B.Sc I Semester

OPEN ELECTIVE-1

Title of the Course: OE-1:	CHEMISTRY IN DAILY LIFE
Number of Theory Credits	3
Number of lecture hours/ semester	42 hrs.

Course outcomes:

At the end of this course, student should be able to:

1. Describe the analysis of important constituents in food items such as fat content in dairy products, caffeine in coffee/tea, methanol in alcoholic beverages, etc.
2. Give details of possible food additives, preservatives, colorants and adulterants commonly used in processed food.
3. Explain the nutritional aspects of macro and micronutrients, namely oils/fats and vitamins respectively.
4. Explain the chemistry of daily used products like soaps/detergents, batteries/fuel cells and polymers.

Course Objective:

The objective of this paper is to equip the non-chemistry students with knowledge about chemistry of some of the products which are commonly used in daily life.

Course specific outcome:

After studying this paper the student would be able to:

1. Describe the composition of the milk and dairy products.

2. Detect/determine the amount of caffeine, chicory in coffee and chloral hydrate in toddy.

3. Explain the preservatives used in food products and their effects and possible adulterants.

4. Acquire detailed information about the colorants used in food products.

5. Differentiate various vitamins, their sources and deficiencies.

6. Examine purity of the oils.

7. Explain how electrical energy is stored in batteries.

8. Classify commonly used polymers in our daily lives.

Content of Theory Course 1	42 Hrs
Unit – 1 **Dairy Products**: Composition of milk and milk products. Analysis of fat content, minerals in milk and butter. Estimation of added water in milk. Beverages: Analysis of caffeine in coffee and tea, detection of chicory in coffee, chloral hydrate in toddy, determination of methyl alcohol in alcoholic beverages.**(06hrs)** **Food additives, adulterants, and contaminants -** Food preservatives like benzoates, propionates, sorbates, and disulphites. Artificial sweeteners: aspartame, saccharin, dulcin, sucralose, and sodium cyclamate. Flavors: vanillin, alkyl esters (fruit flavors), and monosodium glutamate**.(06hrs)** **Artificial food colorants:** Coal tar dyes and non-permitted colors and metallic salts. Analysis of pesticide residues in food. **(02hrs).**	**14 hrs.**
Unit - 2 **Vitamins:** Classification and nomenclature. Sources, deficiency diseases, and structures of vitamin A1, vitamin B1, vitamin C, vitamin D, vitamin E & vitamin K1. **(06hrs).** **Oils and fats**: Composition of edible oils, detection of purity, rancidity of fats and oil. Tests for adulterants like argemone oil and mineral oils. Halphen test. **(05hrs).** **Soaps & Detergents**: Definition, classification, manufacturing of soaps and detergents, composition and uses**(03hrs)**	**14 hrs.**
Unit - 3 Chemical and renewable energy sources: principles and applications of primary & secondary batteries and fuel cells. Basics of solar energy, future energy storer. (**06hrs).** 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. **(08hrs).**	**14 hrs.**

Recommended Books/References:

1. B. K. Sharma: Introduction to Industrial Chemistry, Goel Publishing, Meerut (1998)
2. The chemical analysis of foods. . Pearson, David, 1919-1977. Cox and Pearson.7th ed. Published Edinburgh; New York: Churchill Livingstone, 1976.
3. Foods: Facts and Principles. N. Shakuntala Many and S. Swamy, 4thed. New Age International (1998)
4. Odian; George, Principles of Polymerization, McGraw-Hill Book Co., New York (1970).
5. W. Billmeyer, Text book of polymer science, 3rd Edn., 2007, Wiley.
6. Foods: Facts and Principles. N. Shakuntala Many and S. Swamy, 4thed. New Age International (1998)
7. Subalakshmi, G and Udipi, SA(2006):Food processing and preservation, 1st Ed. New Age International (P)Ltd.
8. SrilakshmiB(2018): Food Science, 7th Colour Ed. New Age International (P) Ltd
9. Potter NN and Hotchkiss JH(1999): Food science,5th Ed , Spinger.
10. M.P. Stevens, Polymer Chemistry: An Introduction 3rd ed. Oxford University Press (2005).

Pedagogy: ICT tools, Chalk & Talk, Models & Charts, MOOC

Formative Assessment (Internal assessment) Theory	
Assessment Occasion/ type	**Weightage in Marks**
Continuous evaluation and class test	20
Seminars/Class work	10
Assignments/Discussions	10
Total	40

Note:

1. Questions from both sections should be given in each batch.

2. In the first 20 minutes the Teacher should discuss in detail the theory, principle, procedure and calculations.

3. Instructions to be given for operating instruments, weighing chemicals and precautions while handling chemical.

Recommended Books/References

1. Practical Volumetric Analysis, Peter A C McPherson, Royal Society of Chemistry, Cambridge, UK (2015).
2. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
3. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
4. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).
5. Athawale V. D. amd Mathur P. Experimental Physical Chemistry, New Age International (2001)

B.Sc Semester II
OPEN ELECTIVE-2

Title of the Course: OE-2:	MOLECULES OF LIFE
Number of Theory Credits	3
Number of lecture hours/ semester	42 hrs.

Course Outcomes:

At the end of this course, student should be able to:

1. Describe the biomolecules, namely carbohydrates, amino acids, lipids and nucleic acids on the basis of their classification and structure.
2. Explain enzyme action, factors influencing enzyme action, co-enzymes andenzyme specificity.
3. Depict the action of drugs in biological systems based on Receptor theory, SARstudies and binding action of various groups.
4. Study the energy dynamics of biological systems in terms of calorific values of macronutrients, their metabolic pathways and ATP as energy currency.

Course Objective:

To make the non-chemistry students aware of various biochemicals/biomolecules involved in various biological processes.

Course specific outcome:

After studying this paper, the student would be able to:

1. Acquire knowledge about different types of sugars and their chemical structures
2. Identify different types of amino acids and determine the structure of peptides.
3. Explain the actions of enzymes in our body and interpret enzyme inhibition..
4. Depict the importance of lipids in the metabolism.
5. Differentiate RNA and DNA and their replication..
6. Explain production of energy in our body.

Content of Theory Course 2	42 hrs.
Unit – 1	**14hrs.**
Carbohydrates Classification of carbohydrates, reducing and non-reducing sugars, general properties of glucose and fructose, their open chain structures. Epimers, mutarotation and anomers. Linkage between monosaccharides, structure of disaccharides (sucrose, maltose, lactose) and polysaccharides (starch and cellulose) excluding their structure elucidation. **(8hrs)** **Amino acids, peptides and proteins** Classification ofamino acids, Zwitterion structure and isoelectric point. Overview of primary, secondary, tertiary and quaternary structure of proteins. Determination of primary structure of peptides. **(6hrs)**	
Unit – 2. **Enzymes and correlation with drug action.** Mechanism of enzyme action, factors affecting enzyme action, co-enzymes and cofactors and their role in biological reactions, Specificity of enzyme action (including stereospecificity). Enzyme inhibitors and their importance, phenomenon of inhibition (competitive and non-competitive inhibition including allosteric inhibition). **(10hrs)** **Drug action**-receptor theory. Structure–activity relationships of drug molecules, binding role of –OH group, -NH_2 group, double bond and aromatic ring. **(2hrs) Lipids.** Introduction to lipids, classification. Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol) **(2hrs)**	**14hrs.**

Unit - 3	14 hrs.
Nucleic acids. Components of nucleic acids: Adenine, guanine, thymine and cytosine (structure only), other components of nucleic acids, nucleosides and nucleotides (nomenclature), structure of polynucleotides: structure of DNA (Watson-Crick model) and RNA (types of RNA), Genetic code, biological roles of DNA and RNA: replication, transcription and translation. **(6hrs)** **Concept of energy in bio systems.** Calorific value of food. Standard caloric content of carbohydrates, proteins and fats. Oxidation of foodstuff (organic molecules) as a source of energy for cells. Introduction to metabolism (catabolism, anabolism), ATP: the universal currency of cellular energy, ATP hydrolysis and free energy change. Conversion of food into energy. Outline of catabolic pathways of carbohydrate- Glycolysis, fermentation, Krebs cycle. Overview of catabolic pathways of fats and proteins. Interrelationships in the metabolic pathways of Proteins, fats and carbohydrates.**(8hrs)**	

Recommended Books/References

1. W. H. Freeman. Berg, J.M., Tymoczko, J. L. &Stryer, L. Biochemistry, 2002.
2. Morrison R. T. and Boyd R. N. Organic Chemistry, Sixth Edition Prentice Hall India, 2003.
3. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2006) Biochemistry. VI the Edition. W.H. Freeman and Co.
4. Nelson, D. L., Cox, M. M. and Lehninger, A. L. (2009) principles of Biochemistry.IV Edition. W.H. Freeman and Co.
5. Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009) Harper's Illustrated Biochemistry. XXVIII edition. Lange medical Books/ McGraw-Hill *Chemistry*(*Volume 2)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6. Crichton R. H. Biological Inorganic Chemistry – An Introduction, Elsevier, 2008.
7. Berg J. M., Tymoczeko J. L., Stryer l. Biochemistry, W. H. Freeman, 2008.
8. Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7th Ed.2006.

Pedagogy: ICT tools, Chalk & Talk, Models & Charts, and MOOC.

Formative Assessment (Internal assessment) Theory.	
Assessment Occasion/ type	**Weightage in Marks**
Continuous evaluation and class test	20
Seminars/Class work	10
Assignments/Discussions	10
Total	40

BSc Semester III –Chemistry (Hons)
with Analytical/ Organic/ Inorganic/ Physical specialization

Title of the Course: Open Elective-3:
ATOMIC STRUCTURE, BONDING AND CONCEPTS IN ORGANIC CHEMISTRY

Contact Hours: 42 **Workload: 3 hours per week**

Credit Points: 3

Evaluation: Continuous Internal Assessment - 40 marks
Semester End Examination - 60 marks

Course Objectives:

- To develop an understanding of principles of Atomic structure
- To know the importance of quantum numbers, writing of electronic configurations and representation of orbitals
- To develop an understanding of the periodic trends
- To understand the nature of bonding and to predict the shapes of molecules
- To construct MO energy level diagrams and predict the properties of molecules
- To understand the formation of sigma and pi bonds and the bond strength.
- To study the classification of organic reactions
- To learn nomenclature preparation and reactions of alkanes, alkenes, alkynes and stability of alicyclic compounds

COURSE OUTCOME:

On completion of the course the student will learn and be able to understand/explain

- the concept of atomic sstructure, significance of quantum numbers, filling of electrons of atoms/ions in various orbitals as per rules
- the trends in periodic properties
- the structures of ionic solids, applications of B-H cycle, solubility of compounds and consequences of polarization of ions

- the shapes of molecules/ions based on VSEPR theory
- the construction of MO energy level diagrams and prediction of properties of molecules/ions like bond order, bond energies, bond lengths and magnetic properties.
- the formation of sigma and pi bonds and the bond strength
- the classification of organic reactions
- nomenclature preparation, and reactions of alkanes, alkenes, alkynes and stability of alicyclic compounds.

Unit I

Atomic Structure

History of an atom. Idea of de Broglie matter waves. Heisenberg uncertainty principle. Schrödinger wave equation, significance of wave functions, Bohr's model of hydrogen atom and its limitations. Quantum numbers and their importance, atomic orbitals and shapes of s, p, d orbitals, Multi-electron atoms, Aufbau's and Pauli exclusion principle and Hund's multiplicity rule- Electronic configurations of the elements (atomic no. up to 30), effective nuclear charge and shielding.

8 hrs

Periodic Properties

Atomic radius, covalent, ionic and van der Waal radii-explanation with examples. Definition and periodicity of the following properties - ionic radii, ionization potential, electron affinity and electronegativity, methods of determination of electronegativity. Factors affecting the values of ionization energy.

6 hrs

Unit II

Chemical Bonding

Ionic Solids– Ionic structures (NaCl, CsCl, TiO_2, ZnS), radius ratio rule and coordination number, limitation of radius ratio rule, lattice energy and Born-Haber cycle, solvation energy and solubility of ionic solids, polarizing power and polarizability of ions, Fajan's rule and their consequences.

4 hrs

Covalent Bond – Valence bond theory and its limitations, directional characteristics of covalent bond, various types of hybridization with examples and shapes of simple inorganic molecules and ions. Shapes of NH_3, I_3^+, I_3^-, SF_4, ClF_3, IF_5, ICl_2^- and H_2O using valence shell electron pair repulsion (VSEPR) theory, linear combination of atomic orbitals (LCAO), bonding, nonbonding and antibonding molecular orbitals, physical picture of bonding and antibonding wave functions. Applications of MO theory to explain the stability of homo dinuclear (He_2, N_2, O_2, F_2, C_2) and hetero dinuclear (NO and CO) molecules. Comparison of M.O. and V.B. Models.

7 hrs

Metallic bond-free electron, Band theory – electrical properties of metals, semiconductors and insulators.

Weak interactions – Hydrogen bonding and its consequences, van der Waals forces.

3 hrs

Unit III

Bonding and molecular structure and hydrocarbons

Bonding and molecular structure: Introduction to organic chemistry, atomic orbitals, sigma and pi bond formation-molecular orbital [MO] method, sp, $sp^2$and sp^3 hybridization, bond length, bond dissociation energies and bond angles (open chain

and cyclic compounds). Electronegativity and polarity of the bonds. Classification and reactions of organic compounds (with examples).

7 hrs.

Aliphatic Hydrocarbons: Alkanes, Alkenes and Alkynes

Definition, Nomenclature, preparations (any two methods)

Reactions: Electrophilic, nucleophilic and free radical addition reactions

Alicyclic compounds:

Nomenclature, preparation and stability of cyclopropane, cyclobutane, Cyclopentane and cyclohexane.

7 hrs.

Reference Books:

1. J. D. Lee, Concise Inorganic Chemistry, ELBS (1996)
2. A. K. Das, Fundamental Concepts of Inorganic Chemistry, CBS; 2nd edition (2019)
3. James E. Huheey, Ellen A. Keiter, Richard L. Keiter Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India; 4th edition (2006)
4. Shriver, D.F. & Atkins, P.W Inorganic Chemistry, Oxford University Press (2009)
5. Herbert Meislich Howard Nechamkin and Jacob Sharefkin Schaum's Outline of Organic Chemistry Theory and Problems of Organic Chemistry. McGrawHill Book Co; (1980)
6. Morrison and Boyd, Organic Chemistry, Sixth Edition ,Pearson Education India; 7th edition (2010)
7. I.L. Finar Organic Chemistry Vol. 1 Pearson Education India; 6th edition (2002)

BSc Semester IV –B Sc / B Sc(Honors) with Analytical/ Organic/ Inorganic/ Physical specialization

Title of the Course: Open Elective-4:

Electrochemistry, Corrosion and Metallurgy

Contact Hours: 42 **Workload: 3 hours per week**

Credit Points: 3

Evaluation: Continuous Internal Assessment - 40 marks

Semester End Examination - 60 marks

This course provides a broad introduction to the fundamental principles of electrochemistry, corrosion and metallurgy. The student will gain an understanding of basic and practical applications in various fields of electrochemistry, corrosion and metals and alloy behaviour and manufacturing processes. This course is a valuable prerequisite for taking more technically challenging courses that will be required for career development.

Course Objectives This course will deal with

1. Types of conductance, concept of electrolytes, electrolysis, redox reactions and EMF
2. Concept of different types of electrochemical cells, Types of electrodes and electrode potential. Application of electrochemical series.
3. Basic principles and applications of conductometric, potentiometric and pH titrations.
4. Different types of Batteries their principle construction and working - lead-acid storage and lithium ion battery. Study of Fuels cells.
5. Concept of corrosion, types of corrosion and its prevention by different methods. Introduction to electroplating.

6. Introduction to ores and minerals, extraction of metals from their ores, and purification. Eg., Manganese, Titanium and Uranium.
7. Study of alloys, classification, production and uses of alloys.

Course Outcomes Upon completion of the course students will be able to

1. Understand the concept of conductance in electrolytic solutions, electrolysis and redox reactions involved in electrode reactions.
2. Learn the different types of electrochemical cells, their symbolical representation and application of electrochemical series.
3. Apply conductometric, potentiometric and pH titrations
4. Know the principle, construction and working of batteries
5. Understand different types of corrosion and its prevention by different methods 6.Learn the methods of extraction of metals from their ores and purification

UNIT I

Electrochemistry

Conductance, specific and molar conductance, Types of electrolytes, conductivity in electrolytic solution, electrolysis, Kohlrausch's law and its application, equivalent conductance of weak electrolyte at Infinite dilution.

Oxidation -reduction reactions, electrode potential, EMF of an electrochemical cell, cell reaction, Daniel cell, dry Cells - electrolytic and Galvanic cell, Representation of a cell. Standard electrode potential, Nernst equation (No derivation) and its application to chemical cell, Electrochemical series and its importance. Types of Electrodes.

Basic Principles of (i) Conductometric titrations- HCl Vs NaOH, CH_3COOH Vs NaOH

(ii) Potentiometric titrations: Acid-base titration HCl Vs NaOH, Redox titration (FAS Vs $K_2Cr_2O_7$)

Determination of p^H using glass electrode.

12 hrs.

Batteries- Primary and secondary batteries, Battery components and their role. Working of the Lead acid and Lithium storage batteries, Fuel cells. **2hrs**.

UNIT II

Corrosion:

Introduction, definition, Types of corrosion, corrosion rate, factors affecting corrosion rate, Metallic factor-purity, electrode potential of metal, hydrogen over voltage, nature of corrosion product. Environmental factors-Temperature, pH of the medium, humidity, presence of impurities, electrical conductivity, velocity and concentration of the medium.

Prevention of Corrosion: Material selection - Metals and alloys, metal purification, non-metallic, Alteration of environment - Changing media, inhibitors, Design-wall thickness, design rules, Coating-Metallic and other inorganic coatings, organic coating.

Electroplating: Introduction, Electroplating of chromium (hard and decorative). Electroless plating: Introduction, distinction between electroplating and electrode plating processes. Electroless plating of copper.

14 hrs.

UNIT III

Metallurgy

Introduction: Ore, minerals, important ores of some common elements in India, General principles of pyrometallurgy, roasting, calcination, gangue, smelting, flux, gravity separation, froth flotation process, leaching. Techniques employed for purification of metal :Distillation process, Bessemerization, Electro-refining ,Van Arkel and De Boer's process.

6 hrs.

Extraction of metals: Extraction of Manganese (Pyrolusite), Titanium (Ilmanite) and Uranium.

4 hrs.

Alloys: Introduction, Classification of alloys, commercially important alloys, gold karats, Production of Ferro alloys- Ferrochrome, Ferromanganese, Uses of alloys.

-4 hrs.

Reference Books

1. Barrow. G.M, Physical chemistry, Tata McGraw-Hill, (2007)
2. An introduction to electrochemistry, Samuel Glasstone, East-West edition New Delhi, (1942)
3. Text book of physical chemistry, Samuel Glasstone, 2nd Edition, Mac Millan India Ltd, (1991)
4. Principles and applications of electrochemistry, D. R. Crow, 3rd edition, Chapmanhall London, (1988)
5. Fundamentals of electrochemical deposition, Milan Paunovic and Mordechay Schlesinger, Wiley Interscience Publications, New York, (1998)
6. Engineering Chemistry, V R Kulkarni and K Ramakrishna Reddy, New Age International, (2015)
7. Electrochemistry and corrosion Science, Nestor Perez, Springer (India) Pvt. Ltd., (2004)
8. Principles and prevention of corrosion, D. A. Jones, Macmillan Publ. Co., (1996)
9. Essential of materials science and engineering, Donald R. Askeland, Thomson Learning, 5th Edition, (2006)
10. Introduction to engineering materials, B. K. Agarwal, Tata McGraw Hill, 1st Edition (2013)
11. Material science and engineering, V. Raghavan, PHI Learning, 5th Edition (2004)
12. Engineering materials and metallurgy, R. K. Rajput, S. Chand - 1st Edition, (2011)