

SYLLABUS
DIBRUGARH UNIVERSITY
FYUGP 2020



B.Sc. IN CHEMISTRY (NEP)

Approved in the BOS, Chemistry held on 16-11-2022

**FOUR-YEAR UNDERGRADUATE 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 research in 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 students as responsible citizens 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



DIBRUGARH UNIVERSITY, RAJABHETA, DIBRUGARH – 786004
FYUGP Structure as per UGC Credit Framework of December, 2022

Year	Semester	Course	Title of the Course	Total Credit	
Year 01	1 st Semester	C - 1	CORE COURSE -1	4	
		Minor 1	Fundamentals of Chemistry - 1	4	
		GEC - 1	Chemistry in Daily Life- I	3	
		AEC 1	Modern Indian Language	4	
		VAC 1	Understanding India	2	
		VAC 2	Health and Wellness	2	
		SEC 1	Basic Analytical Chemistry	3	
	22				
	2 nd Semester	C - 2	CORE COURSE -2	4	
		Minor 2	Fundamentals of Chemistry - 2	4	
		GEC 2	Chemistry in Daily Life- II	3	
		AEC 2	English Language and Communication Skills	4	
		VAC 3	Environmental Science	2	
		VAC 4	Yoga Education	2	
		SEC 2	Basic Analytical Chemistry (Fuel Chemistry)	3	
22					
The students on exit shall be awarded Undergraduate Certificate (in the Field of Study/Discipline) after securing the requisite 44 Credits in Semester 1 and 2 provided they secure 4 credits in work based vocational courses offered during summer term or internship / Apprenticeship in addition to 6 credits from skill based courses earned during 1st and 2nd Semester					
Year 02	3 rd Semester	C - 3	CORE COURSE -3	4	
		C - 4	CORE COURSE -4	4	
		Minor 3	Fundamentals of Chemistry - 3	4	
		GEC – 3	Chemistry in Daily Life- III	3	
		VAC 3	Digital and Technological Solutions / Digital Fluency	2	
		AEC – 3	Communicative English / Mathematical Ability	2	
		SEC – 3	Inorganic Materials of Industrial Importance	3	
22					

Abbreviations Used:

- **C = Major**
- **GEC = Generic Elective Course / Multi Disciplinary Course**
- **AEC = Ability Enhancement Course**
- **SEC = Skill Enhancement Course**
- **VAC = Value Added Course**

B. SC. IN CHEMISTRY PROGRAM (NEP)

DETAILED SYLLABUS OF 1st SEMESTER

Title of the Course	:	CORE COURSE -1
Course Code	:	CHMC1
Nature of the Course	:	CHEMISTRY MAJOR
Total Credits	:	4
Distribution of Marks	:	80 (End Sem) (60T+20P) + 20 (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 (20 Marks)	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).	6	0	-	6
	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 ³ d, sp ³ d 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 heteronuclear diatomic molecules such as CO, NO and NO ⁺	9	0	-	9
II (20 Marks)	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 ideal behavior, van der Waals and Dieterici’s,	10	0	-	10

	<p>Virialequation of state, Boyle's temperature, Critical constants, reduced equation of state, co-efficient of compressibility and thermal expansion.</p> <p>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.</p>	06	0		06
III (20 Marks)	<p>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.</p>	6	0	-	6
	<p>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 diastereoisomers, determination of configuration of geometrical isomers: cis-trans isomerism, syn-anti and E/Z notation with CIP rules. Geometrical isomerism in</p>	8	0	-	8

	oximes and alicyclic compounds.				
IV (20 Marks)	EXPERIMENTAL WORK (A) (i) Determine the surface tension of various liquids by drop number method. (ii) Determination of viscosity of aqueous solutions at room temperature.	-	0	15	15
	EXPERIMENTAL WORK (B) (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) OR (ii) Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC)	-	0	15	15
	Total	45	0	30	75

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT:

(20 Marks)

- One Internal Examination -
- Others (Any one) -
 - Home Assignment
 - Seminar presentation on any of the relevant topics

10 Marks
10 Marks

LEARNING OUTCOMES:

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

- I. To understand the periodic properties of elements, bonding in various molecules, properties of gaseous and liquid states of matter, basic organic chemistry, stereoisomerism etc.
- II. To handle the viscometer and stalagometer for determining the viscosity and surface tension of different compounds which have immense applications in industry and day to day life.
- III. To purify the various organic compounds through recrystallisations and melting point determinations.

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.

B. SC. IN CHEMISTRY PROGRAM (NEP)

DETAILED SYLLABUS OF 1st SEMESTER

Title of the Course	:	Fundamentals of Chemistry - 1
Course Code	:	MINCHM1
Nature of the Course	:	MINOR COURSE 1
Total Credits	:	4
Distribution of Marks	:	80 (End Sem) (60T+20P) + 20 (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 (20 Marks)	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.	9	0	-	9
	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.	6	0	-	6
II (20 Marks)	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 (derivation not required), viscosity of gases and effect of temperature and pressure on coefficient of viscosity).	12	0	-	12

	<p>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.</p>	04	0		04
III (20 Marks)	<p>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.</p>	8	0	-	8
	<p>Aliphatic Hydrocarbons-1: <i>Alkanes</i> (upto 5 carbons) Preparation:- Catalytic hydrogenation, Wurtz reaction, Kolbe's Synthesis, from Grignard reagent. Corey-House Synthesis. Reactions: Free radical Substitution: Halogenations.</p>	06	0	-	06
IV (20 Marks)	<p>Experimental Work: Inorganic Qualitative Analysis</p> <ul style="list-style-type: none"> Analysis of samples containing 4 radicals including interfering radicals, phosphate, borate and fluoride. 			30	30
Total		45	0	30	75

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

MODES OF IN-SEMESTER ASSESSMENT:

(20 Marks)

- One Internal Examination -
- Others (Any one) -
 - Sessional Examination
 - Assignment

10 Marks

10 Marks

LEARNING OUTCOMES:

At the end of this course, students will be able

- I. To *explain* the sign of wave function, counter boundary and probability diagrams, different types of bonds and its application

- II. To understand the kinetic molecular model of a gas, behaviour of real gases, vander Waal's equation, viscosity of gases,
- III. To explain the basic organic chemistry and its importance with reaction mechanism
- IV. To analyse the inorganic salt mixture qualitatively

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.)

B. SC. IN CHEMISTRY PROGRAM (NEP)

DETAILED SYLLABUS OF 1st SEMESTER

Title of the Course	:	Chemistry in Daily Life- I
Course Code	:	GECCHM1
Nature of the Course	:	NATURAL SCIENCE
Total Credits	:	3
Distribution of Marks	:	80 (End Sem) + 20 (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 (24 Marks)	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 (16 Marks)	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 (16 Marks)	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 (24 Marks)	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:

- One Internal Examination -
- Assessment

(20 Marks)

10 Marks

10 Marks

LEARNING OUTCOMES:

At the end of this course, students will be able

- I. To understand the composition, processing and analysis of dairy products.
- II. To learn about the various food preservatives and artificial food colorants and their role in food processing industries.
- III. To aware the adverse effects of food adulterants in human health.

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.

B. SC. IN CHEMISTRY PROGRAM (NEP)

DETAILED SYLLABUS OF 1st SEMESTER

Title of the Course	:	Basic Analytical Chemistry
Course Code	:	SEC123
Nature of the Course	:	SKILL ENHANCEMENT COURSE
Total Credits	:	3
Distribution of Marks	:	80 (End Sem) (60T+20P) + 20 (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 (18 Marks)	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.	3	0	-	3
	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.	5	0	-	5
II (18 Marks)	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.	5	0	-	5
	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	5	0	-	5

	items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc. b. Analysis of preservatives and colouring matter.				
III (24 Marks)	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.	4	0	-	4
	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).	4	0	-	4
	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.	4	0	-	4
IV (20 Marks)	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	0	0	30	30
	Total	30	0	30	60

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT:

- One Internal Examination -
- Others (Any one) -
 - Sessional Examination
 - Assignment

(20 Marks)
10 Marks
10 Marks

LEARNING OUTCOMES:

At the end of this course, students will be able

- I. To understand the analysis of soil, water, food products, cosmetics and principles of different types of chromatography.
- II. To operate flame photometer and spectrophotometer in determination of macro nutrients present in soil and iron in vitamin
- III. To determine pH, physical and chemical parameter in soil and water which are significant in day to day life.
- IV. To separate mixtures using separation techniques.

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., New York (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.

**DETAILED SYLLABUS OF 2nd SEMESTER
B. SC. IN CHEMISTRY PROGRAM (NEP)**

Title of the Course	:	CORE COURSE -2
Course Code	:	CHMC2
Nature of the Course	:	CHEMISTRY MAJOR
Total Credits	:	4
Distribution of Marks	:	80 (End Sem) (60T+20P) + 20 (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 (20 Marks)	<p>Non Transition elements:</p> <p>a) Noble Gas: Compounds of Xenon only</p> <p>b) Boron: wade's rule, nomenclature of closo, nido and arachnoboranes, structure of boron hydrides (B₂H₆), metalloborane and metallocarboranes. borazine, phosphazine, S₄N₄, (SN)_x – preparation, structure and uses.</p> <p>c) Carbon: Fullerenes (C₆₀)</p> <p>d) Silicon: silicones, classifications and structure of silicates. Zeolites, use of Zeolites as catalyst and molecular sieve, aluminosilicates.</p> <p>e) Nitrogen: Hydrazine, hydroxylamine and hydrazoic acid.</p> <p>f) Phosphorus: Phosphines, oxy acids of phosphorus, organophosphorus compounds.</p>	9	0	-	9
	<p>Metals:</p> <p>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 and hydrometallurgy. Study of potassium dichromate, manganese dioxide, potassium permanganate, ammonium molybdate, sodium cobaltinitrite, cobalt nitrate, Ni-DMG, vanadium pentoxide).</p>	6	0	-	6

II (20 Marks)	<p>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, Kirchoff's law relation of reaction enthalpy with internal energy, Bond energy and Bond dissociation energy, calculation from thermo chemical data.</p>	8	0	-	8
	<p>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.</p>	6	0	-	6
III (20 Marks)	<p>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.</p>	4	0	-	4
	<p>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.</p> <p>Reaction of alkenes: Addition Reaction- Electrophilic and free radical additions, their mechanisms. (Markonikoff/ Anti Markonikoff addition) regioselectivity (directional selectivity), and stereoselective of addition reactions. Mechanism of</p>	12	0	-	12

	oxymercuration–demercuration, Hydroboration-Oxidation, Ozonolysis, reduction (catalytic and chemical). <i>Syn and Anti hydroxylation</i> (oxidation), simple effect of stereo selectivity and stereo specificity. <i>Reactions of Alkynes</i> : Acidity, Electrophilic and Nucleophilic additions, Hydration to form carbonyl compounds. Alkylation of terminal alkynes.				
IV (20 Marks)	EXPERIMENTAL WORK (A): Oxidation-Reduction Titrimetry (any one) (i) Estimation of Fe(II) or oxalic acid using standardized KMnO ₄ solution. (ii) Estimation of Fe(II) with K ₂ Cr ₂ O ₇ using diphenylamine as internal indicator.	0	-	15	15
	EXPERIMENTAL WORK (B): (i) Detection of elements (N, S and Halogens) (ii) Detection of functional groups.	0	-	15	15
	Total	45	0	30	75

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

MODES OF IN-SEMESTER ASSESSMENT: **(20 Marks)**

- One Internal Examination - **10 Marks**
- Others (Any one) - **10 Marks**
 - Home Assignment
 - Seminar presentation on any of the relevant topics

LEARNING OUTCOMES:

At the end of this course, students will be able

- I. To understand the preparation, structure and uses of nontransition elements; extraction techniques of metals; various terms and laws of thermodynamics; crystal structure and crystal defects; preparation & properties of alkanes, alkenes and alkynes etc.
- II. To estimate iron and oxalic acid indifferent stock solutions provided to the learners which have immense applications in industry and day to day life.
- III. To detect elements and functional groups indifferent organic samples.

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.

B. SC. IN CHEMISTRY PROGRAM (NEP)

DETAILED SYLLABUS OF 2nd SEMESTER

Title of the Course	:	Fundamentals of Chemistry - 2
Course Code	:	MINCHM2
Nature of the Course	:	MINOR COURSE
Total Credits	:	4
Distribution of Marks	:	80 (End Sem) (60T+20P) + 20 (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 (20 Marks)	Coordination Chemistry: Review of Werner's theory. Types of ligands, monodentate, bidentate ambidentate and polydentate ligands (including π -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.	8	0	-	8
	Chemical Bonding and Molecular Structure-2 Covalent Bonding: VB Approach-Concept of hybridization, sp, sp ² , sp ³ , sp ³ d, sp ³ d 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). 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 heteronuclear diatomic molecules such as CO, NO and NO ⁺	8	0	-	8
II (20 Marks)	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.	9	0	-	9
	Ionic Equilibria: Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization,	6	0	-	6

	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 of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.				
III (20 Marks)	Stereochemistry: Conformation with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso Compounds. Threo and erythro; D and L; Cis-trans nomenclature; CIP Rules.	7	0	-	7
	Aliphatic Hydrocarbons-2 Alkenes: (up to 5 carbons): <i>Preparation:</i> Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule). <i>Reactions:</i> cis-addition (alk. KMnO ₄) and trans-addition (bromine), Addition of HX (Markownikoff's and anti Markownikoff's addition), Hydration, Ozonolysis. Alkynes: (up to 5 carbons): <i>Preparation:</i> Acetylene from CaC ₂ and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal dihalides. <i>Reactions:</i> formation of metal acetylides, addition of bromine and alkaline KMnO ₄ , ozonolysis and oxidation with hot alk. KMnO ₄ .	7	0	-	7
IV (20 Marks)	Experimental Work: 1. pH -metry and (Any one experiment) (i) pH- metric titration; (a) strong acid vs. strong base (b) weak acid vs. strong base (ii) Preparation of buffer solutions of different pH (a) sodium acetate-acetic acid (b) ammonium chloride-ammonium hydroxide 2. 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.	0	0	30	30
	Total	45	0	30	75

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT:

(20 Marks)

- One Internal Examination - **10 Marks**
- Others (Any one) - **10 Marks**
 - Home Assignment
 - Seminar presentation on any of the relevant topics

LEARNING OUTCOMES:

At the end of this course, students will be able

- I. To understand VBT, CFT and applications of some complexes in various fields.
- II. To explain the VSEPR theory, MOT and their applications.
- III. To illustrate the applications of solubility and solubility product principle.
- IV. To understand the stereochemistry and conformational analysis
- V. To handle pH meter, viscometer and stallagometerfor determination of pH, viscosity and surface tension of liquids

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.)

B. SC. IN CHEMISTRY PROGRAM (NEP)

DETAILED SYLLABUS OF 2nd SEMESTER

Title of the Course	:	Chemistry in Daily Life- II
Course Code	:	GECCHM2
Nature of the Course	:	NATURAL SCIENCE
Total Credits	:	3
Distribution of Marks	:	80 (End Sem) + 20 (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 (20 Marks)	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 (20 Marks)	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 (20 Marks)	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 (20 Marks)	Nucleic Acids: Nucleic acids and their Chemical composition. Classifications, 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:

- One Internal Examination -
- Assessment

(20 Marks)
10 Marks
10 Marks

LEARNING OUTCOMES:

At the end of this course, students will be able

- I. To *understand* and demonstrate how structure of biomolecules determines their reactivity and biological functions.
- II. To *explain* the various types of vitamins and their role.

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.

B. SC. IN CHEMISTRY PROGRAM (NEP)

DETAILED SYLLABUS OF 2nd SEMESTER

Title of the Course	:	Basic Analytical Chemistry (Fuel Chemistry)
Course Code	:	SEC223
Nature of the Course	:	SKILL ENHANCEMENT COURSE
Total Credits	:	3
Distribution of Marks	:	80 (End Sem) (60T+20P) + 20 (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 (18 Marks)	Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value.	3	0	-	3
	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.	6	0	-	6
II (25 Marks)	<i>Petroleum and Petrochemical Industry:</i> 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.	9	0	-	9
	<i>Petrochemicals:</i> Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene.	6	0	-	6
III (17 Marks)	<i>Lubricants:</i> Classification of lubricants, lubricating oils (conducting and non-conducting), Solid and semisolid lubricants, synthetic lubricants. Properties of lubricants – viscosity index, cloud point, pore point.	6	0	-	6
IV (20 Marks)	Any one experiment :				
	(i) To determine the Aniline point of a given lubricating oil. (ii) To determine the acid value of a given oil	0	0	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:

(20 Marks)

- One Internal Examination -
- Others (Any one) -
 - Sessional Examination
 - Assignment

10 Marks

10 Marks

LEARNING OUTCOMES:

At the end of this course, students will be able

- I. To distinguish conventional petroleum-based fuels and alternative & renewable fuels.
- II. To gain the knowledge of the origin of petroleum, crude oil, composition, different refining processes employed industrially to obtain different fractions of petroleum.
- III. To perform various test used to qualify different types of fuels.

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.

B. SC. IN CHEMISTRY PROGRAM (NEP)

DETAILED SYLLABUS OF 3rd SEMESTER

Title of the Course	:	CORE COURSE -3
Course Code	:	CHMC3
Nature of the Course	:	CHEMISTRY MAJOR
Total Credits	:	4
Distribution of Marks	:	80 (End Sem) (60T+20P) + 20 (In-Sem)

COURSE OBJECTIVES:

- To understand the chemistry of coordination compounds, inorganic reaction mechanism, 2nd law of thermodynamics, ionic equilibrium, cycloalkanes and conformational analysis, chemistry of halogenated hydrocarbons.

UNITS	CONTENTS	L	T	P	Total Hours
I (20 Marks)	Coordination compounds: Types of ligands: monodentate, bidentate, ambidentate, polydentate and macro cyclic ligand. Effective atomic number rule, VB, crystal field, MO and introduction to ligand field theories and their applications. Spectroscopic terms, RS coupling, Mulliken's symbol (A, B, E, T). Spectrochemical and nephelauxetic series, Electronic spectra of simple T _d and O _h complexes, selection rules and Orgel diagram (d ¹ to d ⁹ system). <i>Magnetic properties:</i> Paramagnetism, diamagnetism, magnetic properties of octahedral complexes, Antiferromagnetism.	9	0	-	9
	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.	6	0	-	6
II (20 Marks)	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), variation of A and G with P,V,T, criteria for spontaneity and equilibrium, Maxwell's relationship, Gibb's-Helmholtz equation. Nernst heat theorem-	10	0	-	10

	<p>consequence of the theorem, third law of thermodynamics, and its verification. Determination of absolute entropies of pure substance.</p> <p>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.</p>	06	0		06
III (20 Marks)	<p>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.</p>	7	0	-	7
	<p>Chemistry of Halogenated Hydrocarbons Alkyl halides: Methods of preparation including Hunsdiecker reaction from silver or lead (IV) salts of carboxylic Acid). Nucleophilic substitution reactions: SN₁, SN₂, 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 SN_{Ar}, Benzyne intermediates. Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions.</p>	7	0	-	7
IV (20 Marks)	<p>EXPERIMENTAL WORK (A): Inorganic Preparation (Any one)</p> <ol style="list-style-type: none"> Potash alum Chrome alum Potassium trioxalato chromate 	0	-	15	15

	iv. Potassium trioxalato ferrate				
	EXPERIMENTAL WORK (B): pH-metry and (Any one experiment) (i) pH metric titration (a) strong acid vs. strong base (b) weak acid vs. strong base (ii) Preparation of buffer solutions of different pH (a) sodium acetate-acetic acid (b) ammonium chloride-ammonium hydroxide	0	-	15	15
	Total	45	0	30	75

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT:

(20 Marks)

- One Internal Examination -
- Others (Any one) -
 - Sessional Examination
 - Assignment/Seminar

10 Marks

10 Marks

LEARNING OUTCOMES:

At the end of this course, students will be able

- I. To understand the coordination chemistry, inorganic reaction mechanism; second law of thermodynamics, Carnot's theorem, Nernst heat theorem, ionic equilibrium, Henderson Equation and its application; conformation & conformational analysis of alkanes & monosubstituted cyclohexane, SN₁, SN₂, and SN_i mechanisms with stereochemical aspects, etc.
- II. To prepare different double salts, complex salts and buffer solutions of different pH applicable in day to day life.
- III. To operate pH meter in pH metric titration of acids and bases.

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.

B. SC. IN CHEMISTRY PROGRAM (NEP)**DETAILED SYLLABUS OF 3rd SEMESTER**

Title of the Course	:	CORE COURSE -4
Course Code	:	CHMC4
Nature of the Course	:	CHEMISTRY MAJOR
Total Credits	:	4
Distribution of Marks	:	80 (End Sem) (60T+20P) + 20 (In-Sem)

COURSE OBJECTIVES:

- To make the students familiar with the principle involved in volumetric analysis, acid-base concepts, in details of electrochemistry, chemistry of lanthanide and actinides, chemistry of arenes and C-O bond alcohols..

UNITS	CONTENTS	L	T	P	Total Hours
I (20 Marks)	Oxidation-Reduction: Redox equations, Standard Electrode Potential and its application to inorganic reactions. Principles involved in volumetric analysis to be carried out in class.	6	0	-	6
	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	6	0	-	6
	Chemistry of Lanthanide and actinides: Electronic structure, oxidation state, ionic radii, Lanthanide and Actinide contraction and separation of lanthanides.	3	0	-	3
II (20 Marks)	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 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	7	0	-	7

	<p>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).</p> <p>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/Sb₂O₃ 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)</p>	7	0		7
III (20 Marks)	<p>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 Friedelcraft's alkylation / acylation with their mechanism. Activation/deactivation of aromatic ring and directing effects of groups. Partial rate factor (O/P ratio)</p>	8	0	-	8
	<p>Chemistry of C-O Bond Alcohols: Preparation and properties of Glycol: Oxidation by OsO₄, alkaline, KMnO₄, periodic acid and lead tetracetate. PinacolPinacolone rearrangement with mechanism. <i>Trihydric alcohol:</i> Glycerol: preparation & properties. <i>Phenols:</i> Preparation and properties:- acidity-comparison with alcohol. Substitution reaction, Reimer- Tiemann and Kolbe-Schmidt reaction, Fries rearrangement with mechanism. Other aromatic Hydroxy compounds: Cresol,</p>	8	0	-	8

	nitrophenols, picric acid, benzyl alcohol, dihydric phenols. Ethers and Epoxides: Preparation and reactions with acids.				
IV (20 Marks)	EXPERIMENTAL WORK (A): Conductometry and thermochemistry (Any one experiment) (i) Determination of cell constant and hence the specific conductance of an electrolyte. (ii) Conductometric titrations: (a) strong acid vs. strong base (b) weak acid vs strong base (iii) Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide. (iv) Calculation of the enthalpy of ionization of ethanoic acid.	0	-	15	15
	EXPERIMENTAL WORK (B): Qualitative analysis of unknown organic compounds (alcohols, carboxylic acid, phenols and carbonyl compounds)	0	-	15	15
Total		45	0	30	75

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

MODES OF IN-SEMESTER ASSESSMENT:

(20 Marks)

- One Internal Examination -
- Others (Any one) -
 - Sessional Examination
 - Assignment/Seminar

10 Marks

10 Marks

LEARNING OUTCOMES:

At the end of this course, students will be able

- I. To understand the redox equation, concepts of acids and bases, chemistry of inner transition elements; electrochemistry, laws governing electrochemical process and their application; synthesis and properties of oxygen containing functional groups. etc.
- II. To operate conductivity bridge in determination of cell constant and in conductometric titrations of acids and bases
- III. To handle calorimeter in determination of heat capacity, enthalpy of neutralization, enthalpy of ionization etc.
- IV. To analyse the unknown organic compounds qualitatively

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 Internatinal Privatr Limited) - P.S.Kalsi.

B. SC. IN CHEMISTRY PROGRAM (NEP)

DETAILED SYLLABUS OF 1st SEMESTER

Title of the Course	:	Fundamentals of Chemistry - 3
Course Code	:	MINCHM3
Nature of the Course	:	MINOR COURSE
Total Credits	:	4
Distribution of Marks	:	80 (End Sem) (60T+20P) + 20 (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 (20 Marks)	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.	8	0	-	8
	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).	7	0	-	7
II (20 Marks)	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 C_p and C_v , adiabatic processes- relation between P, V and T, Joule-Thomson effect, liquefaction 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 equation, enthalpy of different processes. Hess law, calculations based on Hess law. b) Second law of thermodynamics Second law of thermodynamics, Spontaneous and	16	0	-	16

	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 (20 Marks)	Aromatic Hydrocarbons: Preparation (only benzene) from phenol by decarboxylation, from acetylene, from benzenesulphonic acid. Reactions- Electrophilic substitution in benzene-nitration, halogenations, sulphonation, Friedel-Craft alkylation and acylation with mechanism.	6	0	-	6
	Alkyl and Aryl halides: 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 Aryl halides Preparation (chloro, bromo, iodo benzene only): From phenol, Sandmeyer &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, benzyl and vinyl and Aryl halide.	8	0	-	8
IV (20 Marks)	Experimental Work: Organic Qualitative Analysis Detection of elements (nitrogen, sulphur and halogens) and functional groups of organic compound containing one functional group.	0	0	30	30
Total		45	0	30	75

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

MODES OF IN-SEMESTER ASSESSMENT:

- One Internal Examination -
- Others (Any one) -
 - Sessional Examination
 - Assignment/Seminar

(20 Marks)

10 Marks

10 Marks

LEARNING OUTCOMES:

At the end of this course, students will be able

- I. To understand the basic principles involved in metallurgy for some metals.
- II. To explain about thermal equilibrium, first and second law of thermodynamics, enthalpy and entropy change of reaction, free energy and their applications.
- III. To illustrate the electrophilic and nucleophilic substitution in alkyl halides and aryl halides.
- IV. To detect elements and functional groups in different organic samples

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.)

B. SC. IN CHEMISTRY PROGRAM (NEP)

DETAILED SYLLABUS OF 3rd SEMESTER

Title of the Course	:	Chemistry in Daily Life- III
Course Code	:	GECCHM3
Nature of the Course	:	NATURAL SCIENCE
Total Credits	:	3
Distribution of Marks	:	80 (End Sem) + 20 (In-Sem)

COURSE OBJECTIVES:

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

UNITS	CONTENTS	L	T	P	Total Hours
I (20 Marks)	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 (20 Marks)	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 (20 Marks)	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 (20 Marks)	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:

- One Internal Examination -
- Assesment

(20 Marks)

10 Marks

10 Marks

LEARNING OUTCOMES:

At the end of this course, students will be able

- I. To *explain* the principle, working and applications of different batteries.
- II. To *learn* about the chemistry of natural and synthetic polymers.
- III. To *understand* the chemistry of biodegradable and conducting polymers and appreciate the need of biodegradable polymers with emphasis on basic principles.
- IV. To *learn* basic of cosmetics, various cosmetic formulation, ingredients and their roles in cosmetic products.
- V. To *explain* the suitability of fertilizers for different kinds of crops and soil.

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.

B. SC. IN CHEMISTRY PROGRAM (NEP)

DETAILED SYLLABUS OF 3rd SEMESTER

Title of the Course	:	Inorganic Materials of Industrial Importance
Course Code	:	SEC323
Nature of the Course	:	SKILL ENHANCEMENT COURSE-3
Total Credits	:	3
Distribution of Marks	:	80 (End Sem) (60T+20P) + 20 (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 (20 Marks)	Silicate Industries: <i>Glass:</i> 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. <i>Ceramics:</i> 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. <i>Cements:</i> Classification of cement, ingredients and their role, Manufacture of cement and the setting process, quick setting cements.	9	0	-	9
II (20 Marks)	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.	5	0	-	5
III (20 Marks)	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.	8	0	-	8

	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.	8			8
IV (20Marks)	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

<i>Where,</i>	<i>L: Lectures</i>	<i>T: Tutorials</i>	<i>P: Practicals</i>	
MODES OF IN-SEMESTER ASSESSMENT:				(20 Marks)
•	One Internal Examination	-		10 Marks
•	Others (Any one)	-		10 Marks
	○ Sessional Examination			
	○ Assignment/Seminar			

LEARNING OUTCOMES:

At the end of this course, students will be able

- i. To learn the composition and applications of the different kinds of glasses & ceramics.
- ii. To understand the composition of cement and the mechanism of setting of cement.
- iii. To explain the suitability of fertilizers for different kinds of crops and soil.
- iv. To explain the process of formulation of paints and the basic principle behind the protection offered by the surface coatings.
- v. To explain the principle, working and applications of different batteries.

SUGGESTED READINGS:

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