.

CO2: Gain detailed knowledge of the properties, preparation methods, and reactions of important chemical compounds.

CO3: Apply theoretical principles in practical scenarios, including laboratory experiments.

CO4: Acquire practical skills in qualitative analysis, enhancing analytical and problem-solving abilities in chemical investigations.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual		CO1				
Conceptual		CO2				
Procedural				CO3, CO4		
Metacognitive						

SUGGESTED READINGS:

1. Selected Topics in Inorganic Chemistry--Wahid U. Malik, G. D. Tuli and R. D. Madan. (S. Chand & Co. Ltd.)
2. Advanced Inorganic Chemistry – Satyaprakash, Basu, Tuli
3. Inorganic Chemistry – Puri, Sharma and Kalia
4. General and Inorganic Chemistry (Part-I & II) R. Sarkar
5. Organic Chemistry – B.S. Bahl and A. Bahl (Vol. I & II)
6. Organic Chemistry – M.K. Jain, S.Chand& Co.
7. A Text Book of Organic Chemistry (Vol. I & II) – B.K. Sharma, G.P. Pokhriji and S.K. Sharma, (S. Chand & Co.)

FYUGP

DETAILED SYLLABUS OF 3rd SEMESTER

Title of the Course : Chemistry in Daily Life- 3
Course Code : GEC-03
Nature of the Course : CHEMISTRY GEC-03
Total Credits : 3
Distribution of Marks : 60 (End Sem) + 40 (In-Sem)

COURSE OBJECTIVES:

- To understand the learners about the applications of polymers, fertilizers, cosmetics and perfumes in everyday life.

UNITS	CONTENTS	L	T	P	Total Hours
I	**Chemical and Renewable Energy Sources**: Principles and applications of primary & secondary batteries and fuel cells. Basics of solar energy, future energy storer.	11	0	-	11
II	**Polymers:** Basic concept of polymers, classification and characteristics of polymers. Applications of polymers as plastics in electronic, automobile components, medical fields, and aerospace materials. Problems of plastic waste management. Strategies for the development of environment friendly polymers.	11	0	-	11
III	**Chemistry of Cosmetics & Perfumes** A general study including preparation and uses of the following: Hair dye, hair spray, shampoo, suntan lotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishing and shaving creams), antiperspirants and artificial flavours. Essential oils and their importance in cosmetic industries with reference to Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmone, Civetone, Muscone.	12	0	-	12
IV	**Fertilizers:** Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate.	11	0	-	11
	Total	45	0	-	45

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: 40 Marks

- Two Internal Examination - **20 Marks**
- Others (Any one) - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

At the end of this course, students will be able to-

CO1: Develop a thorough understanding of chemical and renewable energy sources, polymers, cosmetics, perfumes, and fertilizers.

CO2: Gain detailed knowledge of the principles, applications, and manufacturing processes related to each unit's content.

CO3: Apply theoretical knowledge to practical scenarios, such as the development of environmentally friendly polymers and the use of essential oils in cosmetics.

CO4: Acquire practical skills in analyzing and evaluating the environmental and industrial implications of chemical substances and processes.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual		CO1				
Conceptual	CO2		CO3			
Procedural			CO4			
Metacognitive						

SUGGESTED READINGS:

1. Barel, A.O.; Paye, M.; Maibach, H.I.(2014),Handbook of Cosmetic Science and Technology, CRC Press.
2. Garud, A.; Sharma, P.K.; Garud, N. (2012),Text Book of Cosmetics, Pragati Prakashan.
3. Gupta, P.K.; Gupta, S.K.(2011),Pharmaceutics and Cosmetics, Pragati Prakashan
4. Butler, H. (2000), Poucher's Perfumes, Cosmetic and Soap, Springer.
5. Kumari, R. (2018),Chemistry of Cosmetics, Prestige Publisher.
6. Gopalan, R. Venkappayya, D.; Nagarajan, S. (2004), Engineering Chemistry, Vikas Publications.
7. Sharma, B. K. Engineering Chemistry, Goel Publishing House, Meerut, 2006
8. Carraher,C. E. Jr. (2013), Seymour's Polymer Chemistry, Marcel Dekker, Inc.
9. Ghosh, P. (2001), Polymer Science & Technology, Tata Mcgraw-Hill.

FYUGP

DETAILED SYLLABUS OF 3rd SEMESTER

Title of the Course : Inorganic Materials of Industrial Importance
Course Code : SEC - 03
Nature of the Course : CHEMISTRY SEC-03
Total Credits : 3
Distribution of Marks : 60 (End Sem) + 40 (In-Sem)

COURSE OBJECTIVES:

- The course introduces the students to the diverse roles of inorganic materials in the industry. It gives an insight into how these raw materials are converted into products used in day-to-day life. Students learn about silicates, fertilizers, surface coatings and batteries. The course helps develop the interest of students in the frontier areas of inorganic and material chemistry.

UNITS	CONTENTS	L	T	P	Total Hours
I	**Silicate Industries**: *Glass*: Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass. *Ceramics*: Important clays and feldspar, ceramic, their types and manufacture. High technology ceramics and their applications, superconducting and semiconducting oxides, fullerenes carbon nanotubes and carbon fibre. *Cements*: Classification of cement, ingredients and their role, Manufacture of cement and the setting process, quick setting cements.	**09**	**0**	**-**	**09**
II	**Fertilizers:** Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate.	**05**	**0**	**-**	**05**
III	**Surface Coatings:** Objectives of coatings surfaces, preliminary treatment of surface, 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), Dyes, Wax polishing, Water and Oil paints, additives, Metallic coatings, metal spraying and anodizing.	**08**	**0**	**-**	**08**

	Batteries: Primary and secondary batteries, battery components and their role, Characteristics of Battery. Working of following batteries: Pb acid, Li-Battery, Solid state electrolyte battery. Fuel cells, Solar cell and polymer cell.	**08**			**08**
IV	**Any one experiment:** (i) Estimation of free phosphoric acid in superphosphate fertilizers. (ii) Estimation of CaO in cement. (iii) Laboratory synthesis of the pigments ; Prussian blue, Malachite green, chrome yellow, etc	**-**	**-**	**30**	**30**
	Total	**30**	**0**	**30**	**60**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others (Any one) - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

At the end of this course, students will be able to-

CO1: Develop a comprehensive understanding of silicate industries, fertilizers, surface coatings, and battery technology.

CO2: Apply theoretical knowledge to analyze and evaluate the production processes, properties, and applications of materials used in these industries.

CO3: Assess the effectiveness, environmental impact, and technological advancements in silicate industries, fertilizer production, surface coatings, and battery technology.

CO4: Apply critical thinking skills to address challenges related to material production, environmental sustainability, and technological innovation in these industries.

CO5: **C**onduct experiments to determine free phosphoric acid in fertilizers and CaO in cement and create pigments like Prussian blue, Malachite green, and chrome yellow, and evaluate their properties.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual			CO2			
Conceptual		CO1	CO4	CO3		
Procedural					CO5	
Metacognitive						

SUGGESTED READINGS:

10. E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
11. R. M. Felder, R. W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
12. W. D. Kingery, H. K. Bowen, D. R. Uhlmann: Introduction to Ceramics, Wiley Publishers, New Delhi.
13. J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
14. P. C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
15. R. Gopalan, D. Venkappayya, S. Nagarajan: Engineering Chemistry, Vikas Publications, New Delhi.
16. B. K. Sharma: Engineering Chemistry, Goel Publishing House, Meerut.

FYUGP

DETAILED SYLLABUS OF 4th SEMESTER

Title of the Course : Chemistry C5: Inorganic
Course Code : C-05
Nature of the Course : CHEMISTRY MAJOR
Total Credits : 4
Distribution of Marks : 60 (End Sem) + 40 (In-Sem)

OBJECTIVES:

- To develop the knowledge of chemistry in relation to nuclear chemistry.
- To develop the knowledge of chemistry in relation to various statistical methods of analysis
- To develop the preliminary idea on organometallic chemistry
- To introduce various organic reagents and their applications in inorganic analysis

UNITS	CONTENTS	L	T	P	Total Hours
I	**Nuclear Chemistry**: Nuclear structure, mass defect, binding energy and stability of nuclei, nuclear transmutations and artificial radioactivity, fundamentals of radioactive decay, nuclear reactions including fission and fusion reactions, nuclear reactor and its components, measurement of radioactivity, analytical applications of nuclear reactions and radioactive tracers - in studying reaction mechanism, in diagnosis and treatment of diseases, in industry, in agriculture, in analytical chemistry, in determination of the age of the earth by rock dating method and determination of the age of recent objects by radio carbon dating method.	**16**	**-**	**-**	**16**
II	**Statistical Methodsof Analysis**: Accuracy, precession, deviation, standard deviation, classification of errors, minimization of errors, significant figures. Indicators: choice of indicators in neutralization, redox, adsorption and complexometric reactions.	**10**	**-**	**-**	**10**

III	**Organometallic Chemistry-I:** Definition andclassification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands. Metal carbonyls: 18 electron rule, electron count of mononuclear,polynuclear and substituted metal carbonyls of 3*d* series. Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT. Oxidative addition and reductive elimination reaction, π-acceptor behaviour of CO (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding. Zeise's salt: preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls.	**11**	**-**	**-**	**11**
IV	**Organic Reagents in Inorganic Analysis**: Cupferron, dithizone, benzoin-α-oxime, 1-nitroso-2- naphthol, diphenyl carbazide, diphenyl carbazone, salicylaldoxime, 1,10-phenanthroline, magneson, thiourea, zinc uranyl acetate, oxine.	**08**	**-**	**-**	**08**
V	**Experimental Work** : (Any One) a) Estimation of Ca^{2+} and Mg^{2+} by EDTA b) Estimation of Cu^{2+} by iodometric method	**-**	**-**	**30**	**30**
	Total	**45**	**0**	**30**	**75**

Where,

L: Lectures ***T: Tutorials*** ***P: Practical***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- **Two Internal Examination -** **20 Marks**
- **Others -** **20 Marks**
  - Assignment/Seminar
  - Lab note book/Attendance
  - Group Discussion

COURSE OUTCOMES:

At the end of this programme, students will be able to-

CO1: To *define* mass defect, binding energy, accuracy, precession, etc.

CO2: To *identify* different organic reagents in inorganic analysis

CO3: To *distinguish* nuclear fission and fusion reactions

CO4: To *explain*18 electron rule

CO5: To *elucidate* the structures of mononuclear and binuclear carbonyls using VBT

CO6: To *apply* organic reagents in inorganic analysis

CO7: To *estimate* of Ca^{2+} and Mg^{2+} by EDTA and Cu^{2+} by iodometric method

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	CO1					
Conceptual		CO2, CO3	CO4, CO5, CO6			
Procedural					CO7	
Metacognitive						

Recommended Books:

1. Selected Topics in Inorganic Chemistry--Wahid U. Malik, G. D. Tuli and R. D. Madan. (S. Chand & Co. Ltd.)
2. Advanced Inorganic Chemistry-- Satyaprakash, Basu, Tuli
3. Inorganic Chemistry -- Puri, Sharma and Kalia
4. General and Inorganic Chemistry (Part-I & II) -- R. Sarkar
5. Concise Inorganic Chemistry Wiley India, 2008 -- Lee J. D.
6. Inorganic Chemistry – Principles of structure and reactivity, Pearson Education-- Huheey J. E., Keiter E. A. and Keiter R. L.
7. Qualitative Analysis-- Vogel

FYUGP

DETAILED SYLLABUS OF 4th SEMESTER

Title of the Course : Chemistry C6: Physical
Course Code : C - 06
Nature of the Course : CHEMISTRY MAJOR
Total Credits : 4
Distribution of Marks : 60 (End Sem) + 40 (In-Sem)

COURSE OBJECTIVES:

- To acquaint students in details on chemical kinetics, catalysis and surface chemistry.

UNITS	CONTENTS	L	T	P	Total Hours
I	**Chemical Kinetics:** Order and Molecularity of a reaction, elementary and complex reactions rate laws, differential and integral forms of rate equations of zero,1st, 2nd order reactions, half life periods of 1st and 2nd order reactions, determination of order of reaction by method of integration, half life period, differential method, isolation method, evaluation of rate constant, integrated equation method, graphical method, Guggenheim method (1st order reaction), rate laws and mechanism, steady state approximation. Rate equation of first order, opposite, parallel, consecutive reaction, chain reactions, chain branching, explosion limit, Hydrogen – Bromine thermal reaction. Temperature dependence of reaction rates, Arrhenius equation, energy of activation, collision theory of bimolecular reactions, its limitation. Introduction to activated complex theory, Lindeman's theory of unimolecular gas phase reaction.	**20**	**0**	**-**	**20**
II	**Surface Chemistry** Physical and chemical adsorption of gases on solid surface, adsorption isotherms, types of adsorption isotherm, Freundlich equation, Langmuir adsorption equation. Determination of surface area. Gibbs adsorption equation, application of adsorption in chemical analysis and in industry.	**15**	**0**	**-**	**15**
III	**Catalysis** Criteria of catalysis, homogeneous and heterogeneous catalysis, introduction to acid base catalysis. Mechanisms of catalyzed reactions at solid surfaces, effect of temperature on surface reactions, nano particles as catalysts, autocatalysis, catalytic poison, Michaelis-Menten equation.	**10**	**0**	**-**	**10**

IV	**EXPERIMENTAL WORK (Any one)** a) To determine the rate constant of hydrolysis of methyl acetate catalyzed by hydrogen ion concentration at room temperature. b) To determine the rate constant of Saponification of ethyl acetate. c) Compare the strengths of HCl and H2SO4 by studying kinetics of hydrolysis of methyl acetate. d) To study the kinetics of iodination of propanone in acidic medium. e) To study the rate constant of hydrolysis of sucrose by polarimeter.	**-**	**-**	**30**	**30**
	Total	**45**	**0**	**30**	**75**

Where,

L: Lectures ***T: Tutorials*** ***P: Practical***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- **Two Internal Examination -** **20 Marks**
- **Others -** **20 Marks**
  - Assignment/Seminar
  - Lab note book/Attendance
  - Group Discussion

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

CO1: Develop a comprehensive understanding of chemical kinetics, surface chemistry, and catalysis principles and their applications.

CO2: Apply theoretical knowledge and experimental techniques to analyze reaction mechanisms, rate laws, and surface phenomena.

CO3: Evaluate the factors influencing reaction rates, adsorption processes, and catalytic mechanisms using kinetic data and experimental results.

CO4: Apply critical thinking skills to design experiments, interpret experimental data, and solve problems related to reaction kinetics and surface chemistry.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual	CO1					
Conceptual			CO2, CO3			
Procedural					CO4	
Metacognitive						

SUGGESTED READINGS:

Text Books:

1. Physical Chemistry- G.W. Castellan, Narosa Publishing House, New Delhi.
2. Physical Chemistry - P.C. Rakshit, Science Book Agency, Kolkata.
3. Physical Chemistry Vols. I, II, III and IV – K.L. Kapoor, MacMillan (India) Ltd., New Delhi.
4. Advanced Physical Chemistry – J.N. Gurta& H. Snehi, Pragati Prakashan.

Ref. Books:

1. P.W. Atkins, Physical Chemistry, Oxford University Press.
2. Physical Chemistry – B.R. Puri, L.R. Sharma, Madan S. Pathania, Shobanlal Nagin, S. Chand & Co.
3. Physical Chemistry – D.S. Pahari (Vol. I &II).
4. Physical Chemistry - Levine

FYUGP
DETAILED SYLLABUS OF 4th SEMESTER

Title of the Course	**:**	**Chemistry C7: Organic**
Course Code	**:**	**C - 07**
Nature of the Course	**:**	**CHEMISTRY MAJOR**
Total Credits	**:**	**4**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

OBJECTIVES:

- To make the students familiar about chemistry of carbonyl compounds, carboxylic acids, thiols and amines.
- To provide knowledge about natural as well as synthetic polymers.

UNITS	CONTENTS	L	T	P	Total Hours
I	**Carbonyl Compounds: (Aliphatic and Aromatic)** **Part A:** Structure, reactivity and preparation;Nucleophilic additions, Nucleophilic addition-elimination reactions with ammoniaderivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagelcondensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, Clemmensen, Wolff-Kishner, MPV reduction Addition reactions of unsaturated carbonyl compounds: Michael addition.Unsaturated Aldehydes (Acrolein, Crotonaldehyde, Cinnamaldehyde) Unsaturated Ketone(MVK) .	**10**	**0**	**-**	**10**
	Part B Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applicationsof diethyl malonate and ethyl acetoacetate, malanonitrile.	**04**	**0**	**-**	**04**
II	**Carboxylic Acids and their Derivatives: (Aliphatic and Aromatic):** Preparation, physical properties, and reactions of monocarboxylic acids (Acidity and factorsaffecting it): Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparativestudy of nucleophilic substitution at acyl group -Mechanism of acidic and alkaline hydrolysisof esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann-bromamide degradation Dicarboxylic acids: Oxalic acid, malonic acid, and succinic acid Hydroxy acids: lactic acid, tartaric acid, citric acid and salicylic acid.	**10**	**0**		**10**

III	**Sulphur containing compounds:** Preparation and reactions of thiols, thioethers and sulphonic acids.	**03**	**0**	**-**	**03**
IV	**Nitrogen Containing Functional Groups (Aromatic and Aliphatic)** Preparation and important reactions of nitro compounds, nitriles and isonitriles Amines: Effect of substituent and solvent on basicity; Preparation and properties: Gabrielphthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustivemethylation, Hofmann-elimination reaction; Distinction between 1°, 2° and 3° amines withHinsberg reagent and nitrous acid. Diazonium Salts: Preparation and their synthetic applications. Diazomethane &DiazoaceticEster with synthetic application.	**10**	**-**	**0**	**10**
V	**Polymers** Introduction and classification of polymers; Polymerisation reactions -Addition and condensation - Mechanism of cationic, anionic and free radical addition polymerization; Ziegler-Natta polymerisation of alkenes; Preparation and applications of plastics – thermosetting (phenol-formaldehyde, Polyurethanes) and thermosoftening (PVC, polythene); Fabrics – natural and synthetic (acrylic, polyamido, polyester); Rubbers – natural and synthetic: Buna-S, Chloroprene and Neoprene; Vulcanization; Polymer additives; Biodegradable polymers with examples.	**08**	**-**	**-**	**08**
VI	**EXPERIMENTAL WORK (Any one)** Systematic qualitative analysis of organic compounds having -OH, $-NH_2$,$-NO_2$, $-CONH_2$, -CHO, -COOH, $-CONH_2$ groups.	**-**	**-**	**30**	**30**
	Total	**45**	**0**	**30**	**75**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others (Any one) - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:
After the end of the course students will be able to

CO1: Learn preparation and properties aldehyde, ketone, carboxylic acid, thiols, amines, etc.

CO2: Understand and analyze the mechanisms of key name reactions involving organic compounds, such as Aldol condensation, Cannizzaro reaction, and Hofmann rearrangement.

CO3: Perform systematic qualitative analysis of organic compounds containing functional groups such as -OH, $-NH_2$, $-NO_2$, $-CONH_2$, -CHO, and -COOH.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual						
Conceptual	CO1		CO2			
Procedural					CO3	
Metacognitive						

SUGGESTED READINGS:

Text Books:

1. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Advanced Organic Chemistry by Bahl and Bahl (S Chand Publication)
4. A Textbook of Organic Chemistry by KS Tiwari (Vikash Publishing)
5. Modern Organic Chemistry by Jain and Sharma (Vishal Publishing)
6. Advanced and General Organic Chemistry by SK Ghosh (NCBA)
7. Practical Organic Chemistry by OP Agarwal (Krishna)

Reference Book

1. Organic Chemistry by Paula Y Bruice (Pearson).
2. Advanced Organic Chemistry by Clayden Greeves and Wothers (Oxford).
3. Advanced Organic Chemistry by J March and Michael B Smith (Wiley).
4. Organic Chemistry by Solomons (Wiley).

FYUGP

DETAILED SYLLABUS OF 4th SEMESTER

Title of the Course : Chemistry C8: Symmetry & Quantum Chemistry-I
Course Code : C - 08
Nature of the Course : CHEMISTRY MAJOR
Total Credits : 4
Distribution of Marks : 60 (End Sem) + 40 (In-Sem)

COURSE OBJECTIVES:

- To make the students familiar with symmetry elements & point groups and the various aspects of basic quantum mechanics with specialreference to classical mechanics.

UNITS	CONTENTS	L	T	P	Total Hours
I	**Symmetry & Group Theory-I** Symmetry elements and symmetry operations. Definition of group, symmetry group, point group. Perspective sketch and point group of some common molecules (H_2, HF, CO_2, C_2H_2, C_2H_4, $CHCl_3$, PCl_5, NH_3, BF_3, $[PtCl_4]^{2-}$, BrF_5). Symmetry and mathematical tools, matrix algebra, reducible and irreducible representation, great orthogonality theorem (deduction not necessary), Character table for C_{2v} and C_{3v} point groups.	**15**	**0**	**-**	**15**
II	**Quantum Chemistry-I** Background of quantum mechanics; Black body radiation – Planck's hypothesis, photoelectric effect, de Broglie hypothesis and Heisenberg's uncertainty principle. Postulates of quantum mechanics,quantum mechanical operators (Linear and Hermitian operators), Wave functions, Normalized and Orthogonal Wave Functions. Schrödinger equation and its application to free particle and "particle-in-a-box" (rigorous treatment), quantization of energy levels, zero-point energy; wave functions, probability distribution functions, nodal properties, separation of variables, two- and three-dimensional boxes, degeneracy. Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wavefunctions. Vibrational energy of diatomic molecules and zero-point energy. Angular momentum: Commutation rules, quantization of square of total angular momentum and z-component. Rigid rotator model of rotation of diatomic molecule:Schrödinger equation and its solution. Qualitative treatment of hydrogen atom and hydrogen-like ions: setting up of Schrödinger equation in spherical polar coordinates, radial part, energy (only final energy	**30**	**0**	**-**	**30**

	expression). Average and most probable distances. Setting up of Schrödinger equation for many-electron atoms (He, Li). Need for approximation methods. Statement of variation theorem and application to simple systems (particle-in-a-box, harmonic oscillator, hydrogen atom).				
III	**EXPERIMENTAL WORK:** **pH-metry and Polarimetry (Any one experiment)** (i) pH metric titration (a) strong acid vs. strong base (b) weak acid vs. strong base (c) strong acid vs. weak base (ii) Preparation of buffer solutions of different pH (a) sodium acetate-acetic acid (b) ammonium chloride-ammonium hydroxide (c) Determination of dissociation constant of weak acid (CH_3COOH) / base (NH_4OH) (iii) To determine the concentration of an optically active substance by polarimetric method.	**-**	**-**	**30**	**30**
	Total	**45**	**0**	**30**	**75**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others (Any one) - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

CO1: Develop a comprehensive understanding of symmetry and group theory principles, quantum mechanics foundations, and experimental techniques in analytical chemistry.

CO2: Apply theoretical knowledge and experimental skills to identify molecular symmetries, analyze quantum mechanical systems, and conduct analytical experiments.

CO3: Evaluate molecular structures, wave functions, and experimental data to assess symmetry elements, energy levels, and chemical concentrations.

CO4: Apply critical thinking skills to solve problems related to molecular symmetry, quantum mechanics, and experimental analysis in chemistry.

CO5: Perform pH metric titrations, prepare buffer solutions to analyze the interaction between different types of acids and bases, including strong acid vs. strong base, weak acid vs. strong base, and strong acid vs. weak base.

CO6: Determine the concentration of optically active substances through polarimetric methods, enhancing the understanding of optical activity and its applications in chemical analysis.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual		CO1			CO3	
Conceptual			CO2, CO4			
Procedural		CO5,	CO6			
Metacognitive						

SUGGESTED READINGS:

Text Books:

1. Quantum Chemistry – Ira N. Levine, PHI, New Delhi.
2. Introductory Quantum Chemistry – A.K. Chandra, Tata- McGraw.
3. Chemical Applications of Group Theory- F.A. Cotton, Wiley Eastern Ltd., New Delhi.

Ref. Books:

1. Quantum Chemistry, R.K. Prasad.
2. Quantum Chemistry, B. K. Sen.

FYUGP

DETAILED SYLLABUS OF 4th SEMESTER

Title of the Course	**:**	**Fundamentals of Chemistry-4**
Course Code	**:**	**MINOR-04**
Nature of the Course	**:**	**CHEMISTRY MINOR COURSE-4**
Total Credits	**:**	**4**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

COURSE OBJECTIVES:

- To develop the knowledge about industrial chemistry like-glass, ceramics and cements.
- To develop the knowledge about nuclear chemistry.
- To study the principles of chemical kinetics and the properties of different types of solutions.
- To study the preparations and the properties of aryl halides, alcohols, phenols and ethers.

UNITS	CONTENTS	L	T	P	Total Hours
I	**Introduction to Industrial Chemistry:** **Glass**: Glassy state and its properties, classification (silicate and nonsilicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, safety glass, borosilicate glass, coloured glass, **Ceramics**: Important clays and feldspar, ceramic, their types and manufacture. fullerenes carbon nanotubes and carbon fibre. **Cements**: Classification of cement, ingredients and their role, Manufacture of cement and the setting process, quick setting cements	**07**	**0**	**-**	**07**
	Nuclear Chemistry: Nuclear structure, Mass defect, Binding energy and stability of nuclei, Nuclear transmutations and Artificial radioactivity, Fundamentals of radioactive decay, Nuclear reactions including fission and fusion reactions, Analytical applications of Nuclear Reactions and Radioactive tracers	**06**	**0**	**-**	**06**
II	**Chemical Kinetics** The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order reactions. Half–life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation. Theories of Reaction Rates: Collision theory and	**08**			**08**

	Activated Complex theory of bimolecular reactions. Comparison of the two theories (qualitative treatment only).				
	Solutions Types of solutions, concentration units, Solution of gases in liquids-Henry's law. Solution of liquids in liquids: Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law – non-ideal solutions. Vapour pressure-composition and temperature composition curves of ideal and non-ideal solutions. Distillation of solutions. Lever rule, Azeotropes. Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids. Immiscibility of liquids- Principle of steam distillation. Nernst distribution law and its applications, solvent extraction. Solutions of solids in liquids: the solubility curves.	**07**			**07**
III	**Aryl Halides**: Preparation (Chloro, Bromo &Iodo benzene only): From phenol, Sandmeyer and Gattermann reaction . Reactions: (Chlorobenzene) Aromatic Nucleophilic substitution (replacement by – OH) and effect of Nitro Substituent Reactivity and relative strength of Carbon- halogen bond in alkyl , allyl, vinyl and Aryl Halide.	**08**			**08**
	Alcohols, Phenols and Ethers: Alcohols: Preparation: Preparation of 1^o, 2^o and 3^o alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters. Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. $KMnO_4$, acidic dichromate, conc. HNO_3). Diols: oxidation of diols. Pinacol-Pinacolone rearrangement. Phenols: Preparation: Cumene hydroperoxide method, from diazonium salts. Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. ReimerTiemann Reaction Ethers (aliphatic and aromatic): Cleavage of ethers with HI.	**09**			**09**
IV	**Experimental Work:** **Inorganic Volumetric Analysis: (any one)** i. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator. ii. Estimation of oxalic acid by titrating it with	**-**	**-**	**30**	**30**

	$KMnO_4$ iii. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$ iv. Estimation of Fe (II) ions by titrating it with $KMnO_4$. v. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$				
	Total	**45**	**0**	**30**	**75**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others (Any one) - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

At the end of this course, students will be able to-

CO1: Recall key concepts in industrial chemistry, nuclear chemistry, chemical kinetics, and solution chemistry.

CO2**:** Develop a comprehensive understanding of the principles underlying industrial chemistry, nuclear chemistry, chemical kinetics, and solution chemistry.

CO3: Apply theoretical knowledge and experimental skills to analyze and solve problems related to industrial processes, reaction kinetics, and solution behavior.

CO4: Analyze reaction mechanisms, solution properties, and experimental data to draw conclusions and make predictions.

CO5: Evaluate the effectiveness of reaction mechanisms, solution properties, and experimental procedures to assess their reliability and accuracy.

CO6**:** Design experiments, propose solutions, and develop new methodologies to address challenges in chemistry and enhance understanding of chemical phenomena.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual	CO1		CO3	CO4		
Conceptual		CO2			CO5	
Procedural					CO6	
Metacognitive						

SUGGESTED READINGS:

1. Puri, Sharma, Kalia, Principles of Inorganic Chemistry, Vishal Pub. Co., 33rd ed., 2017
2. Das Asim K., Fundamentals of Inorganic Chemistry, Vol. I, CBS Publications, 2nd Ed. 2010.
3. Pradeep's Inorganic Chemistry, Vol. I & II, Universal Book seller, 14th Ed. 2017
4. Physical Chemistry- G.W. Castellan, Narosa Publishing House, New Delhi.
5. Physical Chemistry - P.C. Rakshit, Science Book Agency, Kolkata
6. Physical Chemistry Vols. I, II, III and IV – K.L. Kapoor, MacMillan (India) Ltd., New Delhi
7. Advanced Physical Chemistry – J.N. Gurta& H. Snehi, Pragati Prakashan.
8. Organic Chemistry – B.S. Bahl and A. Bahl (Vol. I & II)
9. A Text Book of Organic Chemistry (Vol. I & II) – B.K. Sharma, G.P. Pokhriji and S.K. Sharma, (S. Chand & Co.)

Ref. Books:

1) P.W. Atkins, Physical Chemistry, Oxford University Press
2) Physical Chemistry – B.R. Puri, L.R. Sharma, Madan S. Pathania, Shobanlal Nagin, S. Chand & Co.
3) Physical Chemistry – D.S. Pahari (Vol. I &II)
4) Physical Chemistry - Levine
5) Organic Chemistry – M.K. Jain, S.Chand& Co.

FYUGP
DETAILED SYLLABUS OF 5th SEMESTER

Title of the Course : Chemistry C9: Inorganic
Course Code : C-09
Nature of the Course : CHEMISTRY MAJOR
Total Credits : 4
Distribution of Marks : 60 (End Sem) + 40 (In-Sem)

OBJECTIVES:

- To develop the basic knowledge of chemistry in relation to organometallic compounds and catalysis by organometallic compounds.
- To emphasize on different terms related to organometallic compounds, metal clusters and inorganic polymers.
- To develop the preliminary knowledge about synergic effect, PSEP Theory, synthesis, structural aspects and applications of inorganic polymers, etc
- To develop the basic knowledge of chemistry in relation to different types chromatographic methods.

UNITS	CONTENTS	L	T	P	Total Hours
I	**Organometallic Chemistry-II:**Isolobal analogy, general methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3*d* series. Role of triethylaluminium in polymerization of ethene (Ziegler–Natta Catalyst), species present in ether solution of Grignard reagent and their structures. Ferrocene: preparation and reactions (acetylation, alkylation, metalation, Mannichcondensation), structure and aromaticity, comparison of aromaticity and reactivity with that of benzene. Catalysis by organometallic compounds: study of the following industrial processes and their mechanism: 1. Alkene hydrogenation (Wilkinson's Catalyst) 2. Hydroformylation (Co salts) 3. Wacker Process 4. Synthetic gasoline (Fischer Tropsch reaction)	**16**	**-**	**-**	**16**
II	**Transition metal clusters:**Definition of cluster, metal-metal bond in cluster, synthesis of metal carbonyl cluster of Cr, Fe and Mo (only low nuclearity clusters up to 4 metal atoms). Closed shell electronic requirement for cluster compounds –rules for polyhedral skeletal electron pair theory (PSEPT). Nitrosyl compounds: synthesis, properties and structures of nitrosyls of Fe, Co and Ni.	**14**	**-**	**-**	**14**

III	**Inorganic polymers:**Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes, and polysulphates.	**07**	**-**	**-**	**07**
IV	**Chromatographic Methods:**Paper, thin layer, column,gas chromatography – separation of compounds, development and R_f values. HPLC – principle only.	**08**	**-**	**-**	**08**
IV	**EXPERIMENTAL WORK (Any one):** i) Estimation of Nickel (II) using DMG ii) Estimation of percentage of mixed oxide in an ore Hematite, dolomite, limestone	**-**	**-**	**30**	**30**
	Total	**45**	**0**	**30**	**75**

Where,

L: Lectures ***T: Tutorials*** ***P: Practical***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- **Two Internal Examination -** **20 Marks**
- **Others -** **20 Marks**
  - Assignment/Seminar
  - Lab note book/Attendance
  - Group Discussion

COURSE OUTCOMES:

At the end of this programme, students will be able to-

CO 1. Analyze and apply isolobal analogies and general methods of preparation for mono and binuclear carbonyls of 3d series transition metals.

CO 2. Evaluate the role of triethylaluminium in the polymerization of ethene and the species present in the ether solution of Grignard reagents, including their structures.

CO 3. Analyze the preparation, structure, aromaticity, and reactivity of ferrocene, and compare its aromaticity and reactivity with that of benzene.

CO 4. Apply and explain the mechanisms of industrial catalytic processes involving organometallic compounds, including alkene hydrogenation, hydroformylation, Wacker process, and Fischer-Tropsch reaction.

CO 5. Evaluate the synthesis, properties, and structures of transition metal clusters and nitrosyl compounds, including the application of polyhedral skeletal electron pair theory (PSEPT) for cluster compounds.

CO 6. Analyze the types, synthesis, structural aspects, and applications of inorganic polymers, including silicones, siloxanes, borazines, silicates, and phosphazenes.

CO 7. Apply chromatographic methods such as paper, thin layer, column, and gas chromatography for the separation of compounds, and explain the principles of High-Performance Liquid Chromatography (HPLC).

CO 8. Conduct experimental estimations of Nickel (II) using DMG and determine the percentage of mixed oxides in ores such as hematite, dolomite, and limestone.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO3, CO6	CO2, CO5	
Procedural			CO4, CO7, CO8	CO1		
Metacognitive						

SUGGESTED READINGS:

1. Lee J. D., Concise Inorganic Chemistry Wiley India, 5th Edn., 2008.

2. Huheey J. E., Keiter E. A. and Keiter R. L., Inorganic Chemistry – Principles of structure and reactivity, Pearson Education, 4th Ed. 2002.

3. Puri, Sharma, Kalia, Principles of Inorganic Chemistry, Vishal Pub. Co., 33rd ed., 2017

4. Selected Topic in Inorganic Chemistry, S. Chand, New Delhi, 17th Ed., 2010

5. Das Asim K., Fundamentals of Inorganic Chemistry, Vol. I, CBS Publications, 2nd Ed. 2010

6. Pradeep's Inorganic Chemistry, Vol. I & II, Universal Book seller, 14th Ed. 2017

FYUGP

DETAILED SYLLABUS OF 5thSEMESTER9

Title of the Course : Chemistry C10: Physical
Course Code : C - 10
Nature of the Course : CHEMISTRY MAJOR
Total Credits : 4
Distribution of Marks : 60 (End Sem) + 40 (In-Sem)

COURSE OBJECTIVES:

- To understand physical chemistry in the form of physical forces which govern our surroundings,their mathematical expression and applications.

UNITS	CONTENTS	L	T	P	Total Hours
I	**Solution and Colligative Properties** Dilute solutions, lowering of vapour pressure, Raoult's and Henry's Laws and their applications, distribution of solutes between two immiscible liquids, Nernst's Distribution law, and solvent extraction. Thermodynamic derivation using chemical potential to derive relation between the four colligative properties [i) relative lowering of vapour pressure. ii) elevation of boiling point iii) depression of freezing point iv) osmotic pressure] and amount of solute, application in calculating molar masses of normal, associated and dissociated solutes in solution.	15	0	-	15
II	**System of Variable Composition and Chemical Equilibrium** Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs-Duhem equation, chemical potential of ideal mixtures, effect of temperature and pressure on chemical potential, Duhem-Margules equation, change in thermodynamic functions in mixing of ideal gases. Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases, concept of activity and activity coefficient, concept of fugacity. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Coupling of exoergic and endoergic reactions. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration. Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants *Kp*,*Kc* and *Kx*. Le Chatelier principle; equilibrium between ideal gases and a pure condensed phase.	20	0	-	20
III	**Electrical & Magnetic Properties of Atoms and Molecules** Basic ideas of electrostatics, Electrostatics of dielectric	10	0	-	10

	media, Clausius-Mosotti equation, Debye equation, Lorentz-Laurenz equation, Dipole moment and molecular polarizabilities and their measurements. Diamagnetism, paramagnetism, Ferromagnetism and Antiferromagnetism and their molecular interpretation, Magnetic susceptibility and its measurement.				
IV	**EXPERIMENTAL WORK (Any one experiment)** **Potentiometric titrations** i. Strong acid vs. strong base ii. Weak acid vs. strong base iii. Dibasic acid vs. strong base iv. Strong acid vs weak base iv. Potassium dichromate vs. Mohr's salt **Conductometry** (i) Determination of cell constant and hence the specific conductance of an electrolyte. (ii) Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid. (iii) Conductometric titrations: (a) Strong acid vs. strong base (b) Weak acid vs. strong base (c) Mixture of strong acid and weak acid vs. strong base Strong acid vs. weak base	**-**	**-**	**30**	**30**
	Total	**45**	**0**	**30**	**75**

Where,

L: Lectures ***T: Tutorials*** ***P: Practical***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- **Two Internal Examination -** **20 Marks**
- **Others -** **20 Marks**
  - Assignment/Seminar
  - Lab note book/Attendance
  - Group Discussion

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

CO1: Understand fundamental concepts of dilute solutions and colligative properties.

CO2: Understand thermodynamic principles in systems of variable composition and chemical equilibrium and also analyze ideal gases and equilibrium systems.

CO3: Analyze experimental data from titrations and conductometric measurements.

CO4: Evaluate experimental results and theoretical principles in solution chemistry.

CO5: Design and conduct experiments to investigate solution behavior and properties.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual			CO1			
Conceptual				CO2	CO4	
Procedural				CO3	CO5	
Metacognitive						

SUGGESTED READINGS:

Text Books:

1. Physical Chemistry- G.W. Castellan, Narosa Publishing House, New Delhi.
2. Physical Chemistry - P.C. Rakshit, Science Book Agency, Kolkata.
3. Physical Chemistry Vols. I, II, III and IV – K.L. Kapoor, MacMillan (India) Ltd., New Delhi.
4. Advanced Physical Chemistry – J.N. Gurta& H. Snehi, Pragati Prakashan.

Ref. Books:

1. P.W. Atkins, Physical Chemistry, Oxford University Press.
2. Physical Chemistry – B.R. Puri, L.R. Sharma, Madan S. Pathania, Shobanlal Nagin, S. Chand & Co.
3. Physical Chemistry – D.S. Pahari (Vol. I &II).
4. Physical Chemistry – Levine

FYUGP

DETAILED SYLLABUS OF 5th SEMESTER

Title of the Course : Chemistry C11: Organic
Course Code : C - 11
Nature of the Course : CHEMISTRY MAJOR
Total Credits : 4
Distribution of Marks : 60 (End Sem) + 40 (In-Sem)

Course objective:

1. To make the students familiar about chemistry of Heterocyclic compounds,carbohydrates Nucleic acids, etc.
2. To provide basic concept of disconnection approach

UNITS	CONTENTS	L	T	P	Total Hours
I	**Heterocyclic Compound-I** Classification and nomenclature, structure, synthesis, and properties of 3membered heterocycles: Aziridine, oxirane and thiirane. Aromaticity in 5-numbered and 6-membered rings containing one heteroatom; Synthesis, reactions and mechanism of substitution reactions of: Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis), Indole (Fischer indole synthesis and Madelung synthesis), quinoline and isoquinoline, Skraup synthesis, Friedlander's synthesis, Knorr quinoline synthesis, Doebner- Miller synthesis, Bischler-Napieralski reaction	**16**	**0**	**-**	**16**
II	**Amino acids and peptides** Amino acids, and their classification.α-Amino Acids - Synthesis, ionic properties and reactions. Zwitterions, pKa values, isoelectric point and electrophoresis. Study of peptides: determination of their primary structures-end group analysis, methods of peptide synthesis. Synthesis of peptides using N-protecting, C-protecting and C-activating groups. Proteins: Elementary idea of primary, secondary and tertiary structures of protein	**10**	**0**	**-**	**10**
III	**Disconnection approach in Organic Synthesis** Elementary idea about disconnection, synthon and synthetic equivalent, functional group	**09**	**0**	**-**	**09**

	interconversion (FGI), functional group addition (FGA)., simple examples off retrosynthesis of c-c bond formation (Corey house, Grignard, Aldol condensation, Wittig). retrosynthesis of monofunctionalized and bi-functionalized (1,1 and 1,2) compounds, umpolung.				
IV	**Nucleic acids** Components of nucleic acids, nucleosides and nucleotides; structure, synthesis and reactions of: adenine, guanine, cytosine, uracil and thymine; structure of polynucleotides. structure of DNA (Watson &Crick model) and RNA, genetic code biological role of DNA and RNA, replication,transcription and translation (elementary idea only) Enzymes: classification, active site, specificity, mechanism of enzyme action, co-enzyme	**05**	**0**	**-**	**05**
V	**Pharmaceutical Compounds: Structure and Importance** Classification, structure and therapeutic uses of antipyretics: Paracetamol (with synthesis), Analgesics: Ibuprofen (with synthesis), Antimalarials: Chloroquine (with synthesis). Synthesis and mode of action of Suphanilamides and other Sulphadrugs (sulphapyridine, sulphathiazole) Anelementary treatment of antibiotics and detailed study of chloramphenicol	**05**	**0**	**-**	**05**
VI	**EXPERIMENTAL WORK:** **Practical: (any two)** 1. Isolation and characterization of DNA from onion/ cauliflower/peas. 2. Separation of different amino acids by paper Chromatography 3. Estimation of proteins by Lowry's method. 4. Preparation of biodiesel from vegetable oil	**-**	**-**	**30**	**30**
	Total	**45**	**0**	**30**	**75**

Where,

L: Lectures ***T: Tutorials*** ***P: Practical***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- **Two Internal Examination -** **20 Marks**
- **Others -** **20 Marks**
  - Assignment/Seminar
  - Lab note book/Attendance
  - Group Discussion

COURSE OUTCOMES:

After the end of the course students will be able to-

CO1: Understand the classification, nomenclature, structure, synthesis, and properties of various heterocyclic compounds, amino acids, peptides, nucleic acids, and pharmaceutical compounds.

CO2: Apply the principles of synthesis and reaction mechanisms to heterocyclic compounds, amino acids, peptides, and pharmaceutical compounds, and perform practical techniques such as isolation, separation, and estimation in the laboratory.

CO3: Analyze the aromaticity and substitution reactions of heterocyclic compounds, the primary structures of peptides and proteins, and the disconnection approach in organic synthesis.

CO4: Evaluate the synthesis and biological roles of nucleic acids and enzymes, and assess the therapeutic uses and modes of action of various pharmaceutical compounds.

CO5: Synthesize peptides using N-protecting, C-protecting, and C-activating groups, and design retrosynthetic pathways for monofunctionalized and bifunctionalized compounds.

CO6: Perform experimental procedures to isolate and characterize DNA, separate amino acids, estimate protein content, and prepare biodiesel, demonstrating proficiency in laboratory techniques.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual			CO2			
Conceptual			CO1	CO3	CO4	
Procedural					CO5	CO6
Metacognitive						

SUGGESTED READINGS:

Text Books:

1. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Advanced Organic Chemistry by Bahl and Bahl (S Chand Publication)
4. A Textbook of Organic Chemistry by KS Tiwari (Vikash Publishing)
5. Modern Organic Chemistry by Jain and Sharma (Vishal Publishing)
6. Advanced and General Organic Chemistry by SK Ghosh (NCBA)
7. Organic Chemistry by Mukerji, Singh and Kapoor Vol 3 (Wiley)
8. Practical Organic Chemistry by OP Agarwal (Krishna)

Reference Books:

1. Organic Chemistry by Paula Y Bruice (Pearson)
2. Advanced Organic Chemistry by Clayden Greeves and Wothers (Oxford)
3. Advanced Organic Chemistry by J March and Michael B Smith (Wiley)
4. Organic Chemistry by Solomons (Wiley)

FYUGP
DETAILED SYLLABUS OF 5th SEMESTER

Title of the Course	**:**	**Fundamentals of Chemistry-5**
Course Code	**:**	**MINOR-05**
Nature of the Course	**:**	**CHEMISTRY MINOR COURSE-5**
Total Credits	**:**	**4**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

COURSE OBJECTIVES:

- To develop the idea about supra molecular and nano materials
- To develop the basic knowledge of chemistry in relation to metal ions present in biological systems, toxicity of metal ions.
- To develop the knowledge about the principles of conductance, including conductivity, transference numbers, and their applications.
- To learn electrochemistry concepts such as EMF, Nernst equation, electrode potentials, and their practical applications.
- To study the preparations and the properties of aldehydes, ketones and carboxylic acid.

UNITS	CONTENTS	L	T	P	Total Hours
I	**Introduction to Material Chemistry:** Idea about supra molecular interaction. Solid state reactions. Nano materials – synthesis and characterization. C – C composite, polymer and nanocomposite. Introduction of chemistry of clay (Kaolinite, Montmorillonite and Laponite)	**07**	**0**	**-**	**07**
	Bio inorganic Chemistry: role of alkali metals, Na/K-pump, role of alkaline earth metals, iron, copper, cobalt, zinc and molybdenum. Haemoglobin and myoglobin. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity,	**08**	**0**	**-**	**08**

II	**Conductance** Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch's law of independent migration of ions. Transference number and its experimental determination using Hittorf and Moving boundary methods. Ionic mobility. Applications of conductance measurements: determination of degree of ionization of weak electrolyte, solubility and solubility products of sparingly soluble salts, Ionic product of water, hydrolysis constant of a salt. Conductometric titrations (only acidbase).	**08**	**0**	**0**	**08**
	Electrochemistry Reversible and irreversible cells. Concept of EMF of a cell. Measurement of EMF of a cell. Nernst equation and its importance. Types of electrodes. Standard electrode potential. Electrochemical series. Thermodynamics of a reversible cell, calculation of thermodynamic properties: ΔG, ΔH and ΔS from EMF data. Calculation of equilibrium constant from EMF data. Concentration cells with transference and without transference. Liquid junction potential and salt bridge. P^H determination using hydrogen electrode and quinhydrone electrode. Commercial applications of galvanic cell, dry cell, lead storage battery, fuel cell.	**08**	**0**	**0**	**08**
III	**Aldehydes and Ketones (Aliphatic and Aromatic):** (Formaldehyde, Acetadehyde, Acetone &Benzldehyde) Preparation: From acid chlorides and nitriles. Reactions : reaction with HCN, ROH, $NaHSO_3$, NH_2-G derivatives , Iodoform test, Aldol Condensation, cannizzaro's reaction, Clemenson and Wolf-Kishner reaction, MPV reduction, Wittig reaction, Bnzoin condensation, Rosenmund reduction.	**07**	**0**	**0**	**07**

	Carboxylic Acid and their Derivatives: Carboxylic Acids (Aliphatic & Aromatic): Preparation: Acidic and Alkaline hydrolysis of esters. Reaction: Hell-Volhard-Zelinsky Reaction. Preparation of Acid Chloride, Anhydrides, Esters, Amides from Acids and their interconversion. Reactions: Reformatsky reaction, Perkin reaction, Aromatic Carboxylic acid- Benzoic acid, Cinnamic Acid, Phthalic Acid.	**07**	**0**	**0**	**07**
IV	**Experimental Work: (Any one)** **Potentiometric titrations:** a) Strong acid vs. strong base b) Weak acid vs. strong base c) Dibasic acid vs. strong base d) Strong acid vs weak base **Conductometry:** (iv) Determination of cell constant and hence the specific conductance of an electrolyte. (v) Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid. (vi) Conductometric titrations: (d) Strong acid vs. strong base (e) Weak acid vs. strong base (f) Dibasic acid vs. strong base (g) Strong acid vs. weak base	**-**	**-**	**30**	**30**
	Total	**45**	**0**	**30**	**75**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others (Any one) - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

At the end of this course students will be able to-

CO1: Gain insight into material chemistry, including supra molecular interactions, solid-state reactions, and the synthesis and characterization of nano materials.

CO2: Understand the role of various metals in biological systems and the toxicity of certain metal ions.

CO3: Apply knowledge of conductance principles to analyze the behavior of electrolytes and conductometric titrations and to understand reversible and irreversible cells, EMF measurements, and commercial applications of galvanic cells.

CO4: Analyze the properties and reactions of aldehydes, ketones, carboxylic acids, and their derivatives in both aliphatic and aromatic compounds.

CO5: Design and conduct experiments in potentiometric titrations and conductometry to determine specific conductance, degree of dissociation, and conductometric titrations for various acid-base systems.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual		CO1				
Conceptual		CO2	CO3	CO4		
Procedural					CO5	
Metacognitive						

-

SUGGESTED READINGS:

1. Puri, Sharma, Kalia, Principles of Inorganic Chemistry, Vishal Pub. Co., 33rd ed., 2017
2. Das Asim K., Fundamentals of Inorganic Chemistry, Vol. I, CBS Publications, 2nd Ed. 2010.
3. Pradeep's Inorganic Chemistry, Vol. I & II, Universal Book seller, 14th Ed. 2017
4. A Text Book of Physical Chemistry – Negi & S.C. Anand, Wiley Eastern
5. Physical Chemistry, Castellan G. W., Narosa Publishing
6. Principles of Physical Chemistry, Puri, Sharma, Pathania, Shoban Lal, (S. Chand & Co.)
7. Organic Chemistry – B.S. Bahl and A. Bahl (Vol. I & II)
8. A Text Book of Organic Chemistry (Vol. I & II) – B.K. Sharma, G.P. Pokhriji and S.K. Sharma, (S. Chand & Co.)

Ref. Books:

1) P.W. Atkins, Physical Chemistry, Oxford University Press

2) Physical Chemistry – B.R. Puri, L.R. Sharma, Madan S. Pathania, ShobanlalNagin, S. Chand & Co.

3) Physical Chemistry – D.S. Pahari (Vol. I &II)

4) Physical Chemistry - Levine

5) Organic Chemistry – M.K. Jain, S.Chand& Co.

FYUGP
DETAILED SYLLABUS OF 6th SEMESTER

Title of the Course : Chemistry C12: Inorganic
Course Code : C-12
Nature of the Course : CHEMISTRY MAJOR
Total Credits : 4
Distribution of Marks : 60 (End Sem) + 40 (In-Sem)

OBJECTIVES:

- To develop the basic knowledge of chemistry in relation to metal ions present in biologicalsystems, toxicity of metal ions.
- To develop idea about supra molecular and nano materials
- To develop the knowledge about industrial chemistry like-glass, ceramics and cements.

UNITS	CONTENTS	L	T	P	Total Hours
I	**Bio-Inorganic Chemistry**:Metal ions present in biological systems, classification of elements according to their action in biological system. role of alkali metals, Na/K-pump, role of alkaline earth metals, iron, copper, cobalt, zinc and molybdenum. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Iron and its application in bio-systems, Hemoglobin and myoglobin. Metalloprotein and metalloenzymes, plastocyanin, vitamin B12, carbonic anhydrase and nitrogenase. Metal ion in medicine -- cisplatin and carboplatin. Use of chelating agents in medicine.	**15**	**-**	**-**	**15**
II	**Introduction to material chemistry:** Idea about supra molecular interaction. Solid state reactions. Nano materials – synthesis and characterization. C–C composite, polymer and nanocomposite. Introduction of chemistry of clay (Kaolinite, Montmorillonite and Laponite).	**15**	**-**	**-**	**15**
III	**Industrial Chemistry**: Glass: Glassy state and its properties, classification (silicate and nonsilicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass. Ceramics: Important clays and feldspar, ceramic, their types and manufacture. High technology ceramics and their applications, superconducting and semiconducting oxides, fullerenes carbon nanotubes and carbon fibre. Cements: Classification of cement, ingredients and their role, Manufacture of cement and the setting process,	**15**	**-**	**-**	**15**

	quick setting cements				
IV	**Experimental Work**: Qualitative analysis of inorganic salt mixture including interfering radical (5 radicals)	**-**	**-**	**30**	**30**
	Total	**45**	**0**	**30**	**75**

Where,

L: Lectures ***T: Tutorials*** ***P: Practical***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- **Two Internal Examination -** **20 Marks**
- **Others -** **20 Marks**
  - Assignment/Seminar
  - Lab note book/Attendance
  - Group Discussion

COURSE OUTCOMES:

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

CO1: Recognize roles and classifications of metal ions in biological systems to understand supramolecular interactions and nanomaterial properties.

CO2: Identify properties and manufacturing processes of glass, ceramics, and cement.

CO3: Explain biological and medical roles of metal ions and apply chemistry principles to synthesize nanomaterials.

CO4: Analyze metal ion effects in biological systems and assess applications of nanomaterials and composites.

CO5: Evaluate functions of metalloproteins, metalloenzymes and nanomaterial synthesis methods.

CO6: Perform qualitative analysis of inorganic salts and identify interfering radicals.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual				CO2		
Conceptual			CO1, CO3	CO4		
Procedural					CO5, CO6	
Metacognitive						

SUGGESTED READINGS:

1. Lee J. D., Concise Inorganic Chemistry Wiley India, 5th Edn., 2008

2. Huheey J. E., Keiter E. A. and Keiter R. L., Inorganic Chemistry – Principles of structure and reactivity, , Pearson Education, 4th Ed. 2002

3. Puri, Sharma, Kalia, Principles of Inorganic Chemistry, Vishal Pub. Co., 33rd ed., 2017

4. Selected Topic in Inorganic Chemistry, S. Chand, New Delhi, 17th Ed., 2010

5. Das Asim K., Fundamentals of Inorganic Chemistry, Vol. I, CBS Publications, 2nd Ed. 2010

6. Pradeep's Inorganic Chemistry, Vol. I & II, Universal Book seller, 14th Ed. 2017

FYUGP

DETAILED SYLLABUS OF 6th SEMESTER

Title of the Course : Chemistry C13: Physical
Course Code : C - 13
Nature of the Course : CHEMISTRY MAJOR
Total Credits : 4
Distribution of Marks : 60 (End Sem) + 40 (In-Sem)

COURSE OBJECTIVES:

- To acquaint students in details on phase equilibria, colloidal state,and various aspects of photochemistry.

UNITS	CONTENTS	L	T	P	Total Hours
I	**Phase Equilibria** Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems; Clausius-Clapeyron equation and its applications to solid-liquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems, with applications. Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points, solid solutions. Three component systems, water-chloroform-acetic acid system, triangular plots. *Binary solutions:* Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and nonideal), azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation. Nernst distribution law: its derivation and applications.	**20**	**0**	**-**	**20**
II	**Colloidal state** Electro kinetic phenomenon- electrophoresis, electro-osmosis, electrical double layer and zeta potential, theory of stabilities of colloids, protective action of Lyophillic sol-gold number, determination of Avogadro's number, coagulation of colloids, Schultz – Hardy rule, association of colloids, emulsions, micelles and their structure, critical micelles concentration, Donnan membrane equilibria.	**15**	**0**	**-**	**15**
III	**Photochemistry** Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws of photochemistry, quantum yield, actinometry, examples and reasons of low and high quantum yields, photochemical	**10**	**0**	**-**	**10**

	equilibrium and the differential rate of photochemical reactions, photosensitised reactions, quenching. Role of photochemical reactions in biochemical processes, photostationary states, chemiluminescence, luminescence. Photodimerisation-dimerisation of Anthracene, photochemical reaction– H_2-Cl_2, H_2-Br_2, dissociation of HI, fluorescence, phosphorescence, Joblonski diagram.				
IV	**Experimental Work: (Any one)** a) Determination of critical solution temperature and composition of the phenol-water system b) To study the effect of impurity (succinic acid) on the CST of phenol-water system. c) To study the effect of impurity (sodium chloride) on the CST of phenol-water system d) Distribution of acetic/ benzoic acid between water and cyclohexane. e) To study the distribution of iodine between CCl_4 and water. f) To prepare arseneoussulphide sol and compare the precipitating power of mono-, di- and tri-valent cations.	**-**	**-**	**30**	**30**
	Total	**45**	**0**	**30**	**75**

Where,

L: Lectures ***T: Tutorials*** ***P: Practical***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- **Two Internal Examination -** **20 Marks**
- **Others -** **20 Marks**
  - Assignment/Seminar
  - Lab note book/Attendance
  - Group Discussion

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

CO1: Develop a comprehensive understanding of phase equilibria and interpret phase diagrams for both single-component and multi-component systems, including solid-liquid equilibria and binary solutions.

CO2: Apply knowledge of colloidal state principles to analyze phenomena such as electrokinetics, colloidal stability, coagulation, and emulsions.

CO3: Utilize theories of colloidal stability and properties in practical scenarios, such as determining Avogadro's number and understanding mechanisms of coagulation.

CO4: Analyze the characteristics of electromagnetic radiation and the fundamental laws governing photochemistry and understand photochemical reactions, quantum yield, and the significance of photochemistry in biochemical processes.

CO5: Design and execute experiments to investigate critical solution temperature, distribution phenomena, and colloidal properties, applying the principles acquired during the course.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual			CO3	CO2		
Conceptual			CO1	CO4		
Procedural						CO5
Metacognitive						

SUGGESTED READINGS:

Text Books:

1. Physical Chemistry, G.W. Castellan, Narosa Publishing House, New Delhi.
2. Physical Chemistry - P.C. Rakshit, Science Book Agency, Kolkata.
3. Physical Chemistry Vols. I, II, III and IV – K.L. Kapoor, MacMillan (India) Ltd., New Delhi.
4. Advanced Physical Chemistry – J.N. Gurta& H. Snehi, Pragati Prakashan.
5. Physical Chemistry – B.R. Puri, L.R. Sharma, Madan S. Pathania, Shobanlal Nagin, S. Chand& Co.

Ref. Books:

1. Physical Chemistry- P.W. Atkins, Oxford University Press.
2. Physical Chemistry – D.S. Pahari (Vol. I &II).
3. Physical Chemistry - Levine

FYUGP

DETAILED SYLLABUS OF 6th SEMESTER

Title of the Course : Chemistry C14: Organic
Course Code : C - 14
Nature of the Course : CHEMISTRY MAJOR
Total Credits : 4
Distribution of Marks : 60 (End Sem) + 40 (In-Sem)

Course objective:

1. To make the students familiar about chemistry of carbohydrates, dyesand lipids
2. To provide basic concept of Pericyclic reaction and spectroscopy.

UNITS	CONTENTS	L	T	P	Total Hours
I	**Introduction toabsorption and emission spectroscopy.** UV Spectroscopy: Types of electronic transitions, λ_{max}, Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; Application of Woodward. Rules for calculation of λ_{max} for the following systems: α,β unsaturated aldehydes, ketones; Conjugated dienes: alicyclic, homoannular and heteroannular; distinction between cis and trans isomers. IR Spectroscopy: functional group and Fingerprint region and its significance; application of IR spectroscopy in functional group analysis. NMR Spectroscopy: Basic principles of Proton Magnetic Resonance, chemical shift and factors influencing it; Spin – Spin coupling and coupling constant; Anisotropic effects in alkene, alkyne, aldehydes and aromatics, Concept of Relaxation and Interpretation of NMR spectra of simple compounds. Mass spectrometry: Basic principles, Concept of Molecular ion and base Peak, Mc Lafferty rearrangement. Applications of IR, UV, NMR and Mass for identification of simple organic molecules.	**15**	**0**	**-**	**15**
II	**Carbohydrates** Occurrence, classification, and their biological importance. Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, determination of ring size of glucose and fructose, Haworth projections and conformational structures; Ascending and	**08**	**0**	**-**	**08**

	descending in monosaccharide; Interconversions of aldoses and ketoses; Killiani- Fischer synthesis and Ruff degradation.				
III	**Lipids** Introduction to oils and fats; common fatty acids present in oils and fats, Hydrogenation of fats and oils, Saponification value, acid value, iodine number. Reversion and rancidity.	**08**	**0**	**-**	**08**
IV	**Pericyclic reactions:** Basic concepts of pericyclic reaction and examples of electrocyclic, cycloaddition and sigmatropic rearrangements reactions, FMO analysis and Woodward Hoffmann selection rules. Orbital symmetry, selection rules and stereochemistry of electrocyclic reaction. Cycloaddition: [2+2] and [4+2] cycloaddition FMO approach, DielsAlder reaction-endo/exo-regioselectivity. 1,3-dipolar cycloaddition Sigmatropicrearrangements[1,3], [1,5] sigmatropic rearrangements, Claisen, and Cope rearrangement,	**08**	**0**	**-**	**08**
V	**Dyes** Classification, Colour and constitution; Mordant and Vat Dyes; Chemistry of dyeing; Synthesis and applications of: Azo dyes – Methyl Orange and Congo Red (mechanism of Diazo Coupling); Triphenyl Methane Dyes - Malachite Green, Rosaniline and Crystal Violet; Phthalein Dyes – Phenolphthalein and Fluorescein; Synthesis of Alizarin and Indigotin; Edible Dyes with examples.	**06**	**0**	**-**	**06**
VI	**Experimental Work:(Any two experiments)** 1. Identification of simple organic compounds by IR spectroscopy and NMR Spectroscopy (Spectra to be provided). 2. Extraction of caffeine from tea leaves. 3. Saponification value of an oil or a fat. 4. Determination of Iodine number of an oil/ fat. 5. To determine the molecular weight of camphor by Rust method.	**-**	**-**	**30**	**30**
	Total	**45**	**0**	**30**	**75**

Where,

L: Lectures ***T: Tutorials*** ***P: Practical***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- **Two Internal Examination -** **20 Marks**
- **Others -** **20 Marks**
  - Assignment/Seminar
  - Lab note book/Attendance
  - Group Discussion

COURSE OUTCOMES:

After the end of the course students will be able to-

CO1: Understand the fundamental principles and applications of various spectroscopic techniques (UV, IR, NMR, Mass Spectrometry) and their roles in identifying organic molecules.

CO2: Apply spectroscopic methods to analyze and interpret the structures of simple organic compounds, and perform laboratory experiments to extract, saponify, and determine values related to lipids and other compounds.

CO3: Analyze the structural and functional aspects of carbohydrates, lipids, and dyes, including their classification, synthesis, and reactions, using both theoretical and practical approaches.

CO4: Evaluate the mechanisms and stereochemistry of pericyclic reactions, and assess the chemical properties and synthesis of various dyes, considering their industrial and biological significance.

CO5: Synthesize and characterize organic compounds, including carbohydrates and dyes, utilizing learned reactions and spectroscopic techniques, and plan experimental approaches for analyzing chemical properties of substances.

CO6: Develop practical skills through hands-on experiments, such as the identification of organic compounds by IR and NMR spectroscopy, extraction of caffeine, and determination of saponification and iodine values of oils and fats.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual		CO1				
Conceptual			CO2, CO3	CO4	CO5	
Procedural						CO6
Metacognitive						

Text Books:

1. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Advanced Organic Chemistry by Bahl and Bahl (S Chand Publication)
4. A Textbook of Organic Chemistry by KS Tiwari (Vikash Publishing)
5. Modern Organic Chemistry by Jain and Sharma (Vishal Publishing)
6. Advanced and General Organic Chemistry by SK Ghosh (NCBA)
7. Organic Spectroscopy by PS Kalsi
8. Organic Spectroscopy by YR Sharma (S Chand)

Reference Book

1. Organic Chemistry by Paula Y Bruice (Pearson)
2. Advanced Organic Chemistry by Clayden Greeves and Wothers (Oxford)
3. Advanced Organic Chemistry by J March and Michael B Smith (Wiley)
4. Organic Chemistry by Solomons (Wiley).

FYUGP

DETAILED SYLLABUS OF 6th SEMESTER

Title of the Course : Chemistry C15: Spectroscopy
Course Code : C - 15
Nature of the Course : CHEMISTRY MAJOR
Total Credits : 4
Distribution of Marks : 60 (End Sem) + 40 (In-Sem)

COURSE OBJECTIVES:

- To make the students familiar with the interaction of electromagnetic radiation with matter in various forms.

UNITS	CONTENTS	L	T	P	Total Hours
I	**Spectroscopy** General Principles,Interaction of electromagnetic radiation with molecules and various types of spectra; Born-Oppenheimer approximation. **Rotation spectroscopy:** Diatomic molecules, Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.	**10**	**0**	**-**	**10**
II	**Infrared and Raman spectroscopy:** Classical equation of vibration, vibrational energies of diatomic molecules, zero point energy, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, effect of isotopic substitution, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies. Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches. Raman Effect, Classical and Quantum theory of Raman scattering, Polarizability tensor, Rayleigh and Raman scattering, Stokes and antistokes lines, structure elucidation by Raman spectroscopy (AB, A2B, and AB3), stretching frequencies of bonds and functional groups (Example from both organic and inorganic molecules), Rule of Mutual Exclusion, Depolarization ratio.	**15**	**0**	**-**	**15**
III	**Electronic spectroscopy** The Beer – Lambert Law, molar absorption coefficient, selection rules for electronic transitions, Franck-Condon principle, chromophores, auxochromes, bathochromic and hypsochromic shift. Electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation, calculation of electronic transitions of polyenes using free electron model. Solvent Effects on Electronic Spectra.	**10**	**0**	**-**	**10**

IV	**Spin resonance spectroscopy** Nuclear Magnetic Resonance (NMR) spectroscopy: Principles of NMR spectroscopy, Larmor precession, chemical shift and low resolution spectra, different scales, spin-spin coupling and high resolution spectra, interpretation of PMR spectra of organic molecules. Electron spin resonance (ESR) spectroscopy and its principle, hyperfine structure, ESR of simple free radicals, and copper (II) compounds.	**10**	**0**	**-**	**10**
V	**Experimental Work: (Any one)** a) Study the 200-500 nm absorbance spectra of $KMnO_4$ and $K_2Cr_2O_7$ (in 0.1 M H_2SO_4) and determine the λ_{max} values. Calculate the energies of the two transitions in different units (J molecule^{-1}, kJ mol^{-1}, cm^{-1}, eV). b) Study the pH-dependence of the U V-Vis spectrum (200-500 nm) of K2Cr2O7. c) Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds. d) Analysis of the given vibration-rotation spectrum of HCl(g) e) Verify Lambert-Beer's law and determine the concentration of CuSO4/KMnO4/K2Cr2O7 in a solution of unknown concentration f) Determine the concentrations of KMnO4 and K2Cr2O7 in a mixture. g) Study the kinetics of iodination of propanone in acidic medium. h) Determine the amount of iron present in a sample using 1, 10-phenathroline. i) Determine the dissociation constant of an indicator (phenolphthalein/ methyl red). j) Determine phosphate concentration in a soft drink	**-**	**0**	**30**	**30**
	Total	**45**	**0**	**30**	**75**

Where,

L: Lectures ***T: Tutorials*** ***P: Practical***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- **Two Internal Examination -** **20 Marks**
- **Others -** **20 Marks**
  - Assignment/Seminar
  - Lab note book/Attendance
  - Group Discussion

COURSE OUTCOMES:
After the completion of this course, the learner will be able to:

CO1: Understand spectroscopy principles, including interaction with molecules and types of spectra of rotation spectroscopy and Raman scattering concepts.

CO2: Apply vibrational and electronic spectroscopy to analyze molecular structures

CO3: Use spin resonance spectroscopy to interpret spectra and identify molecules.

CO4: Analyze spectroscopic data to draw conclusions about molecular properties.

CO5: Design and conduct spectroscopic experiments to determine concentrations and study reaction kinetics.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual		CO1		CO3		
Conceptual			CO2	CO4		
Procedural					CO5	
Metacognitive						

SUGGESTED READINGS:
Text Books:

1. Fundamentals of Molecular Spectroscopy, C.N. Banwell and E.M. McCash, Tata-McGrawHill.
2. Molecular Spectroscopy, G.M. Barrow.
3. Spectroscopy, Satyanarayana

Ref. Books:

1. Spectroscopy – Vol. I , II & III – Strawghan and Walker (Chapman & Hall)

FYUGP

DETAILED SYLLABUS OF 6th SEMESTER

Title of the Course	**:**	**Fundamentals of Chemistry - 6**
Course Code	**:**	**MINOR-06**
Nature of the Course	**:**	**CHEMISTRY MINOR COURSE-6**
Total Credits	**:**	**4**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

COURSE OBJECTIVES:

- To develop the knowledgeabout potable water, sampling and purification methods of water.
- To develop the knowledge about determination of dissolved oxygen, pH, acidity and alkalinity of a water sample.
- To understand the principles and applications of phase and chemical equilibrium, including Gibbs Phase Rule, phase diagrams, free energy changes, and the relationships governing chemical equilibrium.
- To develop the knowledgeabout amines, diazonium salts, amino acids, peptides and proteins

UNITS	CONTENTS	L	T	P	Total Hours
I	**Analytical Chemistry-I:** **Analysis of water:** Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods. a. Determination of pH, acidity and alkalinity of a water sample. b. Determination of dissolved oxygen (DO) of a water sample.	**15**	**0**	**-**	**15**
II	**Phase Equilibrium** Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic deviation. Phase diagrams of one-component systems (water and sulphur) and two component systems involving eutectics, congruent and incongruent melting points (lead –silver, Zn-Mg, $FeCl_3$-H_2O and Na-K only)	**08**	**0**	**-**	**08**

	Chemical Equilibrium Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG^o, Le Chatelier's principle. Relationships between *Kp*, *Kc* and *Kx* for reactions involving ideal gases.	**07**	**-**	**-**	**07**
III	**Amines & Diazonium salts:** Amines (Aliphatic and Aromatic) : Preparation – from alkyl halides, Gabriel's Phthalimide Synthesis, Hofmann Bromamide Reaction Reactions: Hofmann vs Saytzeff elimination, Carbylamine Test, Hinsberg test, with HNO_2, electrophiicSubstiution(in case of aniline) : Nitration, Bromination, Sulphonation. Diazonium Salts: Preparation from Aromatic Amines, Synthetic uses of benzene diazonium chloride including preparation of Dyes - Coupling Reaction.	**08**	**0**	**-**	**08**
	Amino Acids, Peptides & Proteins: Classification, Preparation (Gabriel phthalimide method and Strecker Synthesis),Zwitter ion, Isoeleectric point and Electrophoresis. Reactions of Amino Acids-Esterification and Acetylation reactions, Elementary ideas of Peptides and Proteins.	**07**	**0**		**07**
IV	**Experimental Work:Either (i. + iii.) or (ii. + iii.)** **i.** Purification of organic compounds by crystallization (from water and alcohol) and distillation. **ii.** Criteria of Purity: Determination of melting and boiling points. **iii.** Preparations: Mechanism of various reactions involved to be discussed. Recrystallisation, determination of melting point and calculation of quantitative yields to be done. (a) Bromination of Phenol/Aniline (b) Benzoylation of amines/phenols (c) Oxime and 2, 4-dinitrophenylhydrazone of aldehyde/ketone	**-**	**-**	**30**	**30**
	Total	**45**	**0**	**30**	**75**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others (Any one) - **20 Marks**
    - Home Assignment
    - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

At the end of this course students will be able to-

CO1: Understand the principles of water analysis, including methods for determining pH, acidity, alkalinity, and dissolved oxygen,

CO2: Understand the significance of phase equilibrium, Gibbs Phase Rule, and phase diagrams in one-component and two-component systems.

CO3: Apply thermodynamic concepts to analyze chemical equilibrium, including the relationship between free energy change and the law of chemical equilibrium.

CO4: Apply knowledge of organic chemistry to understand the preparation and reactions of amines, diazonium salts, amino acids, peptides, and proteins.

CO5: Analyze experimental data obtained from water analysis, phase equilibrium studies, and chemical equilibrium calculations to draw conclusions and make predictions.

CO6: Design and conduct experiments to purify organic compounds using crystallization and distillation methods and solve problems related to the determination of purity criteria, such as melting and boiling points, and the preparation of specific organic compounds.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual		CO1				
Conceptual			CO2	CO3		
Procedural					CO4, CO5	CO6
Metacognitive						

SUGGESTED READINGS:

1. Puri, Sharma, Kalia, Principles of Inorganic Chemistry, Vishal Pub. Co., 33rd ed., 2017
2. Das Asim K., Fundamentals of Inorganic Chemistry, Vol. I, CBS Publications, 2nd Ed. 2010.
3. Pradeep's Inorganic Chemistry, Vol. I & II, Universal Book seller, 14th Ed. 2017
4. A Text Book of Physical Chemistry – Negi & S.C. Anand, Wiley Eastern

5. Physical Chemistry, Castellan G. W., Narosa Publishing
6. Principles of Physical Chemistry, Puri, Sharma, Pathania, Shoban Lal, (S. Chand & Co.)
7. Organic Chemistry – B.S. Bahl and A. Bahl (Vol. I & II)
8. A Text Book of Organic Chemistry (Vol. I & II) – B.K. Sharma, G.P. Pokhriji and S.K. Sharma, (S. Chand & Co.)

Reference Books:

1) P.W. Atkins, Physical Chemistry, Oxford University Press

2) Physical Chemistry – B.R. Puri, L.R. Sharma, Madan S. Pathania, ShobanlalNagin, S. Chand & Co.

3) Physical Chemistry – D.S. Pahari (Vol. I &II)

4) Physical Chemistry - Levine

5) Organic Chemistry – M.K. Jain, S.Chand& Co.

FYUGP
DETAILED SYLLABUS OF 7th SEMESTER

Title of the Course : **Chemistry C16: Inorganic Spectroscopy and Photochemistry**
Course Code : **C-16**
Nature of the Course : **CHEMISTRY MAJOR**
Total Credits : **4**
Distribution of Marks : **60 (End Sem) + 40 (In-Sem)**

OBJECTIVES:

- To develop the knowledge of NMR, ESR, NQR, Photoelectron and Mossbauer spectroscopy in relation to inorganic compounds
- To develop the knowledge of photochemical reactions of transition metals

UNITS	CONTENTS	L	T	P	Total Hours
I	**Inorganic Spectroscopy**: NMR spectroscopy (^{1}H, ^{13}C, ^{31}P, and ^{19}F): Chemical shift, factorscontributing to chemical shift, spin-spin coupling and its implication to structure determination; simplification of complex spectra; Use of^{31}P and ^{19}F NMR in coordination chemistry: metal-ligand interaction; isomer determination; evaluation ofstereo chemical non-rigidity in molecules; NMR spectra of paramagnetic compounds.	**13**	**-**	**-**	**13**
II	ESR spectroscopy: Principle, resonance condition, Origin of g-value, spin orbit coupling, Kramer degeneracy, zero-field splitting, hyperfine &superhyper interaction, line width and application of ESR in organic radicals and transition metal coordination complexes (e.g.d^1, $d^3$and d^9).	**09**	**-**	**-**	**09**
III	Mossbauer spectroscopy: Principle of Mossbauer spectroscopy, Instrumentation, Doppler effect, Introduction to recoil energy, Application of Mossbauer spectroscopy: the isomer shift, magnetic interaction, quadruplesplitting, line width. Application to iron, tinandiodidecompounds.	**08**	**-**	**-**	**08**
IV	NQR spectroscopy: Principle of NQR, Quadruple constant, Asymmetric parameter (η), Application of NQR spectroscopy.	**05**			**05**
V	Introduction to Photoelectron Spectroscopy: Auger electron spectroscopy.	**04**			**04**

VI	Photochemical reactions of Transition metals: Basic photochemical processes, photosubstitution reactions, photoredox reactions, ligand photoreactions, photoreactions and solar energy conversion.	**06**			**06**
VII	**Experimental Work**: Preparation of inorganic solids and its spectroscopic analysis.	**-**	**-**	**30**	**30**
	Total	**45**	**0**	**30**	**75**

Where,

L: Lectures ***T: Tutorials*** ***P: Practical***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- **Two Internal Examination -** **20 Marks**
- **Others -** **20 Marks**
  - Assignment/Seminar
  - Lab note book/Attendance
  - Group Discussion

COURSE OUTCOMES:

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

CO 1. Analyze and interpret NMR spectra (1H, 13C, 31P, and 19F) to determine chemical shifts, spin-spin coupling, and structural information in coordination compounds.

CO 2. Evaluate the use of 31P and 19F NMR in studying metal-ligand interactions, isomer determination, and stereochemical non-rigidity in coordination complexes.

CO 3. Apply ESR spectroscopy principles to analyze organic radicals and transition metal coordination complexes, focusing on g-value, spin orbit coupling, and hyperfine interactions.

CO 4. Explain the principles and instrumentation of Mossbauer spectroscopy and apply it to study isomer shifts, magnetic interactions, and quadrupole splitting in iron, tin, and iodide compounds.

CO 5. Analyze the principles and applications of NQR spectroscopy to determine quadrupole constants and asymmetric parameters in various compounds.

CO 6. Evaluate photochemical reactions of transition metals, including photosubstitution, photoredox, ligand photoreactions, and their potential for solar energy conversion.

CO 7. Conduct experimental preparation of inorganic solids and analyze their spectroscopic properties using various spectroscopic techniques.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual						
Conceptual					CO2, CO6	
Procedural			CO3, CO4, CO7	CO1, CO5		
Metacognitive						

SUGGESTED READINGS:

1. Inorganic Chemistry, Shriver & Atkins, 5th Edition Oxford

2. Fundamentals of Molecular Spectroscopy: C.N. Banwell and E.M. McCash, Tata McGraw Hills.

3. Physical Methods for Chemist, Russell S. Drago.

FYUGP

DETAILED SYLLABUS OF 7th SEMESTER

Title of the Course : Chemistry C17: Physical
Course Code : C - 17
Nature of the Course : CHEMISTRY MAJOR
Total Credits : 4
Distribution of Marks : 60 (End Sem) + 40 (In-Sem)

COURSE OBJECTIVES:

- To acquaint students on macromolecules and the kinetics of polymerization reactions.
- To give idea about the basic knowledge of statistical thermodynamics and its application in simple systems

UNITS	CONTENTS	L	T	P	Total Hours
I	**Macromolecules** Condensation polymerization: degree of polymerization, Carother equation, Control of molecular weight. Addition polymerization: free radical polymerization, anionic, cationic polymerization and their kinetic studies. Ring opening polymerization. Weight and number average molecular weight, viscometric and osmometric methods of molecular weight determination. Coordination Polymerization; Zeigler Natta catalysts. Co-polymerisation; Reactivity ratios and its significance. Living polymers. Polymer Stereochemistry and Tacticity.	**20**	**0**	**-**	**20**
II	**Statistical Thermodynamics** Statistical methods (Basic ideas)- Probability theorem,Micro and macro state, concept of ensemble, postulates of statistical thermodynamics, thermodynamic probability,Boltzmann method (or Maxwell- Boltzmann statistics), Stirling approximation, Boltzmann distribution law, relation between entropy and thermodynamic probability, Canonical Partition function (Q), molecular partition function (q), relationship between Q and q, thermodynamic functions (internal energy, heat capacity, entropy) in terms of partition function. Translational, rotational and vibrational partition functions of ideal gases. Thermodynamic quantities (U,H,S,A,Cv,Cp) and chemical equilibrium in terms of partition functions for ideal monoatomic and diatomic gases. Einstein Model of monoatomic crystal. Introduction to Bose-Einstein statistics and Fermi Dirac statistics	**25**	**0**	**-**	**25**

III	**Experimental Work:** a) Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid/oxalic acid on activated charcoal. b) Determination of the molecular weight of polystyrene by viscometric method c) Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution or enthalpy of neutralization). d) Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide. e) Calculation of the enthalpy of ionization of ethanoic acid. f) Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts. g) Determination of enthalpy of hydration of copper sulphate. h) Study of the solubility of benzoic acid in water and determination of ΔH.	**-**	**-**	**30**	**30**
	Total	**45**	**0**	**30**	**75**

Where,

L: Lectures ***T: Tutorials*** ***P: Practical***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- **Two Internal Examination -** **20 Marks**
- **Others -** **20 Marks**
  - Assignment/Seminar
  - Lab note book/Attendance
  - Group Discussion

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

CO1: Learn about how polymers are made, their molecular structure, and different types of polymerization processes and understand how to determine the size of polymers and their stereochemistry.

CO2: Apply statistical methods to understand how gases and crystals behave and use statistical techniques to analyze and predict changes in energy and chemical reactions.

CO3: Analyze data from experiments on adsorption, molecular weight determination, and calorimetry and learn how to interpret experimental results to draw meaningful conclusions.

CO4: Design and conduct experiments to solve problems related to polymer properties and thermodynamic processes and apply theoretical knowledge to practical situations, such as determining enthalpy changes and molecular weights.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual		CO1	CO2			
Procedural				CO3	CO4	
Metacognitive						

SUGGESTED READINGS:

Text Books:

1. Physical Chemistry, G.W. Castellan, Narosa Publishing House, New Delhi.
2. Polymer Science and Technology: Plastics, Rubber, Blends and Composites by PremamoyGhosh,McGraw-Hill Education (2011)
3. Physical Chemistry - P.C. Rakshit, Science Book Agency, Kolkata.
4. Physical Chemistry Vols. I, II, III and IV – K.L. Kapoor, MacMillan (India) Ltd., New Delhi.
5. Advanced Physical Chemistry – J.N. Gurta& H. Snehi, Pragati Prakashan.
6. Physical Chemistry – B.R. Puri, L.R. Sharma, Madan S. Pathania, Shobanlal Nagin, S. Chand& Co.

Ref. Books:

1. Physical Chemistry- P.W. Atkins, Oxford University Press.
2. Physical Chemistry – D.S. Pahari (Vol. I & II).
3. Physical Chemistry - Levine

FYUGP

DETAILED SYLLABUS OF 7th SEMESTER

Title of the Course : Chemistry C18: Organic
Course Code : C - 18
Nature of the Course : CHEMISTRY MAJOR
Total Credits : 4
Distribution of Marks : 60 (End Sem) + 40 (In-Sem)

Course objective:

1. To make the students familiar about chemistry of alkaloids and terpenoids
2. To provide knowledge about some name reactions of synthetic importance
3. To provide basic concepts of pericyclic reactions

UNITS	CONTENTS	L	T	P	Total Hours
I	**Selected Organic Reactions and Reagents** Selected important reactions: Julia olefination, Suzuki reaction, Sonogashira coupling, directed aldol addition, Mukaiyama aldol addition, Robinson annulation, Sharpless epoxidation, Simmons-Smith reaction, McMurry reaction, Stork enamine reaction, Nef carbonyl synthesis, Benzil- Benzilic acid rearrangements, Baeyer Villiger oxidation, Favörski rearrangement, Beckmann rearrangement, Hofmann-Loffler-Freytag reaction, Wolff rearrangement, Curtius rearrangement Lossen rearrangement, Shapiro reaction,	**20**	**0**	**-**	**20**
II	**Organic photochemistry:** Theory of photochemistry, Photosensitisers, Einstein's law of photochemical equivalence, typical photoreactions such as photoreaction of benzophenone, photolytic reactions of ketones. Photochemistry of conjugated dienes-cycloaddition and dimerisation: Paterno-Buchi reaction, Norrish type I & II reaction, dipimethane rearrangement, Barton reaction.	**10**	**0**	**-**	**10**
III	**Alkaloids** Natural occurrence, General structural features, Isolation and their physiological action, Alkaloidal reagents, Detection of different groups,Hoffmann's exhaustive methylation, Emde's modification, Structure elucidation and synthesis of Hygrine, coniine, Nicotine, and piperine. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine.	**10**	**0**	**-**	**10**

IV	**Terpenoids** Occurrence, classification, isoprene rule special isoprene rule; Elucidation of structure and synthesis of Citral,linalol, citronellol Nerol and α-terpineol.	**05**	**0**	**-**	**05**
V	**Experimental Work: (Any one)** 1. Estimation of glucose by standardised Fehling solution 2. Estimation of glucose by benedict solution method 3. Estimation of glycine by Sorenson's method	**-**	**-**	**30**	**30**
	Total	**45**	**0**	**30**	**75**

Where,

L: Lectures ***T: Tutorials*** ***P: Practical***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- **Two Internal Examination -** **20 Marks**
- **Others -** **20 Marks**
  - Assignment/Seminar
  - Lab note book/Attendance
  - Group Discussion

COURSE OUTCOMES:

After the end of the course students will be able to-

CO1: Understand the fundamental principles, mechanisms, and applications of selected important organic reactions and photochemical processes.

CO2: Apply knowledge of organic reactions and reagents to synthesize and transform organic compounds, and execute specific laboratory techniques for the estimation of glucose and glycine.

CO3: Analyze the structures, synthesis pathways, and physiological actions of alkaloids and terpenoids, and evaluate their medicinal significance.

CO4: Critically evaluate the mechanisms and outcomes of organic photochemical reactions, and assess the biological roles and industrial applications of various alkaloids and terpenoids.

CO5: Synthesize complex organic molecules through the application of learned reactions, and design experimental procedures for the quantitative estimation of carbohydrates and amino acids.

CO6: Develop hands-on laboratory skills in estimating biochemical substances using standard methods, and in isolating and analyzing the structure of naturally occurring compounds like alkaloids and terpenoids.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual			CO2			
Conceptual		CO1		CO3	CO4, CO5	
Procedural					CO6	
Metacognitive						

Text Books:

1. Advanced Organic Chemistry by Clayden Greeves and Wothers (Oxford)
2. Modern Organic Chemistry by Jain and Sharma (Vishal Publishing)
3. Advanced Organic Chemistry by J March and Michael B Smith (Wiley)
4. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
5. Chemistry of Natural Products Vo1 By OP Agarwall (Goel Publication)
6. Sengupta, S. *Basic Stereochemistry of Organic Molecules*, 1st Edn., (Oxford University Press, 2014).ew Delhi, 1997)
7. Sankararaman, S. Pericyclic reactions—a textbook: reactions, applications and theory**,** 1st Edn., (Wiley VCH, 2005).
8. Rohatgi-Mukherjee, K. K. Fundamentals of Photochemistry,2nd Revised Edn., (New Age international Publishers, 2006).
9. Organic Synthesis by MP Saluja (Krishna Publication

Reference Books

1. Mundy, B. P. and Ellerd, M. G. Name reaction and reagent in organic synthesis(John Wiley and Sons. 1998).
2. Smith, M. B. Organic Synthesis, 2nd Edn., (McGraw Hill, 2002)
3. Fleming, I. Molecular Orbitals and Organic Chemical Reactions,(Oxford University Press, 2010).

FYUGP
DETAILED SYLLABUS OF 7th SEMESTER

Title of the Course	**:**	**Fundamentals of Chemistry-7**
Course Code	**:**	**MINOR-07**
Nature of the Course	**:**	**CHEMISTRY MINOR COURSE-7**
Total Credits	**:**	**4**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

COURSE OBJECTIVES:

- To develop the knowledgeabout sampling methods of soil sample.
- To develop the knowledge about determination of soil pH, calcium and magnesium
- To understand theprinciples of photochemistry, including light absorption, Lambert Beer's law,
- To understand thedifferent colligative properties of dilute solutions and their applications in determining molar masses of solutes in solution and Raoult's law.
- To develop the knowledgeabout carbohydrates and polymers

UNITS	CONTENTS	L	T	P	Total Hours
I	**Analytical Chemistry II:** **Analysis of soil:** Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators a. Determination of pH of soil samples. b. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometrictitration.	**15**	**0**	**-**	**15**
II	**Photochemistry:** Adsorption of light, Lambert Beer's law, Laws of photochemistry, Quantum yield, Quantum efficiency, fluorescence, phosphorescence, chemiluminescence, phosphorsensitized reaction.	**08**	**0**	**-**	**08**
	Colligative Properties: Colligative properties,relative lowering of vapour pressure, elevation of boiling point, depression of freezing point, osmotic pressure, relationship between the four colligative properties and amount/concentration of solute, application in calculating molar masses of normal, associated and dissociated solutes in solution.	**07**			**07**
III	**Carbohydrates:** Classification and general properties, open chain structure of Glucose**,** Mutarotation, Ascending and Descending in monosaccharides.	**07**	**0**	**-**	**07**

	Polymers: Classification of polymers, addition or chain growth polymerization(vinyl polymerization only), condensation or step growth polymerization.	**08**	**0**	**-**	**08**
IV	**Experimental Work:** **Inorganic Preparation (Any one)** i. Potash alum ii. Chrome alum iii. Potassium trioxalato chromate iv. Potassium trioxalato ferrate	**-**	**-**	**30**	**30**
	Total	**45**	**0**	**30**	**75**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others (Any one) - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

At the end of this course students will be able to-

CO1: Understand about soil components and analysis techniques, including pH measurement and complexometric titrations.

CO2: Learn photochemical laws and phenomena like Lambert Beer's law, fluorescence, and phosphorescence.

CO3: Utilize colligative properties to comprehend vapor pressure, boiling and freezing points, and osmotic pressure in solutions.

CO4: Examine carbohydrate classifications and properties, including mutarotation and structural isomerism.

CO5: Assess addition and condensation polymerization mechanisms and their implications on polymer properties.

CO6: Design and perform experiments for synthesizing inorganic compounds, like potash alum or potassium trioxalato ferrate.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual		CO1		CO4		
Conceptual		CO2		CO3	CO5	
Procedural						CO6
Metacognitive						

SUGGESTED READINGS:

1. Puri, Sharma, Kalia, Principles of Inorganic Chemistry, Vishal Pub. Co., 33rd ed., 2017
2. Das Asim K., Fundamentals of Inorganic Chemistry, Vol. I, CBS Publications, 2nd Ed. 2010.
3. Pradeep's Inorganic Chemistry, Vol. I & II, Universal Book seller, 14th Ed. 2017
4. A Text Book of Physical Chemistry – Negi & S.C. Anand, Wiley Eastern
5. Physical Chemistry, Castellan G. W., Narosa Publishing
6. Principles of Physical Chemistry, Puri, Sharma, Pathania, Shoban Lal, (S. Chand & Co.)
7. Organic Chemistry – B.S. Bahl and A. Bahl (Vol. I & II)
8. A Text Book of Organic Chemistry (Vol. I & II) – B.K. Sharma, G.P. Pokhriji and S.K. Sharma, (S. Chand & Co.)

Reference Books:

1) P.W. Atkins, Physical Chemistry, Oxford University Press

2) Physical Chemistry – B.R. Puri, L.R. Sharma, Madan S. Pathania, ShobanlalNagin, S. Chand & Co.

3) Physical Chemistry – D.S. Pahari (Vol. I &II)

4) Physical Chemistry - Levine

5) Organic Chemistry – M.K. Jain, S.Chand& Co.

FYUGP
DETAILED SYLLABUS OF 8th SEMESTER

Title of the Course : Chemistry C19: Advanced (Inorganic and Physical)
Course Code : C-19
Nature of the Course : CHEMISTRY MAJOR
Total Credits : 4
Distribution of Marks : 60 (End Sem) + 40 (In-Sem)

OBJECTIVES:

- To develop the knowledge about supra molecular and materials chemistry
- To make the students familiar with the various aspects of extended quantum mechanics with special reference to classical mechanics.

UNITS	CONTENTS	L	T	P	Total Hours
I	**Supramolecular Chemistry**: concepts of host guest chemistry, classification, non-covalent interactions, molecular recognition, supramolecular reactivity and catalysis, effects of medium, chiral recognition.	10	-	-	10
II	**Materials Chemistry**: synthesis and modification of inorganic solids: general principle of solid-state reaction, experimental procedure (co-precipitation, sol-gel, hydrothermal, Intercalation etc.), preparation of crystalline materials, nucleation, crystal growth, graphite and zirconium intercalation compounds, transition metal chalcogenide, thin films, growth of single crystals. Catalyst immobilization onto silica andclay surfaces and applications, pillaring of certain clays. Electronic and optical properties ofsome inorganic and organic solids (solid electrolytes, inorganic-coloured solids, white and black pigments). Design and properties of composites, polymer matrix andcarbon-carbon composites. Brief idea about drilling muds.	20	-	-	20
III	**Quantum Chemistry - II** Perturbation and Variation Methods. Electronic structure of diatomic molecules. Born-Oppenheimer approximation. Slater Determinant. LCAO-MO and VB treatment of the Hydrogen moleculeand Hydrogen molecule ion, Comparison of Molecular Orbital and Valence Bond Methods. Huckelmolecular orbital theory: Postulates, application to ethylene, butadiene, and benzene. Introduction to extended Huckel theory.	15	-	-	15

IV	**Experimental Work**: Preparation of nanoparticles and their spectroscopic analysis.	**-**	**-**	**30**	**30**
	Total	**45**	**0**	**30**	**75**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others (Any one) - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

At the end of this course, students will be able to-

CO1: Identify foundational concepts in supramolecular chemistry, materials chemistry, and quantum chemistry.

CO2: Explain the principles and theories underlying host-guest chemistry, solid-state reactions, and molecular orbital theory.

CO3: Demonstrate techniques for synthesizing and analyzing materials, preparing nanoparticles, and employing quantum chemistry methods.

CO4: Examine the properties and behaviors of various chemical systems, including non-covalent interactions, composite materials, and electronic structures of molecules.

CO5: Assess the effectiveness of different synthesis methods, catalytic applications, and theoretical models in chemistry.

CO6: Design and execute experiments in nanoparticle synthesis and develop new materials or theoretical models based on course concept.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual						
Conceptual			CO1, CO2		CO3, CO4	
Procedural					CO5	CO6
Metacognitive						

SUGGESTED READINGS:

1. Supramolecular Chemistry, Jonathan W. Steed and Jerry L. Atwood
2. Solid State Chemistry and its applications, by A.R. West, Plenum.

3. Inorganic Chemistry, Shriver & Atkins, 5th Edition Oxford.
4. Quantum Chemistry – Ira N. Levine, PHI, New Delhi.
5. Introductory Quantum Chemistry – A.K. Chandra, Tata- McGraw.
6. Chemical Applications of Group Theory- F.A. Cotton, Wiley Eastern Ltd., New Delhi.
7. Quantum Chemistry, R.K. Prasad.
8. Quantum Chemistry, B. K. Sen.

FYUGP

DETAILED SYLLABUS OF 8th SEMESTER

Title of the Course : Chemistry C20: Advanced (Organic + Group Theory)
Course Code : C - 20
Nature of the Course : CHEMISTRY MAJOR
Total Credits : 4
Distribution of Marks : 60 (End Sem) + 40 (In-Sem)

COURSE OBJECTIVES:

1. To make the students familiar about some oxidizing and reducing agents
2. To provide knowledge about stereochemistry, protecting groups and some recent topics of organic chemistry
3. To make the students familiar with the symmetry & group theory and bonding.

UNITS	CONTENTS	L	T	P	Total Hours
I	**Organic reagents** Oxidation: Transition metal-based oxidants: Jones reagent, Collins Reagent, PCC, PDC, MnO_2, Moffatt-Pfitzner Oxidation, Swern Oxidation. Other oxidants: Dess-Martin reagent, Oxidation of alkenes/alkynes: Prévost dihydroxylation, Woodward dihydroxylation, other oxidising agents: SeO_2, $Pb(OAc)_4$& HIO_4 Reduction: Aluminium-based reagents: lithium aluminum hydride (LAH), lithium trimethoxyaluminium hydride (LTBA), diisobutylaluminium hydride (DIBAL-H), Organo Rhodium complex (Wilkinson's catalyst, reduction by sodium borohydride, Lindlar's catalyst, Birch Reduction Synthetic importance of DCC, LDA, 1,3–dithiane, Baker's Yeast, organo borane (9-BBN, thexylborane)	12	0	-	12
II	**Some Advanced Topics of Stereochemistry** Methods of asymmetric synthesis (including enzymatic and catalytic nexus), enantio-, and diastereo selective synthesis, determination of enantiomeric and diastereomeric excess, stereospecific synthesis, effect of conformation on reactivity, methods of resolution, optical purity, optical activity in absence of chiral atom, Conformation of mono and disubstituted cyclohexane.	10	0	-	10
III	**Protecting groups:** Introduction, Common groups to be protected (hydroxyl, aldehyde and ketones, amino, carboxylic)	05	0	-	05

	Carbohydrates II Structure, reaction and conformation of disaccharides- sucrose, maltose and lactose. Polysaccharides- starch and cellulose	**03**	**0**	**-**	**03**
	Heterocycles Classification Nomenclature, preparation and properties of heterocycles having two hetero atoms: imidazole, isoxazole, Pyrazole and pyrimidine.	**05**	**0**	**-**	**05**
IV	**Some advanced topics** Elementary idea of PASE synthesis, tandem reaction, combinatorial chemistry, microwave assisted synthesis, nanocatalyst in organic synthesis. Olefin metathesis **Group Theory - II** Matrix: transformation of matrix, group theory, sub group, characters of different operations, multiplication table for C2V, C3V, D2 and C2h in terms of symmetry elements. Construction of character tables for C2V and C3V point group. Orthogonality theorem and its application, reducible and irreducible representations. Components of reducible representations Γ_{3N} and Γ_V. Symmetry selection rules of IR and Raman spectra. Direct product representation. Projection operators and symmetry adapted linear combinations (C2v, C3v and D4h systems).	**10**	**0**	**-**	**10**
VII	**EXPERIMENTAL WORK:** Organic Preparation and testing of purity by TLC (any one) a) Benzoin to benzil, benzil to benzilic acid (benzilic acid rearrangement) b) Benzophenone to benzophenone oxime, benzophenone oxime to benzanilide (Beckmann rearrangement) c) Acetophenone to acetophenone oxime to acetanilide (Beckmann Rearrangement)	**-**	**-**	**30**	**30**
	Total	**45**	**0**	**30**	**75**

Where,

L: Lectures ***T: Tutorials*** ***P: Practical***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- **Two Internal Examination -** **20 Marks**
- **Others -** **20 Marks**
  - Assignment/Seminar
  - Lab note book/Attendance
  - Group Discussion

COURSE OUTCOMES:

After the end of the course students will be able to-

CO1: Recall key concepts and reagents in organic synthesis, stereochemistry, protecting groups, and advanced organic topics.

CO2: Explain the mechanisms and importance of various organic reactions, stereochemical principles, and the roles of protecting groups.

CO3: Utilize appropriate reagents and techniques for oxidation, reduction, asymmetric synthesis, and protecting group strategies in organic chemistry.

CO4: Examine stereo selective synthesis methods, the conformation of cyclic compounds, and the structural properties of carbohydrates and heterocycles.

CO5: Assess the effectiveness and outcomes of different synthetic methods and the application of group theory to molecular symmetry and spectroscopy.

CO6: Design and conduct organic synthesis experiments, utilizing advanced techniques such as tandem reactions, combinatorial chemistry, and the use of nanocatalysts, while ensuring product purity through TLC analysis.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual		CO1	CO5			
Conceptual			CO2, CO4	CO3		
Procedural					CO6	
Metacognitive						

SUGGESTED READINGS:

1. Quantum Chemistry – Ira N. Levine, PHI, New Delhi.
2. Introductory Quantum Chemistry – A.K. Chandra, Tata- McGraw.
3. Chemical Applications of Group Theory- F.A. Cotton, Wiley Eastern Ltd., New Delhi.

FYUGP
DETAILED SYLLABUS OF 8th SEMESTER

Title of the Course	**:**	**Fundamentals of Chemistry-8**
Course Code	**:**	**MINOR-08**
Nature of the Course	**:**	**CHEMISTRY MINOR COURSE-8**
Total Credits	**:**	**4**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

COURSE OBJECTIVES:

- To develop the knowledgeabout Fertilisers and Inorganic polymers.
- To develop the knowledge about Rotational and Vibrational Spectroscopy and their applications.
- To develop the knowledgeabout drugs and pharmaceuticals

UNITS	CONTENTS	L	T	P	Total Hours
I	**Fertilizers**: Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate.	**08**	**0**	**-**	**08**
	Inorganic polymers: Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes, and polysulphates.	**07**	**0**	**-**	**07**
II	**Molecular Spectroscopy**: Interaction of electromagnetic radiation with molecules and various types of spectra; BornOppenheimer approximation. **Rotation spectroscopy**: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution. **Vibrational spectroscopy**: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies. Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches.	**15**	**0**	**-**	**15**

III	**Drugs and Pharmaceuticals**: Drug discovery, design and development; Basic Retrosynthetic approach. Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin, paracetamol, lbuprofen); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam),Cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT- Zidovudine).	**15**	**0**	**-**	**15**
IV	**Experimental Work: (any One)** **Thermochemistry and Binary Mixture** a) Determination of critical solution temperature and composition of the phenol-water system b) To study the effect of impurity (succinic acid) on the CST of phenol-water system. c) To study the effect of impurity (sodium chloride) on the CST of phenol-water system. d) Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide. e) Calculation of the enthalpy of ionization of ethanoic acid. f) Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts.	**-**	**-**	**30**	**30**
	Total	**45**	**0**	**30**	**75**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others (Any one) - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

At the end of this course students will be able to-

CO1: Identify various types of fertilizers, inorganic polymers, spectroscopic techniques, and classes of drugs and pharmaceuticals.

CO2: Explain the synthesis, structural aspects, and applications of fertilizers, inorganic polymers, and the principles of molecular spectroscopy.

CO3: Use knowledge of molecular spectroscopy to determine molecular structures and the principles of retrosynthesis in drug development.

CO4: Evaluate the interaction of electromagnetic radiation with molecules and analyze the structural properties of inorganic polymers and pharmaceuticals.

CO5: Assess the effectiveness and applications of different fertilizers, the structural integrity of polymers, and the efficacy of various drugs.

CO6: Design and conduct thermochemical and binary mixture experiments to explore critical solution temperatures, heat capacities, and enthalpy changes.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual		CO1				
Conceptual		CO2	CO3	CO4, CO5		
Procedural					CO6	
Metacognitive						

SUGGESTED READINGS:

1. Puri, Sharma, Kalia, Principles of Inorganic Chemistry, Vishal Pub. Co., 33rd ed., 2017
2. Das Asim K., Fundamentals of Inorganic Chemistry, Vol. I, CBS Publications, 2nd Ed. 2010.
3. Pradeep's Inorganic Chemistry, Vol. I & II, Universal Book seller, 14th Ed. 2017
4. A Text Book of Physical Chemistry – Negi & S.C. Anand, Wiley Eastern
5. Physical Chemistry, Castellan G. W., Narosa Publishing
6. Principles of Physical Chemistry, Puri, Sharma, Pathania, Shoban Lal, (S. Chand & Co.)
7. Organic Chemistry – B.S. Bahl and A. Bahl (Vol. I & II)
8. A Text Book of Organic Chemistry (Vol. I & II) – B.K. Sharma, G.P. Pokhriji and S.K. Sharma, (S. Chand & Co.)

Reference Books:

1) P.W. Atkins, Physical Chemistry, Oxford University Press

2) Physical Chemistry – B.R. Puri, L.R. Sharma, Madan S. Pathania, ShobanlalNagin, S. Chand & Co.

3) Physical Chemistry – D.S. Pahari (Vol. I &II)

4) Physical Chemistry - Levine

5) Organic Chemistry – M.K. Jain, S.Chand& Co.

FYUGP

DETAILED SYLLABUS OF 8th SEMESTER

Title of the Course : DSE-1: Green and Environment Chemistry
Course Code : DSECHM - 801
Nature of the Course : CHEMISTRY DSE COURSE-01
Total Credits : 4
Distribution of Marks : 60 (End Sem) + 40 (In-Sem)

COURSE OBJECTIVES:

- To develop the basic knowledge of ecosystem, air pollution, water pollution and their treatments
- To develop the basic knowledge of energy & environment sources of energy
- To develop the basic knowledge of biocataysis and organic farming

UNITS	CONTENTS	L	T	P	Total Hours
I	**Environment and its segments**: Ecosystem, Biogeochemical cycles of carbon, nitrogen and sulphur. **Air Pollution**: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature. Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, major sources of air pollution. Pollution by SO_2, CO_2, CO, NOx, H_2S and other foul smelling gases, Methods of estimation of CO, NOx, SOx and control procedures. Effects of air pollution on living organisms and vegetation. Greenhouse effect and Global warming, Ozone later depletion and causes, Control of particulates.	**10**	**0**	**-**	**10**
	Water pollution: Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems.	**06**	**0**	**-**	**6**
II	**Energy & Environment Sources of energy**: Coal, petrol and natural gas. Nuclear Fusion/ Fission, Solar energy, Hydrogen, Geothermal, Tidal and Hydel etc. Nuclear pollution: Disposal of nuclear waste, nuclear disaster and its management.	**06**	**0**	**-**	**06**

	Water purification methods: Effluent treatment plants (primary, secondary and tertiary treatment).Industrial waste management, incineration of waste. Water treatment and purification (Reverse osmosis, electro dialysis, ion-exchange). Water quality parameters for waste water	**09**	**0**	**-**	**09**
III	**Biocataysis**: Introduction to biocatalysis: Importance in " Green Chemistry" and " Chemical Industry"	**06**	**0**	**-**	**06**
	Organic farming: Green manuring and organic fertilizers, Recycling of bio- degradable municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field Application.	**08**	**0**	**-**	**08**
IV	**Experimental Work:** Any one experiment from the following i) Determination of dissolved oxygen in water. ii) Determination of Chemical Oxygen Demand (COD) iii)Determination of Biological Oxygen Demand (BOD) iv)Estimation of total alkalinity of water samples (CO_3^{-2}, HCO_3^-) is using double titration method. vi) Measurement of dissolved CO_2	**-**	**-**	**30**	**30**
	Total	**45**	**0**	**30**	**75**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others (Any one) - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

At the end of this course, students will be able to -

CO1: Identify key environmental segments, types and sources of pollutants, and renewable energy sources.

CO2: Explain the biogeochemical cycles, atmospheric chemical reactions, and principles of biocatalysis and organic farming.

CO3: Utilize methods for measuring and controlling air and water pollution and techniques for water purification.

CO4: Assess the environmental effects of various pollutants, the impact of energy sources on the environment, and the effectiveness of biocatalysis in green chemistry.

CO5: Analysis of different waste management strategies and the role of organic farming in sustainable agriculture.

CO6: Design and conduct experiments to measure dissolved oxygen, COD, BOD, and alkalinity in water samples.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual		CO1	CO2	CO3		
Conceptual				CO4		
Procedural					CO5, CO6	
Metacognitive						

SUGGESTED READINGS:

1. E. Stocchi: Industrial Chemistry, Vol-1, Ellis Horwood Ltd, UK.
2. R. M. Felder, R. W. Rousseau: Elementary Principles of Chemical Processes, WileyPublishers, New Delhi
3. J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi
4. S.S.Dara: A Textbook of Engineering Chemistry, S. Chand & Company Ltd, New Delhi
5. K.De, Environmental Chemistry: New Age International Pvt. Ltd., New Delhi
6. S. M. Khopkar, Environmental Pollution Analysis: Wiley Eastern Ltd, New Delhi
7. S.E. Manahan, Environmental Chemistry, CRC Press (2005)
8. G. T. Miller, Environmental Science, 11th Ed. Brooks/ Cole (2006)
9. A. Mishra, Environmental Studies. Selective and Scientific Books, New Delhi (2005)
10. B. K. Sharma , Industrial Chemistry, Goel Publishing House, Merrut, 2014
11. B.C.Das, Industrial Chemicals and Environment, Kalyani Publisher, 2018.
12. Rose Philo K.J. and Joyes Jacob, Industrial Chemicals and Environment,0Vishal Publishing Co., 2019.

FYUGP

DETAILED SYLLABUS OF 8th SEMESTER

Title of the Course : DSE-2: Analytical Methods in chemistry
Course Code : DSECHM - 802
Nature of the Course : CHEMISTRY DSE COURSE-02
Total Credits : 4
Distribution of Marks : 60 (End Sem) + 40 (In-Sem)

OBJECTIVES:

- To understand the principles and application of separation techniques in chemical analysis.
- To develop a knowledge on qualitative and quantitative aspects of analysis.
- To develop a knowledge on UV-Visible and Infraredspectroscopy.
- To develop a knowledge on qualitative and quantitative aspects of analysis .

UNITS	CONTENTS	L	T	P	Total Hours
I	**Qualitative and quantitative aspects of analysis**: Sampling, evaluation of analytical data, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals. ***Treatment of analytical data:*** Types of errors, significant figures and its importance, *Accuracy* - methods of expressing accuracy, error analysis and minimization of errors, *Precision* - methods of expressing precision, standard deviation and confidence limit.	**10**	**-**	**-**	**10**
II	**Separation Techniques in Chemical Analysis:** *Solvent Extraction*: Introduction,principle,techniques,factorsaffectingsolventextraction, Batch extraction, continuous extraction and counter current extraction. Application - Determination of Iron (III) *Ion Exchange*:Introduction,action of ion exchange resins, separationof inorganic mixtures, applications.	**12**	**-**	**-**	**12**
III	**UV-Visible Spectrometry**: Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law. Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument; Basic principles of quantitative analysis: estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers. Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method.	**13**	**-**	**-**	**13**

IV	**Infrared Spectrometry:** Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques. Structural illustration through interpretation of data, effect and importance of isotope substitution. Flame Atomic Absorption and	**10**	**-**	**-**	**10**
V	EXPERIMENTAL WORK (A): i) Determine the pH of the given aerated drinks fruit juices, shampoos and soaps	**-**	**-**	**30**	**30**
	EXPERIMENTAL WORK (B): ii) Analysis of soil: determination of pH of soil, estimation of calcium and magnesium				
	Total	**45**	**0**	**30**	**75**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others (Any one) - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

Upon completing the course, students will be able to:

CO1: Identify and describe the principles and techniques used in qualitative and quantitative analysis, including sampling methods, statistical data evaluation, and error analysis.

CO2: Explain the concepts and principles behind solvent extraction, ion exchange, UV-Visible spectrometry, and infrared spectrometry, including instrumentation and applications.

CO3: Utilize various analytical methods to perform quantitative analysis of metal ions, determine pH levels, and analyze soil composition for calcium and magnesium.

CO4: Interpret spectral data for structural elucidation, assess the accuracy and precision of analytical data, and evaluate the effectiveness of different separation techniques.

CO5: Examine experimental results, apply statistical tests to data sets, and determine the significance and reliability of the findings.

CO6: Design and conduct experiments involving the determination of pH in various samples, perform quantitative analysis using spectrometric techniques, and apply separation techniques for practical chemical analysis.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual		CO1				
Conceptual			CO2, CO3	CO4		
Procedural					CO5, CO6	
Metacognitive						

SUGGESTED READINGS:

1. Fundamentals of Analytical Chemistry by F.James Holler, Stanley R Crouch, Donald M.Westand Douglas A.Skoog, Ninth edition, Cengage.
2. Analytical Chemistry by Gary D.Christian, PurnenduK.Dasgupta and KevinA.Schug,Seventh edition, Wiley.
3. Quantitative analysis by R.A.DayJr. And A.L.Underwood, Sixth edition, Pearson.
4. Text book of Vogel's Quantitative Chemical Analysis, Sixth edition, Pearson.
5. Text book of Environmental Chemistry and Pollution Control by S.S.Dara and D.D.Mishra, Revised edition, S Chand &CoLtd.
6. Vogel, Arthur I: A Test book of Quantitative Inorganic Analysis (Rev. by G.H. Jeffery and others) 5th Ed., The English Language Book Society of Longman.
7. Willard, Hobert H. et al.: Instrumental Methods of Analysis, 7th Ed., Wardsworth Publishing Company, Belmont, California, USA, 1988.
8. Christian, Gary D; Analytical Chemistry, 6th Ed., John Wiley & Sons, New York, 2004.
9. Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W. H. Freeman, 2001.
10. Khopkar, S. M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.
11. Skoog, D. A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Thomson Asia Pvt. Ltd. Singapore.

FYUGP

DETAILED SYLLABUS OF 8th SEMESTER

Title of the Course : DSE 3: Introduction to Computational Chemistry
Course Code : DSECHM - 803
Nature of the Course : CHEMISTRY DSE COURSE-03
Total Credits : 4
Distribution of Marks : 60 (End Sem) + 40 (In-Sem)

Course Objectives: The course introduces the students

- To the elementary ideas of computational chemistry. It gives an insight into how the numerical methods are used to study the properties of atoms/molecules. The course helps students to learn the basic of python programming.

UNITS	CONTENTS	L	T	P	Total Hours
I	Introduction to Computational Chemistry: Representation of molecules, Born Oppenheimer Approximation, Potential energy surface, Geometry Optimization, global and local minima, Frequency calculation.	15	0	0	15
II	Introduction to python programming: Introduction to Pydroid 3 app, Constants and variables, arithmetic, conditional statements (If statements), loop (for loop, whileloop), arrays, modules	15	0	0	15
III	Numerical Analysis: Numerical Methods to find the Roots of an equation (Quadratic formula, iterative method, Newton-Raphson method),Numerical integration (Trapezoidal method, Simpson's rule, Gaussian quadrature)	15	0	0	15
IV	**EXPERIMENTAL WORK:**(Any two experiments) (i) To calculate the volume of an ideal gas and van der Waals gas for given Temperature and Pressure using python (ii) To determine pH of a solution for a given H+ ion concentration for both strong and weak acid using python (iii) To determine thermodynamic quantities of a monoatomic gas (Internal energy, heat capacity, entropy and free energy) using python (iv) To determine the value of determinant using python (v) To plot the graph of e^{-r} vs r in excel	-	-	30	30
	Total	45	-	30	75

Where, *L: Lectures* *T: Tutorials* *P: Practicals*

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others (Any one) - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

At the end of this course, students will be able to-

CO1: Identify and remember the basic principles of computational chemistry, Python programming, and numerical analysis techniques.

CO2: Explain key concepts in computational chemistry such as Born-Oppenheimer Approximation, geometry optimization, and potential energy surfaces, as well as Python programming fundamentals and numerical methods.

CO3: Utilize Python programming to perform calculations related to computational chemistry and numerical analysis, such as root finding, numerical integration, and solving equations.

CO4: Interpret and analyze results from computational chemistry simulations and numerical methods, comparing them to theoretical predictions.

CO5: Assess the accuracy and efficiency of different numerical methods and computational techniques, and validate results obtained from Python programming against known values.

CO6: Develop and execute Python programs to solve chemical problems, perform numerical calculations, and generate graphical representations of data.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual						
Conceptual		CO1	CO2	CO3, CO4		
Procedural					CO5, CO6	
Metacognitive						

SUGGESTED READINGS:

Textbooks:

1. A Textbook of physical chemistry, Volume 6, K.L. Kapoor, MacMillan
2. Computational Chemistry, Errol Lewars, Kluwer Academic Publisher.

Reference Books:

1. Introduction to Computational Chemistry, Frank Jensen, John-Wiley and Sons
2. Learning Python, Mark Lutz, O'Reilly Media

FYUGP

DETAILED SYLLABUS OF 8th SEMESTER

Title of the Course : DSE-4: Polymer Chemistry
Course Code : DSECHM - 804
Nature of the Course : CHEMISTRY DSE COURSE-04
Total Credits : 4
Distribution of Marks : 60 (End Sem) + 40 (In-Sem)

OBJECTIVES:

- To prepare skillful PolymerScientists to meet the growing requirements in polymer based industry,Government, research & development organizations and teaching institutions.
- To learn how to determine the molar mass of polymers using the viscometric method and to prepare conducting polymers such as polyaniline to study their electrical conductivity

UNITS	CONTENTS	L	T	P	Total Hours
I	Introduction and history of polymeric materials. Different Schemes of Classification of Polymers, Polymer nomenclature, Molecular forces and chemical Bonding in Polymers, Texture of Polymers.	**10**	**-**	**-**	**10**
II	Functionality and its importance, Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bi-functional systems, Poly-functional systems.	**12**	**-**	**-**	**12**
III	Kinetics of Polymerization: Mechanism and Kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques.	**10**	**-**	**-**	**10**
IV	Crystallization and Crystallinity, Determination of Crystalline melting point and degree of Crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point. Nature and structure of polymers-Structure Property relationships. Determination of molecular weight of polymers (Mn, Mw, etc), by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index.	**13**	**-**	**-**	**13**

V	**Experimental Work:** [A] Determine the molar mass of a polymer by viscometric method. [B] Preparation of conducting polymer (polyaniline) and study of their electrical conductivity.	**-**	**-**	**30**	**30**
	Total	**45**	**-**	**30**	**75**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others (Any one) - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

At the end of this programme, students will be able to

CO1: Identify the basic concepts and historical background of polymeric materials, including their classification and nomenclature.

CO2: Explain the significance of polymer functionality, polymerization processes, and the relationships between functionality, reaction extent, and degree of polymerization.

CO3: Use principles of polymer kinetics to describe mechanisms and kinetics of various polymerization methods, including step growth, radical chain growth, and ionic chain polymerizations.

CO4: Evaluate factors affecting polymer crystallinity and melting points, and interpret molecular weight determinations using various methods.

CO5: Assess the structure-property relationships of polymers, the significance of molecular weight distribution, and the polydispersity index.

CO6: Conduct experimental work to determine the molar mass of a polymer using viscometric methods, and synthesize conducting polymers to study their electrical conductivity.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual		CO1				
Conceptual			CO2, CO3	CO4, CO5		
Procedural					CO6	
Metacognitive						

SUGGESTED READINGS:

1) Seymour Polymer Chemistry, Marcel Dekker, Inc.
2) G. Odian: Principles of Polymerization, John Wiley.
3) F.W. Billmeryer: Text Book of Polymer Science, John Wiley.
4) P.Ghosh: Polymer Science & Technology, Tata Mcgraw-Hill.
5) R.W. Lenz: Organic Chemistry of Synthetic High Polymers.