IFTM University, Moradabad
Bachelor of Science (Hons) Chemistry Programme
B.Sc. (Hons) Chemistry I Year (I Semester)
BCHECC(H)-101: INORGANIC CHEMISTRY

Objectives: This course will equip students with skill development and to understand chemistry at the most fundamental level to understand the periodic properties of different elements, different principles for filling electrons in different energy levels and to draw energy diagrams, and how to calculate bond order.

Unit-I **(08 Sessions)**

Periodic Properties:

Atomic and ionic radii, ionization energy, electron affinity and electro negativity - definition, methods of determination or evaluation, trends in periodic table and applications in predicting and explaining the chemical behavior for skill development and employability in chemical sector.

Unit – II **(08 Sessions)**

Chemical Bonding:

Covalent Bond–Valence bond theory and its limitations, directional characteristics of covalent bond, MO theory, homonuclear and heteronuclear (CO and NO) diatomic molecules, multicenter bonding in electron deficient molecules, bond strength and bond energy, percentage ionic character from dipole moment and electronegativity difference .

Unit-III **(10 Sessions)**

s-block Elements:

Comparative study, diagonal relationship, salient features of hydrides, solvation and complexation tendencies including their function in bio-systems for better skilling of entrepreneurship, an introduction to alkyls and aryls.

Unit –IV **(10 Sessions)**

p-block Elements:

Comparative study of group 13 – 17 elements , compounds like hydrides, oxides, oxyacids and halides of group 13–16, hydrides of boron–diborane and higher boranes, fullerenes, carbides, silicates, interhalogens.

Chemistry of Noble Gasses: Chemical properties of the noble gases, chemistry of xenon, structure and bonding in xenon compounds and its application for employability in industries.

Course Outcomes:

Students completing this course will able to:

CO1: Describe the periodic table as a list of elements to demonstrate trends in their physical and chemical properties for skill development and employability at local level

CO2: Gain an understanding of the bonding fundamentals and predicting geometries of simple molecules.

CO3: Understand properties and applications of S-block elements, hydrogen and their compounds for employability.

CO4: Learn about the structure and applications of compounds of xenon, boron and carbon.

Suggested Readings:

1. Inorganic Chemistry by J. E. Huheey.
2. Basic Inorganic Chemistry by Cotton and Wilkinson.

3.Organic Chemistry by Morrisson and Boyd.
4. Concise Inorganic Chemistry by J.D.Lee.

Website Sources:

- https://www.internetchemistry.com/
- http://www.chemguide.co.uk/
- https://freebookcentre.net/
- Chemical Elements.com

Note: Latest edition of all the suggested readings must be used.

Mapping of Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	3	1	3	2	1	2	1	2	1
CO2	1	1	3	3	2	3	2	2	1	3	1	1
CO3	2	3	3	3	1	3	1	1	1	1	1	2
CO4	2	2	3	3	1	3	2	2	2	3	2	1

CO-Curriculum Enrichment Mapping
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship
CO1	3	2	1
CO2	3	1	1
CO3	3	2	1
CO4	3	2	2

IFTM University, Moradabad
Bachelor of Science (Hons) ChemistryProgramme
B.Sc.(Hons) Chemistry I Year (I Semester)
BCHECC(H)-102: ORGANIC CHEMISTRY

Objectives: The main objective of this course is to make the students knowledgeable about the fundamentals of carbon chemistry, to understand the consequences (reactivity, properties) of the three-dimensionality of molecules, so that they may be able to interpret patterns of reactivity on the basis of mechanistic reasoning and to provide employability & entrepreneurial skills for industrial purpose.

Unit – I **(08 Sessions)**

Mechanism of Organic Reactions:
Homolytic and heterolytic bond fission, Types of reagents – electrophiles and nucleophiles, Types of organic reactions, Reactive intermediates – Carbocations, carbanions, free radicals, carbenes, arynes and nitrenes (with examples), charge transfer complexes, resonance, hyperconjugation, inductive and electromeric effects and skill development to understand general chemistry.

Unit – II **(10 Sessions)**

Stereochemistry of Organic Compounds:
Concept of isomerism, types of isomerism: Optical isomerism – elements of symmetry, molecular chirality, enantiomers, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centers , diastereomers, threo and erythrodiastereomers, meso compounds, resolution of enantionmer and recemization. Relative and absolute configuration, sequence rules, R & S systems of nomenclature.
Geometric isomerism – determination of configuration of geometric isomers, E & Z system of nomenclature.

Unit – III **(08 Sessions)**

Cycloalkanes: Nomenclature, Baeyer's strain theory and its limitations, Ring strain in small rings (cyclopropane and cyclobutane), theory of strain less rings. Preparation and properties of cyclo alkane to enhance employability skill in chemical industries.

Unit – IV **(08 Sessions)**

Arenes and Aromaticity: Huckel's rule, aromatic ions, Nomenclature of benzene derivatives, the aryl group, aromatic nucleus and side chain, Aromatic electrophilic substitution-Mechanism of nitration, halogenation, sulphonation and Friedel-Crafts reaction. Orientation and ortho/para ratio, side chain reactions of benzene derivatives, Birch reduction: Methods of preparation and chemical reactions of alkyl benzenes and naphthalene and anthracene for entrepreneurship & employability.

Course Outcomes:

Students completing this course will able to:

CO1: Understand the mechanisms of various organic reactions as well as reaction tendency of electrophiles, nucleophiles and reaction intermediates, their importance for industries and employability at local level.
CO2: Develop an understanding of characteristics of organic compounds due to three dimensional arrangement and skill development for synthesis of compounds.
CO3: Interpret the preparation, properties and reactions of cycloalkanes.
CO4: Analyze the concept of aromaticity and the main properties of aromatic compounds.

Suggested readings:

1. A Textbook of Qualitative Inorganic Analysis by A.I. Vogel.
2. A Text Book of Organic Chemistry by I. L.FinarVol I.
3. M.S Singh, Advanced Organic Chemistry/Reactions and Mechanism: Pearson Education Pvt.Ltd.
4. S.M. Mukerjee and S. P., Singh Reaction Mechanism in Organic Chemistry Macmillan India Ltd.

Web sources:

- https://www.masterorganicchemistry.com/
- https://www.organic-chemistry.org/

Note: Latest edition of all the suggested readings must be used.

Mapping of Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**2**	**1**	**3**	**3**	**3**	**3**	**1**	**1**	**3**	**3**	**1**	**2**
CO2	**2**	**1**	**3**	**3**	**2**	**3**	**1**	**2**	**1**	**3**	**2**	**2**
CO3	**1**	**3**	**3**	**3**	**2**	**3**	**3**	**1**	**2**	**2**	**2**	**2**
CO4	**2**	**2**	**3**	**3**	**2**	**3**	**3**	**3**	**2**	**3**	**1**	**1**

CO-Curriculum Enrichment Mapping
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship
CO1	**3**	**3**	**1**
CO2	**3**	2	**1**
CO3	**3**	2	**2**
CO4	**3**	1	**1**

IFTM University, Moradabad
Bachelor of Science (Hons) ChemistryProgramme
B.Sc.(Hons) Chemistry I Year (I Semester)
BCHECC(H)-151: CHEMISTRY PRACTICAL

Objectives: The objective of this course is to give knowledge to the students about the chemical experiments, properly carry out the experiments, and appropriately record and skill development to analyze the results. Students will be able to use standard laboratory equipment, modern instrumentation, and classical techniques to carry out experiments. Students will know and follow the proper procedures and regulations for safe handling and use of chemicals and employability in chemical industries. Students will be able to successfully pursue their career objectives in advanced education in professional and/or graduate schools, in a scientific career in government or industry, in a teaching career in the school systems, in entrepreneurship or in a related career following graduation.

INORGANIC CHEMISTRY PRACTICALS

(10 Sessions)

1. Qualitative inorganic analysis: Analysis of mixture salt containing two anions and two cations (From two different groups) from the following:
   Anions: Carbonate, sulphate, chloride, bromide, acetate, nitrate, borate, phosphate.
   Cations: Lead, copper, iron, aluminum, zinc, manganese, calcium, strontium, barium, potassium and ammonium.
2. Semi micro Analysis – cation analysis, separation and identification of ions from Group I, II, III, IV, V and VI.
3. Find the strength in grams per litre of the given solution of sodium hydroxide with the help of standard oxalic acid solution.
4. Determine the total alkalinity in parts per million in the given sample of water using standard acid solution.
5. Determination of Fe(II) using $KMnO_4$with oxalic acid as primary standard.

ORGANIC CHEMISTRY PRACTICALS

(10 Sessions)

1) Determination of melting point:
   Naphthalene 80 – 82^0, Benzoic acid 121.5 - 122^0, m-Dinitrobenzene 90^0
Urea 132.5 - 133^0, Succinic acid 184.5 - 185^0, p-Dichlorobenzene 52^0
2) Crystallization:
   i- Phthalic acid from hot water (using fluted filter paper and steam less funnel)
   ii- Naphthalene from ethanol
   iii- Benzoic acid from water
3) Decolorisation and crystallization using charcoal:
   i- Decolorisation of brown sugar (Sucrose) with animal charcoal using gravity filtration.
   ii- Crystallization and decolorisation of impure naphthalene (100g of naphthalene mixes with 0.3 gm of Congo Red using 1g decolorizing carbon)from ethanol.
4) Detection of extra element (N and halogens) and functional groups in the given organic compound
5) Qualitatative analysis of organic compounds - phenols, carboxylic acids, carbonyl compounds (aliphatic and aromatic, carbohydrates, amines, acetamide amides).

Course outcomes:

Students completing this course will able to:

CO1: Demonstrate mastery of basic organic chemistry laboratory techniques, including distillation, recrystallization, melting point determination, liquid-liquid extraction, gravity and liquid filtration, and chromatography for employability in local and national industries.

CO2: Demonstrate the skill development to safely and effectively perform reactions, using proper glassware set-up, handling of hazardous chemicals, and following the prescribed experimental procedures.

CO3: Demonstrate safe laboratory practices through the use of appropriate personal protective equipment and appropriate handling of all chemicals, including proper disposal of waste.

CO4: Assess the progress and success of their experiments, and be able to adjust experimental procedures when necessary.

Suggested Readings:

1. Practical Chemistry - Giri, Bajpai and Pandey, S. Chand & Co. Ltd., New Delhi.
2. Laboratory Manual in Organic Chemistry, R.K. Bansal, Willey Eastern.
3. Experimental Organic Chemistry, Vol. I and II, P. R. Singh, D.S. Gupta and K.S. Bajpai, Tata Mc-graw Hill.
4. Instrumental Methods of Chemical Analysis G.W. Ewing McGraw Hill.
5. Experiments in General Chemistry, N. R. Rado and U.C. Agarwal, Eastern Press.

Web Sources:

- https://www.acs.org/content/acs/en/education/students/highschool/chemistryclubs/activities/simulations.html
- http://www.chem.ox.ac.uk/vrchemistry/

Note: Latest edition of all the suggested readings must be used.

Mapping of Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	3	3	1	3	2	3	3	3
CO2	2	2	2	3	2	2	2	2	3	3	2	3
CO3	3	2	3	1	3	2	1	2	3	3	2	3
CO4	2	2	2	2	3	3	2	1	3	3	2	3

CO-Curriculum Enrichment Mapping
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship
CO1	3	3	1
CO2	3	3	2
CO3	3	3	2
CO4	3	3	1

IFTM University, Moradabad
Bachelor of Science (Hons) ChemistryProgramme
B.Sc.(Hons) Chemistry I Year (II Semester)
BCHECC(H)-201: PHYSICAL CHEMISTRY

Objectives: The main objectives of this course are to develop skills to learn errors and data analysis methods.
To understand the fundamental theory and laboratory techniques in physical chemistry.Also to calculate gaseous state numerical problem analysis and to know about colloids and their practical application.

Unit – I **(10 Sessions)**

Mathematical Concepts and Computers:
Mathematical Concepts: Logarithmic relations, curve sketching, linear graphs and calculation of slopes, differentiation of functions like Kx, X^n, Sin x, log x maxima and minima, differentiation and reciprocity relations. Integration of some useful/relevant functions
Computers: General introduction to computers, different components of a computer, hardware and software for entrepreneurship & employability, input-output devices, binary numbers and arithmetic.

Unit – II **(10 Sessions)**

Gaseous State: Postulates of kinetic theory of gases, deviation from ideal behavior, Vander Waals equation, relationship between critical constants and Vander Waals constants, law of corresponding states, reduced equation of state.
Molecular velocities: Root mean square, average and most probable velocities, collision number, mean free path and collision diameter, Liquefaction of gases.
Liquid State: Intermolecular forces, structure of liquids (a qualitative description).
Liquid crystals: Classification& application of liquid crystals.
Solid State: Space lattice, unit cell. Laws of crystallography, X–Ray diffraction by crystals, Derivation of Bragg's equation.

Unit – III **(08 Sessions)**

Colloids: Definition and classification
Sols: kinetic, optical and electrical properties, coagulation, stability of colloids, Hardy–Schulze law, gold number.
Emulsions: Types of emulsions, preparation, Emulsifiers.
Gels: Preparation and properties.
Applications of colloids and their knowledge for better employability in industry.

Unit – IV **(08 Sessions)**

Chemical kinetics:
Rate of a reaction, factors influencing the rate of a reaction.
Reactions: Zero order, first order, second order, half life and mean life. Determination of the order of reaction-integration method, Effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy. Collision theory and transition state theory.

Course outcomes:
Students completing this course will able to:
CO1: Skill development for basic computer system and mathematical concepts such as logarithmic relations, differentiation and integration etc. which are useful to learn chemistry.

CO2: Understand the concept of kinetic theory of gases, behavior of real gases, basic concepts of liquid and solid state.
CO3: Apply the concepts of sol, gel and emulsions to various solutions for better employability in local industries.
CO4: Evaluate rate constant of a reaction as well as understand theories of reaction rates.

Suggested readings:

1. Spectroscopy by William Kemp.
2. Spectroscopy by Pavia.
3. Organic Spectroscopy by J. R. Dyer.
4. Modern Electrochemistry by J.O. M. Bockris and A.K.N.Reddy.
5. Advanced Physical Chemistry by Atkins.
6. Introduction to Electrochemistry by S. Glasstone.
7. Elementary organic spectroscopy by Y.R. Sharma.
8. Spectroscopy by P.S.Kalsi.

Web Sources:

- https://www.edx.org/learn/physical-chemistry
- https://www.learnchem.net/

Note: Latest edition of all the suggested readings must be used.

Mapping of Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1	3	2	2	2	2	3	3	1	3
CO2	2	2	3	3	1	3	2	2	3	2	2	2
CO3	2	2	3	3	1	3	1	2	3	3	2	1
CO4	1	2	3	3	2	3	1	1	3	1	2	2

CO-Curriculum Enrichment Mapping
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship
CO1	3	2	1
CO2	3	2	1
CO3	3	2	2
CO4	3	2	1

IFTM University, Moradabad
Bachelor of Science (Hons) ChemistryProgramme
B.Sc.(Hons) Chemistry I Year (II Semester)
BCHECC(H)-202: BASICS OF ANALYTICAL CHEMISTRY

Objectives: The main objectives of this course are to develop skill to learn intermediate theory and laboratory techniques in analytical and physical chemistry. To know about the advanced data analysis methods and goodness-of-fit criteria required for employability and entrepreneurship. Fourier transforms spectroscopic methods and instrumentation.

Unit–I **(10 Sessions)**

Data Analysis-

Concept of significant figures-its importance, accuracy, methods of expressing accuracy, error analysis, types of errors, minimizing errors, precision-mean, median, mean deviation, standard deviation and confidence limit and its requirement for employability in industrial level.

Chemical and single pan balance, precautions in using balance, sources of error in weighing, correction for buoyancy, temperature effects, calibration of weights.

Unit–II **(10 Sessions)**

Calibration of glassware and volumetric analysis

Calibration of pipette, volumetric flask, Burette.Measurements in analytical chemistry, S.I units-Fundamental units (Mass, amount of substances, distance, time, temperature, current) and Derived. Units(Area, Volume,density, velocity, force, pressure, energy, heat, work, power, charge, potential, resistance, frequency) (S.I Units and Symbol only)

Preparation of standard solution, indicators, acid base titration, complex metric titration for better employability in pharmaceutical and chemical sectors.

Unit–III **(08 Sessions)**

Chromatographic Techniques-

Types of chromatography, principle, column chromatography-principle, types of adsorbents, preparation of the column, elution, recovery of substances and applications.

TLC-principles, choice of adsorbent and solvent, preparation of chromatoplates.R_f values. Factors affecting the R_f values. Significance of R_f values.

Paper Chromatography-principle, solvent used development of chromatogram, ascending, descending and radial paper chromatography and application to develop skills for employability.

Unit–IV **(08 Sessions)**

Gravimetric Analysis-

Principle-theories of precipitation-solubility product and precipitation-factors affecting solubility. Conditions of precipitation, co-precipitation and post precipitation.Reduction of errors.Precipitation from homogeneous solution-washing and drying of precipitate.

Skill development of the precipitant-Specific and selective precipitants-Anthranilic acid,Cupferon, Dimethyl glyoxime, Ethylenediamine.

Course Outcomes:

Students completing this course will able to:

CO1: Skill development significant figures, accuracy, precision and errors in a given set of results.

CO2: Calibrate various analytical instruments and learn about SI units and standard solutions for employability in local industries.

CO3: Apply separation technique such as chromatography for separation of compounds.

CO4: Perform gravimetric separation and estimation of different components in a mixture.

Suggested readings:

1. Analytical Chemistry by Skoog and Miller.
2. A Textbook of Qualitative Inorganic Analysis by A.I. Vogel.
3. Nano-chemistry by Geoffrey Ozin and Andre Arsenault.
4. Stereochemistry by D. Nasipuri.
5. Organic Chemistry by Clayden.
6. J.H. Keneedy, Analytical Chemistry.

Web Source:

- https://edu.rsc.org/teacher-pd/in-person/analytical-chemistry/classroom-resources.

Note: Latest edition of all the suggested readings must be used.

Mapping of Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	1	3	2	2	1	3	1	3
CO2	3	3	2	1	3	2	2	2	2	3	3	3
CO3	3	2	2	3	2	3	2	2	3	3	2	3
CO4	3	2	2	2	2	2	3	1	3	3	2	3

CO-Curriculum Enrichment Mapping
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship
CO1	3	3	1
CO2	3	2	1
CO3	3	3	2
CO4	3	3	2

IFTM University, Moradabad
Bachelor of Science (Hons) ChemistryProgramme
B.Sc.(Hons) Chemistry I Year (II Semester)
BCHECC(H)-251: CHEMISTRY PRACTICAL

Objectives: Students will understand the scientific reasoning, quantitative analysis laboratory practice and safety. Skill development for basic analytical and technical work effectively in the various fields of chemistry. The ability to perform accurate quantitative measurements with an understanding of the theory and use of contemporary chemical instrumentation, interpret experimental results, perform calculations on these results and draw reasonable, accurate conclusions for employability in industries**.**

PHYSICAL CHEMISTRY

(10 Sessions)

1. Determination of relative surface tension of the given organic compound.
2. Determination of relative viscosity of the given organic compound.
3. Determination of order of reaction.
4. Determination of number of molecules of water of crystallization (n) in the given sample of Mohr's salt.
5. Determination of percentage purity of an impure sample of $KMnO_4$.

ANALYTICAL CHEMISTRY

(10 Sessions)

1. Determination of R_f value by using paper chromatography.
2. Determination of common food adulteration in various food samples (desi ghee, mustard oil, turmeric powder, chili powder) and development of employability skill for food industries.
3. Determination of chloride content in a given water sample.
4. Determination of quantity of casein present in different samples of milk.
5. Determination of dosage of bleaching powder required for disinfection of different samples of water taken from different sources.

Course Outcomes:
Students completing this course will able to:
CO1: Understand the principles defining analytical chemistry from the point of view of the "problem solving" approach for employability in local and national industries
CO2: Furthermore, they will develop skills about the chemical equilibria in solution,carrying out simple qualitative tests and of defining the optimal conditions for a reaction to proceed.
CO3: Volumetric and gravimetric quantitative determinations; standard analysis procedures, understanding and development of a SOP.
CO4: Statistical treatment of the data and significance tests for the final evaluation of analytical data and its applications.

Suggested Readings:
1. D.A. Skoog, Principles of Instrumental Analysis: Sundars College Publicing.
2. Modern Methods of Chemical Analysis: R. L. Pecsok, John Wiley New York.
3. Experiments in Physical Chemistry - J.C. Ghose, Bharti Bhawan.

Web Sources
- https://www.labster.com/chemistry-virtual-labs/
- https://digitallearning.ucf.edu/ilab/remote-labs/college-of-sciences-remote-lab-resources/

Note: Latest edition of all the suggested readings must be used.

Mapping of Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	2	2	2	3	3	1	3
CO2	3	3	2	1	2	2	2	1	3	3	2	2
CO3	3	3	1	3	1	1	2	1	3	3	2	3
CO4	3	3	2	2	2	2	2	1	3	3	2	3

CO-Curriculum Enrichment Mapping
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship
CO1	3	3	1
CO2	3	3	1
CO3	3	3	1
CO4	3	3	2

IFTM University, Moradabad
Bachelor of Science (Hons) ChemistryProgramme
B.Sc.(Hons) Chemistry II Year(III Semester)
BCHECC(H)-301: INORGANIC CHEMISTRY

Objectives: This course will equip students with the skill development to understand chemistry at the most fundamental level. Understand the Characteristic properties of d-block elements. To understand coordination compounds, Werner's coordination theory and its experimental verification. Learning of lanthanides and actinides their properties and applications.

Unit – I **(09 Sessions)**

Elements of First Transition Series

Characteristic properties of d-block elements.Binary compounds (hydrides, carbides and oxides) of the elements of the first transition series and study of their complexes with respect to relative stability of their oxidation states, coordination number and geometry.

Unit – II **(09 Sessions)**

Coordination Compounds

Werner's coordination theory and its experimental verification, effective atomic number (E.A.N.) concept, chelates, nomenclature of coordination compounds, isomerism in coordination compounds, valence bond theory of transition metal complexes.

Unit – III **(09 Sessions)**

Lanthanides and Actinides

Electronic configuration, oxidation states, ionic radii and magnetic properties, lanthanide and actinide contraction, complex formation, application and employability skills in research field.

Unit – IV **(09 Sessions)**

Oxidation and Reduction:

Oxidation Number, Oxidising agents, Reducing agents, Electrode potential, electrochemical series and its applications,

Acids and Bases:

Arrhenius, Bronsted-Lowry, Lewis, Lux-Flood concept, Usanovitch and solvent system concepts of acids and bases.

Non-aqueous Solvents:

Physical properties of a solvent, types of solvents and their general characteristics, Reactions in non-aqueous solvents with reference to liquid NH_3 and Liquid SO_2.

Course outcomes:

Students completing this course will able to:

CO1: Gain an understanding of elements of first transition series elements.
CO2: Learn about coordination compounds of transition metal complexes and their applications.
CO3: Describe the properties and applications of lanthanides and actinides.
CO4: Assess oxidation and reduction in different reactions and understand the characteristics of non-aqueous solvents for local industries.

Suggested readings:

1. Inorganic Chemistry by J. E. Huheey.
2. Basic Inorganic Chemistry by Cotton and Wilkinson.
3. Organic Chemistry by Morrisson and Boyd.
4. Concise Inorganic Chemistry by J. D. Lee.

Website Sources:

- https://www.internetchemistry.com/
- http://www.chemguide.co.uk/
- https://freebookcentre.net/

Note: Latest edition of all the suggested readings must be used.

Mapping of Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	2	2	3	2	2	3	2	2	2
CO2	2	2	3	2	2	3	2	1	3	3	2	1
CO3	2	3	2	3	1	2	3	2	3	1	1	1
CO4	2	1	3	1	3	3	1	2	3	3	2	1

CO-Curriculum Enrichment Mapping
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship
CO1	3	2	1
CO2	3	2	1
CO3	3	2	1
CO4	3	1	1

IFTM University, Moradabad
Bachelor of Science (Hons) ChemistryProgramme
B.Sc.(Hons) Chemistry II Year (III Semester)
BCHECC(H)-302: ORGANIC CHEMISTRY

Objectives: This course will give an introduction to modern spectroscopic techniques including time-resolved laser methods. Skill development to learn theory and application, ultraviolet and visible spectroscopy, infrared spectroscopy, Raman, fluorescence, nuclear magnetic resonance spectroscopy,time-resolved spectra including lifetime measurements, etc. Comprehension and industrial applications of alcohols, phenols and ethers and synthesis of many carboxylic acids and their industrial production and employability skills.

Unit – I (**09 Sessions)**

Electromagnetic Spectrum: Absorption Spectra-
Brief idea about Ultraviolet (UV) absorption spectroscopy –Beer-Lambert's law; molar absroptivity, presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation. Concept of chromophore and auxochrome, Bathochromic, hypsochromic, hyperchromic and hypochromic shifts.
Infrared (I.R.) absorption spectroscopy – molecular vibrations, Hooke's law, selection rules, intensity and position of I.R. bands, fingerprint region, characteristic absorptions of various functional groups and interpretation of I.R. spectra and development of skill for interpretation of simple organic compounds.

Unit – II **(09 Sessions)**

Phenols:
Nomenclature, structure and bonding, preparation of phenols, physical properties and acidic character, Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols: electrophilic aromatic substitution, acylation and carboxylation. Mechanisms of Friedel Craft reaction, Fries rearrangement, Kolbe Schmitt reaction, oxidation and reduction of phenol, brief idea about dihydric phenols and their importance for industries and employbility**.**

Unit – III **(09 Sessions)**

Aldehydes and Ketones:
Nomenclature and structure of the carbonyl group , synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides, synthesis of ketones from nitrile and from carboxylic acids, Mechanism of nucleophillic additions to carbonyl group with particular emphasis on Benzoin, Aldol, Perkin and Knoevenagel Condensations. Application of named reaction for industries and for better imploybility.

Unit – IV **(09 Sessions)**

Carboxylic Acids:
Nomenclature, structure and bonding, acidity of carboxylic acids, effects of substituent on acid strength, Preparation of carboxylic acids, Reactions of carboxylic acids, Synthesis of acid chlorides, esters and amides, Reduction of carboxylic acids, Hydroxy acids: lactic, Tartaric and Citric Acids.
Carboxylic Acid Derivatives: Preparation of carboxylic acid derivatives, chemical reactions. Mechanism of Esterification and Hydrolysis(Acidic and Basic).

Course Outcomes:

Students completing this course will able to:

CO1: Development of skills to Learn about UV & IR spectroscopy and importance of spectroscopy to elucidate the molecular structure of organic compounds for employability in local and national industries

CO2: Describe the nomenclature, structure, bonding, preparation and properties of phenols.

CO3: Understand the chemistry of aldehydes and ketones as well mechanisms of nucleophillic addition reactions and their importance for employment in industries.

CO4: Describe the nomenclature, structure, bonding, preparation and properties of carboxylic acids.

Suggested readings:

1. Inorganic Chemistry by J. E. Huheey.
2. Basic Inorganic Chemistry by Cotton and Wilkinson.
3. Organic Chemistry by Morrisson and Boyd.
4. Concise Inorganic Chemistry by J. D. Lee.

Web Sources:

- https://www.masterorganicchemistry.com/
- https://www.organic-chemistry.org/

Note: Latest edition of all the suggested readings must be used.

Mapping of Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	2	2	3	3	2	3
CO2	2	2	3	2	2	3	1	2	3	3	2	3
CO3	2	1	3	2	2	3	2	2	3	3	2	2
CO4	2	3	3	1	2	3	1	1	3	3	2	2

CO-Curriculum Enrichment Mapping
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship
CO1	3	2	2
CO2	3	3	1
CO3	3	2	1
CO4	3	3	1

IFTM University, Moradabad
Bachelor of Science (Hons) Chemistry Programme
B.Sc. (Hons) Chemistry II Year (III Semester)
BCHECC(H)-351: CHEMISTRY PRACTICAL

Objectives: Students will be able to understand the objective of their chemical experiments, properly carry out the experiments, and appropriately record and analyze the results. Skills will develop to use standard laboratory equipment, modern instrumentation, and classical techniques to carry out experiments. Students will know and follow the proper procedures and regulations for safe handling and use of chemicals and its requirement for employability in industries. Students will be able to communicate the concepts and results of their laboratory experiments through effective writing and oral communication skills.

A) Inorganic Chemistry: (10 Sessions)

1) Determination of alkali content – an acid tablet using HCl.
2) Estimation of hardness of water by EDTA.
3) Estimation of ferrous and ferric ions by dichromate method.
4) Estimation of copper using sodium thiosulphate solution.
5) Inorganic preparations:
   a) Preparation of chrome alum.
   b) Preparation of potash alum.
   c) Preparation of chrome red.

B) Organic Chemistry: (10 Sessions)

1) Determination of R_f values and identification of organic compounds using paper chromatography.
2) Separation of green leaf pigments (spinach leaves may be used).
3) Separation of a mixture of phenylalanine and glycine, Alanine and aspartic acid, Leucine and glutamic acid, using Spray reagent –ninhydrin.
4) Separation of monosaccharide- A mixture of D- galactose and D-fructose using n-butanol: acetone: water (4:5:1), spray reagent – aniline hydrogen phthalate.
5) Identification of an organic compound through the functional group analysis, determination of melting point and preparation of suitable derivatives.

Course outcomes:

Students completing this course will able to:

CO1: Demonstrate basic organic chemistry laboratory techniques, including identification of organic compounds using paper chromatography and their application for better employability in chemical sector at national and global level.

CO2: Development of skills for Separation of a mixture of amino acids by paper chromatography.

CO3: Understand the estimation of hardness of water.

CO4: Assess the progress and success of their experiments, and be able to adjust experimental procedures when necessary.

Suggested Readings:

1. Practical Chemistry - Giri, Bajpai and Pandey, S. Chand & Co. Ltd., New Delhi.
2. Laboratory Manual in Organic Chemistry, R.K. Bansal, Willey Eastern.
3. Experimental Organic Chemistry, Vol. I and Ii, P.R. Singh, D.S. Gupta and K.S. Bajpai, Tata McGraw Hill.
4. Method of Chemical Analysis G.W. Ewing McGraw Hill.
5. Experiments In General Chemistry, N. R. Rado and U.C. Agarwal, Eastern Press.

Web Sources:

- https://www.acs.org/content/acs/en/education/students/highschool/chemistryclubs/activities/simulations.html
- http://www.chem.ox.ac.uk/vrchemistry/

Note: Latest edition of all the suggested readings must be used.

Mapping of Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	2	3	2	2	3	3	2	3
CO2	3	3	3	2	1	2	3	2	3	3	3	3
CO3	3	2	2	2	3	1	2	3	3	3	2	3
CO4	3	2	2	3	2	2	3	1	3	3	2	3

CO-Curriculum Enrichment Mapping
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship
CO1	3	3	1
CO2	3	3	2
CO3	3	3	1
CO4	3	3	2

IFTM University, Moradabad
Bachelor of Science (Hons) ChemistryProgramme
B.Sc.(Hons) Chemistry II Year (IV Semester)
BCHECC(H)-401: PHYSICAL CHEMISTRY

Objectives: To develop skills for electrochemistry and Conductance in electrolyte. Fundamental theory of thermodynamics and variables used to calculate gaseous state numerical problem related to thermodynamics and electrochemistry. To know the Statement and meaning of the terms- phase equilibrium system of two component system-(Pb-Ag system).

Unit – I (**10 Sessions**)

Thermodynamics – I

First Law of Thermodynamics:

Statement, definition of internal energy and enthalpy, Heat capacity, heat capacities at constant volume and pressure and their relationship, Joule's law – Joule-Thomson coefficient and inversion temperature. Calculation of w, q, dU&dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process. Kirchhoff's equation. Application of thermodynamics and its importance in employability

Unit – II (**10 Sessions)**

Thermodynamics – II

Second Law of Thermodynamics:

Need for the law, different statements of the law, Cornot's cycle and its efficiency, Carnot's theorem. Thermodynamic scale of temperature. Skill development to connect thermodynamics with day to day life

Concept of entropy:

Entropy as a state function, entropy as a function of V & T, entropy as a function of P & T, entropy change in physical change, ClausiusClapeyron equation, entropy as a criteria of spontaneity and equilibrium.

Gibbs and Helmholtz functions:

Gibbs function (G) and *Helmholtz* function (A) as thermodynamic quantities, A &G as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change, Variation of G and A with P, V and T.

Unit – III **(08 Sessions)**

Electrochemistry:

Conductance in electrolyte solutions, variation of molar equivalent and specific conductance with dilution.Migration of ions and Kohlrausch's law, weak and strong electrolytes, Ostwald's dilution law, Transport number, and its determination by Hittorf's method.Applications of conductivity measurements. Nernst theory and equation, derivation of cell E.M.F. and single electrode potential, standard hydrogen electrode, standard electrode potential, sign conventions, Electrolytic, Galvanic cells and its Application & role in development of employability

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Unit – IV **(08 Sessions)**

Phase Equilibrium:

Statement and meaning of the terms-phase, component and degree of freedom, phase equilibrium system of one component system-(water, and Sulphur) phase equilibrium system of two component system-(Pb-Ag system), desilverisation of lead (Pattinson’s Process)

Course Outcomes:

Students completing this course will able to:

CO1: Skill development to understand the concept of heat, work and internal energy.

CO2: Understand the entropic changes for reversible & irreversible process and application of Gibb's & Helmholtz equations & its impact on temperature, volume & pressure for employability at local and national level

CO3: Understand the concept of conductance and electrochemistry as well as determine the EMF of the cells.

CO4: Learn the concept of phases, component and degree of freedom and its applications to various phase diagrams

Suggested Readings:

1. Text Book of Physical Chemistry by S.Glasstone.
2. Advanced Physical Chemistry by Gurudeep Raj.
3. Modern Electrochemistry J.O.M. Bockrisand A. K. M. Reddy: Plenium Press New York.
4. Physical Chemistry: Atkins, Oxford University Press, New York.
5. Physical Chemistry, I.N.Livine: Tata McGraw Hill Publication New Delhi.

Web sources:

- https://www.acs.org/content/acs/en/education/students/highschool/chemistryclubs/activities/simulations.html
- http://www.chem.ox.ac.uk/vrchemistry/

Note: Latest edition of all the suggested readings must be used.

Mapping of Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	3	3	3	3	2	3	2	2	2
CO2	2	2	3	3	3	3	2	2	3	3	1	2
CO3	2	2	3	3	3	3	2	2	3	3	2	1
CO4	1	2	3	3	3	3	2	1	3	3	2	2

CO-Curriculum Enrichment Mapping
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship
CO1	3	2	2
CO2	3	2	1
CO3	3	3	1
CO4	3	2	1

IFTM University, Moradabad
Bachelor of Science (Hons) Chemistry Programme
B.Sc. (Hons) Chemistry II Year (IV Semester)
BCHECC(H)-402: ENVIRONMENTAL CHEMISTRY

Objectives: This course provides development of skills of the concepts and applications used to predict and explain chemical concentrations found in different parts of indoor and outdoor environments. The course main objectives are to answer the connection between chemical uses and mishaps, and damage to human health or to ecologies. This course introduces concepts that form a basis for rationalizing or predicting environmental behavior of pollutant chemicals and opportunities of employability in green chemical industries.

Unit – I **(09 Sessions)**
Skill development to understand components of Environment (a brief introduction), air and water pollutants and their classification, air and water quality standards, soil chemistry: inorganic and organic chemistry of soil, macro and micro nutrients of soil.

Unit – II **(09 Sessions)**
Methods of control of air and water pollution:
Adsorption of gaseous pollutants, electrostatic precipitation of air pollutants, cyclonic separation of air pollutants, aeration of water, waste water treatment, softening of water, Methods of water treatment and its importance for employability in industries

Unit – III **(09 Sessions)**
Sampling and analysis of air and water pollutants:
Skill development of sampling gaseous, liquid and solid pollutants by different methods, analysis of NO_2, SO_2, H_2S And CO, analysis of toxic heavy metals(Cd, Cr, As, Pd, Cu, Hg).
Analysis of total cationic and anionic burdens of water.
Analytical techniques for pesticide residue analysis.

Unit – IV **(09 Sessions)**
Environmental Toxicology:
Bio-degradability, Bio-Oxidation, Bio-reduction, Bio-hydrolysis, Biochemical effects of arsenic, cadmium, lead, mercury, designing a green synthesis, designing safer chemicals.

Course Outcomes:
Students completing this course will able to:
CO1: Development of skills to understand chemical and biochemical principles of fundamental environmental processes in air, water, and soil.
CO2: Recognize different types of toxic substances & responses and analyze as well as treat toxicological compounds in air and water for employability in local and national industries
CO3: Perform sampling and analysis of various pollutants in air and water.
CO4: Describe biological and green methods of treatment of toxic environmental pollutants.

Suggestive Readings:
1. Fundamentals of ecology by M. C. Dash.
2. A Text book of Environmental chemistry by W. Moore and F. A. Moore.
3. Environmental Chemistry by Samir k. Banerji.

Web Sources:
- https://nptel.ac.in/courses/104/103/104103020/

- https://www.openlearning.com/courses/introduction-to-environmental-chemistry/
- https://environmentalchemistry.com/

Note: Latest edition of all the suggested readings must be used.

Mapping of Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	3	2	3	2	1	3	3	2	3
CO2	3	2	3	3	1	3	2	2	3	3	2	3
CO3	3	2	3	3	2	3	2	2	3	3	1	3
CO4	2	2	3	3	2	3	2	2	3	3	1	3

CO-Curriculum Enrichment Mapping
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship
CO1	3	2	2
CO2	3	3	3
CO3	3	3	3
CO4	3	2	3

IFTM University, Moradabad
Bachelor of Science (Hons) ChemistryProgramme
B.Sc.(Hons) Chemistry II Year (IV Semester)
BCHECC(H)-451: CHEMISTRY PRACTICAL

Objectives: To develop skill to perform accurate quantitative measurements with an understanding of the theory and use of contemporary chemical instrumentation, interpret experimental results, perform calculations on these results and draw reasonable, accurate conclusions to the students. They will understand the scientific reasoning and quantitative analysis, laboratory practice and safety. Students will learn the basic analytical and technical skills to work al and technical skills to work effectively in the various fields of chemistry like physical and environmental chemistry and their role in employability.

Physical Chemistry:

(10 Sessions)

1. Determination of the transition temperature of the given substance by thermometric method (e.g. $MnCl_2.4H_2O$ / $CuSO_4.5H_2O$) / $Na_2CO_3.10H_2O$)
2. Determination of the solubility of benzoic acid at different temperatures and to determine ΔH of the dissolution process.
3. Determination of the enthalpy of neutralization of a weak acid/weak base versus strong base/strong acid and determine the enthalpy of ionization of the weak acid/weak base.
4. Acid-base titration by pH meter.
5. Determination of the equivalent conductance of given electrolyte solution at room temperature using conductivity meter.

Environmental Chemistry:

(10 Sessions)

1. Determination of the percentage of available chlorine in the given sample of bleaching powder.
2. Determination of total dissolved solids in water / effluent sample.
3. Determination of Biological Oxygen Demand (BOD) of the given water sample.
4. Determination of Chemical Oxygen Demand (COD) of the given water sample using $K_2Cr_2O_7$ solution.
5. Determination of the conductivity of the soil sample and its importance for employability in research and development.

Course outcomes:

Students completing this course will able to:

CO1: Understand the principles defining physical chemistry and environmental chemistry from the point of view of the "problem solving" approach for employability in **local** and **national** industries.

CO2: Furthermore, he will acquired knowledge about total dissolved solids in water, Chemical Oxygen Demand (COD) of the given water sample carrying out simple qualitative tests and of defining the optimal conditions for a reaction to proceed.

Suggestive Readings:

1. Experimental physical chemistry by Frederick A. Bettelheim.
2. Experimental physical chemistry by G. Peter Matthews.
3. Experimental physical chemistry by Farrington Daniels.
4. Experimental physical chemistry by Halpern and McBane.
5. Experiments in physical chemistry by Shoemaker, Garland and Nible.

Web Sources

- https://www.labster.com/chemistry-virtual-labs/
- https://digitallearning.ucf.edu/ilab/remote-labs/college-of-sciences-remote-lab-resources/

Note: Latest edition of all the suggested readings must be used.

Mapping of Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	2	3	2	2	3	3	3	3
CO2	3	3	2	3	3	2	2	3	3	3	2	3

CO-Curriculum Enrichment Mapping
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship
CO1	3	3	2
CO2	3	3	1

IFTM University, Moradabad
Bachelor of Science (Hons) ChemistryProgramme
B.Sc.(Hons) Chemistry III Year (V Semester)
BCHE(H)-501 -INORGANIC CHEMISTRY

Objectives: This course develops skills for production, chemistry and properties of the transition metals, lanthanides and actinides. Specifically, the class introduces electron configurations for the elements and oxidation state trends for each group. Including bonding and isomerism in coordination compounds, crystal field theory, and electronic properties of ligands. Also cover metal bonding in clusters, the HSAB concept, chelate effect, and complex stability.

Unit – I **(09 Sessions)**

Transition Metal Complexes:

Limitations of valance bond theory, an elementary idea of crystal field theory, crystal field splitting in octahedral, tetrahedral and square planner complexes, factors affecting the crystal-field parameters.

Stability of metal complexes and factors affecting the stability, stability constants of complexes and their determination. Role of transition metals in employability in manufacturing industries.

Unit – II **(09 Sessions)**

Magnetic Properties of Transition Metal Complexes:

Types of magnetic behavior, methods of determining magnetic susceptibility,spin-only formula, L-S coupling, orbital contribution to magnetic moments, application of magnetic moment data for 3d metal complexes.

Unit – III **(09 Sessions)**

Metal carbonyls, Silicones and Phosphazenes

Metal carbonyls: 18 electron rule, preparation, structure and nature of bonding in the mononuclear carbonyls. Silicones and phosphazenes as examples of inorganic polymers.

Unit – IV **(09 Sessions)**

Hard and Soft Acids and Bases (HSAB)

Classification of acids and bases as hard and soft, Pearson's HSAB concept, acid-base strength and hardness and softness, Symbiosis, theoretical basis of hardness and softness, electro negativity and hardness and softness. Water softening methods and its importance for employability in industries

Course Outcomes:

Students completing this course will able to:

CO1: Gain knowledge of crystal field theory &relative stability about coordination complexes.
CO2: Describe the magnetic behavior of transition metal complexes
CO3: Understand nature and bonding in metal carbonyl, silicones and phosphazenes.
CO4: Apply the concept of hard and soft acids and bases to explain feasibility of reactions for skill development to get local employability

Suggested Readings:

1. Inorganic Chemistry by J. E. Huheey.
2. Basic Inorganic Chemistry by Cotton and Wilkinson.
3. Concise Inorganic Chemistry by J. D. Lee.
4. The Organometallic Chemistry of Transition Metals: John Wiley.

Web Sources:

- www.chem.tamu.edu
- www.academia.edu
- www.amu.ac.in
- www.chem.tamu

Note: Latest edition of all the suggested readings must be used.

Mapping of Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	3	2	3	2	2	3	2	2	2
CO2	2	2	3	3	2	3	2	2	3	3	2	2
CO3	2	2	3	3	2	3	2	2	3	2	2	1
CO4	2	1	3	3	3	3	1	1	3	3	2	2

CO-Curriculum Enrichment Mapping
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship
CO1	3	2	1
CO2	3	2	2
CO3	3	2	1
CO4	3	2	1

IFTM University, Moradabad
Bachelor of Science (Hons) ChemistryProgramme
B.Sc.(Hons) Chemistry III Year (V Semester)
BCHE(H)-502: ORGANIC CHEMISTRY

Objective: To Predict and explain patterns in shape, structure of organic compounds. To give idea about synthesis and reactivity for carbohydrates. To provide explanation of the chemistry of amino acids and proteins to understand the concepts of organic chemical structure and bonding and stability found in fats and oils and its importance for employability in food & chemical sector.

Unit – I **(09 Sessions)**

Spectroscopy

Nuclear magnetic resonance (NMR) spectroscopy, Proton magnetic resonance (^{1}H- NMR) spectroscopy, nuclear shielding and deshielding, chemical shift and molecular structure, spin-spin splitting and coupling constants, areas of signals, interpretation of 1H NMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1, 1, 2-tribromoethane, ethyl acetate, toluene and acetophenone, Problems pertaining to the structures elucidation of simple organic compounds using UV, IR and ^{1}H NMR spectroscopic, techniques. Application of NMR to develop employability in research and development.

Unit – II **(09 Sessions)**

Carbohydrates

Classification and nomenclature, Monosaccharides, mechanism of osazone formation, interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses. Conversion of glucose intro mannose, Skill development in formation of glcosides, Determination of ring size of monosaccharides, Structures of ribose and deoxyribose.

An introduction to disaccharides (maltose, sucrose and lactose)

Unit – III **(09 Sessions)**

Amino Acids, Peptides and Proteins:

Classification, structure and stereochemistry of amino acids, Acid-base behavior isoelectric point and electrophoresis, Preparation and reactions of - amino acids, classification and structure of proteins, selective hydrolysis of peptides, Protein denaturation/renaturation.

Unit – IV **(09 Sessions)**

Fats, Oils and Detergents

Natural fats, edible and industrial oils of vegetable origin, common fatty acids, glycerides, hydrogenation of unsaturated oils, Saponification value, iodine value, acid value, Soaps, synthetic detergents. Importance for employability in research and development and entrepreneurship.

Course Outcomes:

Students completing this course will able to:

CO1: Development of skills to analyze the structure of organic compound based on UV, IR and ^{1}H NMR spectroscopy for employability in local and national industries

CO2: Understand classification, nomenclature, preparation of monosaccharides and its role in employability.

CO3: Learn the synthesis and properties of amino acids, peptides and proteins.

CO4: Explore the knowledge about effects of fats, oils and detergents for useful applications and and its role in entrepreneurship.

Suggested Readings:

1. Biochemistry: L. Steyer, Freeman and Co. New York.
2. Organic Synthesis: M. B. Smith, McGraw Hill, New York.
3. Advanced Organic Chemistry Reaction, Mechanism and Structure, M.B. Smith and J. March, John Wiley and Sons, New York.

Web Sources:

- www.structbio.ptt.edu>notes>nmr_ref_notes-2011
- www.academia.edu>CHE_320_organic_spectroscopy
- www.chtf.stuba.sk>files>Carbohydrates_Boudreaux
- https://nptel.ac.in/content/storage2/courses/104103071/pdf/mod11.pdf

Note: Latest edition of all the suggested readings must be used.

Mapping of Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	2	3	2	2	3	3	2	3
CO2	2	2	3	3	2	3	3	2	3	2	2	2
CO3	2	3	3	3	2	3	3	1	3	2	2	2
CO4	2	2	3	3	1	3	2	3	3	3	2	3

CO-Curriculum Enrichment Mapping
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship
CO1	3	2	2
CO2	3	2	2
CO3	3	2	2
CO4	3	3	3

IFTM University, Moradabad
Bachelor of Science (Hons) Chemistry Programme
B.Sc. (Hons) Chemistry III Year (V Semester)
BCHE(H)-503:GREEN CHEMISTRY

Objectives: The primary objective of this course is to make students aware of how chemical processes can be designed, developed and run in a sustainable way. Student will acquire the competence to think of chemistry as a sustainable activity. Development of skills about the design competitive chemical products and processes that attain the highest level of the pollution-prevention hierarchy by reducing pollution at its source.

Unit – I **(09 Sessions)**

Introduction to Green Chemistry

Introduction to Green Chemistry Need for Green Chemistry. Goals of Green Chemistry.Limitations/ Obstacles in the pursuit of the goals of Green Chemistry.

Unit – II **(09 Sessions)**

Principles of Green Chemistry

Principles of Green Chemistry with their explanations and examples; Designing a Green Synthesis; Prevention of Waste/ byproducts/ toxic products; maximum incorporation of the materials used in the process into the final products (Atom Economy). Importance of green chemistry for employability in research and development and entrepreneurship.

Unit –III **(09 Sessions)**

Designing a Chemical synthesis

Designing safer chemicals-different basic approaches to do so; selection of appropriate auxiliary substances (solvents, separation agents), green solvents, solventless processes, immobilized solvents and ionic liquids; energy requirements for reactions; selection of starting materials; designing of biodegradable products.

Green Synthesis of the following compounds: adipic acid, catechol, methyl methacrylate, urethane, benzyl bromide, citral, ibuprofen, paracetamol, furfural.

Unit – IV **(09 Sessions)**

Trends in Green Chemistry

Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; Green chemistry in sustainable development, Use of microwaves in green chemistry. Role of green chemistry in employability in industries.

Course Outcomes:

Students completing this course will able to:

CO1: Skill development to learn the basic principles and goals of green and sustainable chemistry.

CO2: Understand principles of Green Chemistry and relate them to green process metrics for application at **local** level.

CO3: Learn alternative solvent media and energy sources for chemical processes.

CO4: Review the trends in Green Chemistry and learn about oxidation reagents and catalysts.

Suggested Readings:

1. V.K. Ahluwalia & M.R. Kidwai: New Trends in Green Chemistry, Anamalaya

Publishers (2005).
2. P.T. Anastas& J.K. Warner: Oxford Green Chemistry-Theory and Practical, University Press.
3. A.S. Matlack: Introduction to Green Chemistry, Marcel Dekker (2001).
4. M.C. Cann& M.E. Connely: Real-World cases in Green Chemistry, American Chemical Society, Washington (2000).
5. M.A. Ryan & M. Tinnesand, Introduction to Green Chemistry, American Chemical Society, Washington (2002).
6. Green Chemistry Theory and Practice. P.T.Anatas and J. C. Warner.
7. Real world cases in Green Chemistry M.C. Cann and M. E. Connelly.
8. Green Chemistry: Introductory Text M.Lancaster: Royal Society of Chemistry (London)
9. Green Chemistry: Introductory Text, M.Lancaster.
10. Principles and practice of heterogeneous catalysis, Thomas J.M.,Thomas M.J., John Wiley.

Web Sources:

- https://www.internetchemistry.com/chemistry/green-chemistry.php
- https://www.asdlib.org/onlineArticles/ecourseware/Manahan/GreenChem-2.pdf
- https://ncert.nic.in/ncerts/l/kech207.pdf

Note: Latest edition of all the suggested readings must be used.

Mapping of Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	3	2	3	2	2	3	3	2	3
CO2	2	3	3	3	2	3	2	2	3	3	2	3
CO3	2	2	3	3	2	3	1	2	3	3	2	3
CO4	2	2	3	3	2	3	2	3	3	3	1	3

CO-Curriculum Enrichment Mapping
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship
CO1	3	2	1
CO2	3	2	2
CO3	3	3	2
CO4	3	3	1

IFTM University, Moradabad
Bachelor of Science (Hons) Chemistry Programme
B.Sc.(Hons) Chemistry III Year (V Semester)
BCHE(H)-504: PHARMACEUTICAL CHEMISTRY
Elective Course

Objectives: A main objective of this course is to understand the fundamentals pharmaceutical organic chemistry. To know the reactions of functional groups with mechanism to convert organic molecule as medicine. Skill development of the basics of stereochemistry of different drugs and their physiological effects. Also to learn the applications of reagents in organic synthesis of drugs. To learn the therapeutic uses of organic compounds as drug.

Unit –I **(09 Sessions)**

Drugs & Pharmaceuticals: Drug discovery, design and development; Basic Retro synthetic approach. Physiochemical properties of drugs (carboxylic acids and phenols). Importance for employability and entrepreneurship.

Unit –II **(09 Sessions)**

Non-steroidal Anti-inflammatory Drugs (NSAIDs):
Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin, paracetamol, lbuprofen).

Unit-III **(09 Sessions)**

Antibiotics, Antiviral, antibacterials and anti-fungal drugs:
antibiotics (Chloramphenicol),
Antiviral – Acyclovir
antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim)

Unit-IV **(09 Sessions)**

Fermentation:
Aerobic and anaerobic fermentation. Production of (i) Ethyl alcohol and citric acid, (ii) Antibiotics; Penicillin, Chloromycetin and Streptomycin, (iii) Lysine, Glutamic acid, Vitamin B_2 and Vitamin C. Importance of employability in research and development and entrepreneurship.

Course outcomes:
Students completing this course will able to:
CO1: Understand the concept of drug discovery, design and development.
CO2: Skill development to learn the synthesis of different Non-steroidal Anti-inflammatory Drugs.
CO3: Learn the characteristics and methods of synthesis of Antibiotics, Antiviral, antibacterials and anti-fungal drugs for employability at local and national level
CO4: Understand the fermentation method for the production of various drugs, antibiotics and other organic molecules.

Suggested Readings:

1. G.L. Patrick: Introduction to *Medicinal Chemistry, Oxford University* Press, UK.
2. Hakishan, V.K. Kapoor: *Medicinal and Pharmaceutical Chemistry,*VallabhPrakashan, Pitampura, New Delhi.
3. William O. Foye, Thomas L., Lemke, David A. William: *Principles of MedicinalChemistry*, B.I. Waverly Pvt. Ltd. New Delhi.

Web Sources:

- https://guides.lib.uiowa.edu/c.php?g=132196&p=863259
- https://stuvera.com/pharmaceutical-chemistry-books-pdf/

Note: Latest edition of all the suggested readings must be used.

Mapping of Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	3	3	3	2	2	3	3	2	3
CO2	2	3	3	3	3	3	2	2	3	3	2	3
CO3	2	3	3	3	3	3	2	1	3	3	2	3
CO4	2	2	3	3	3	3	1	2	3	3	2	3

CO-Curriculum Enrichment Mapping
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship
CO1	3	2	2
CO2	3	3	3
CO3	3	3	3
CO4	3	2	2

IFTM University, Moradabad
Bachelor of Science (Hons) ChemistryProgramme
B.Sc.(Hons) Chemistry III Year (V Semester)
BCHE(H)-505-NOVEL INORGANIC SOLIDS
Elective Course

Objectives: Development of skills to learn about advanced material characterization and synthesis. To know about the connections between the structure and properties of solids, including theory and methods. Students will understand the development of new materials with particular desired properties conduct chemical analyses and characterization of the physical properties of solids and role in entrepreneurship and employability.

Unit-I **(09 Sessions)**

Synthesis and modification of inorganic solids:
Conventional heat and beat methods, Co-precipitation method, Sol-gel methods, Hydrothermal method, Ion-exchange and Intercalation methods.
Inorganic solids of technological importance:
Solid electrolytes – Cationic, anionic, skill development of mixed Inorganic pigments – coloured solids, white and black pigments.

Unit-II **(09 Sessions)**

Nanoparticles/Nanomaterials:
Overview of nanostructures and nanomaterials: classification.
Preparation of gold and silver metallic nanoparticles, self-assembled nanostructures-control of nanoarchitecture-one dimensional control.Carbon nanotubes and inorganic nanowires.Bio-inorganic nanomaterials, DNA and nanomaterials, natural and antisicalnanomaterials, bionano composites.

Unit-III **(09 Sessions)**

Composite materials:
Introduction, limitations of conventional engineering materials, role of matrix in composites, classification, matrix materials, reinforcements, metal-matrix composites, polymer-matrix composites, fibre-reinforced composites, environmental effects on composites, applications of composites.

Unit-IV **(09 Sessions)**

Specialty polymers:
Conducting polymers -Introduction, conduction mechanism, polyacetylene, polyparaphenylene and polypyrole, applications of conducting polymers, Ion-exchange resins and their applications.
Ceramic & Refractory: Introduction, classification, properties, raw materials, manufacturing and applications. Importance of polymer in employability in research and industries.

Course outcomes:
Students completing this course will be able to:
CO1: Understand mechanisms of various methods for synthesis and modification of inorganic solids for employability at local and national industries.

CO2: Analyze the concept of nanotechnology for preparation and application of various nanomaterials.
CO3: Development of skills for understanding of the design, processing and behavior of composite materials.
CO4: Demonstrate the importance of various specialty polymers as well as refractory materials, their mechanism of action, properties and applications.

Suggested readings:

1. Shriver & Atkins. Inorganic Chemistry, Peter Alkins, Tina Overton, Jonathan Rourke, Mark Weller and Fraser Armstrong, 5th Edition, Oxford University Press (2011-2012).
2. Adam, D.M. Inorganic Solids: An introduction to concepts in solid-state structural chemistry.
3. Frank J. Ovens, Introduction to Nanotechnology.

Web Sources

- http://www.freebookcentre.net/Chemistry/InOrganic-Chemistry-Books.html
- http://www.freebookcentre.net/Chemistry/InOrganic-Chemistry-Books.html

Note: Latest edition of all the suggested readings must be used.

Mapping of Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs) (Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	3	3	2	3	2	1	3	3	2	3
CO2	2	1	3	3	2	3	1	2	3	3	2	3
CO3	2	2	3	3	2	3	2	2	3	3	2	3
CO4	2	2	3	3	2	3	2	2	3	3	1	3

CO-Curriculum Enrichment Mapping (Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship
CO1	3	2	1
CO2	3	2	2
CO3	3	3	3
CO4	3	3	3

IFTM University, Moradabad
Bachelor of Science (Hons) Chemistry Programme
B.Sc.(Hons) Chemistry III Year (V Semester)
BCHE(H)-507A: Synthesis of Nanomaterials
Elective Course

Objectives: To understand modification techniques of nanomaterials. To make students understand the basic concepts of nanomaterials. To learn the effect of shape, size, dispersion and percolation of nanomaterials for skill development and employability.

Unit-I **(08 Sessions)**

Introduction, definitions and course organization, Historical development of nanomaterials Classification of nanomaterials, Fundamentals, Size & Scale Units Scaling Atoms, Molecules, Clusters and Supramolecules, Structure and Bonding in Nanomaterials Chemical Bonds (types and strength) Intermolecular Forces Molecular and Crystalline Structures Hierarchical Structures Bulk to Surface transition, surface reconstruction.

Unit – II **(08 Sessions)**

Properties and Size dependence of properties Chemical Optical, vibrational, thermal Electrical Magnetic Mechanical Theoretical Aspects-e.g. density functional theory

Unit-III **(10 Sessions)**

Nanomaterial Synthesis Chemical routes Electrochemical methods Vapor growth Thin films methods: chemical vapor deposition, physical vapor deposition (sputtering, laser ablation), Langmuir-Blodgett growth Mechanical methods: ball milling, mechanical attrition Sol-gel methods Special nanomaterials: carbon nanotubes, fullerenes, nanowires, porous silicon Bio-inspired synthesis Nanocomposite fabrication Nanolithography

Unit –IV **(10 Sessions)**

Nanomaterial characterization techniques Scanning and Transmission Electron Microscopy Scanning Probe Microscopies: Atomic Force, scanning tunneling microscopy Diffraction and scattering techniques Vibrational spectroscopy Surface techniques, Applications Nano-electronics Nano optics Nanoscale chemical- and bio-sensing Biological/bio-medical applications Photovoltaic, fuel cells, batteries and energy-related applications High strength nanocomposites Nanoenergetic materials

Course outcomes:

Students completing this course will be able to:
CO1: Understand classification and fundamentals of nanomaterials.
CO2: Analyze the concept of nanotechnology for size dependent preparation of nanomaterials.
CO3: Develop skills to understand various methods of synthesis of the nanomaterials.
CO4: Demonstrate various characterization techniques of nanomaterials for global employability

Suggested Readings:

1. Nanomaterials- Synthesis, Properties and Applications, Edited by A.S. Edelstein and R.C. Cammarata, Institute of Physics Publishing, London, 1998 (paper back edition)
2. Nanochemistry: A Chemical Approach to Nanomaterials, by G. Ozin and A. Arsenault, RSC Publishing, 2005

3. Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience, Edward L. Wolf, Wiley-VCH, 2nd Reprint (2005)

Web Sources:

- https://edujournal.in/physical-chemistry-handwritten-notes-download-free-notes/
- https://www.internetchemistry.com/chemistry/physical_chemistry.htm
- http://www.freebookcentre.net/Chemistry/Physical-Chemistry-Books.html

Note: Latest edition of all the suggested readings must be used.

Mapping of Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	3	3	2	3	2	1	3	3	2	3
CO2	2	1	3	3	2	3	1	2	3	3	2	3
CO3	2	2	3	3	2	3	2	2	3	3	2	3
CO4	2	2	3	3	2	3	2	2	3	3	1	3

CO-Curriculum Enrichment Mapping
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship
CO1	3	2	1
CO2	3	2	1
CO3	3	3	1
CO4	3	2	1

IFTM University, Moradabad
Bachelor of Science (Hons) Chemistry Programme
B.Sc.(Hons) Chemistry III Year (V Semester)
BCHE(H)-508A: Chemistry of Carbon & Allotropes
Elective Course

Objectives: A systematic study of the chemistry of carbon compounds emphasizing reactions, mechanisms, and synthesis with a focus on functional groups, addition reactions to alkenes and alkynes, alcohols and ethers, stereochemistry, nomenclature, acid-base chemistry, reaction kinetics and thermodynamics for skill development and employability.

Unit-I **(08 Sessions)**

Carbon group Allotropes of Carbon, C_{60} and compounds (fullerenes), Intercalation compounds of Graphite, Carbon nanotubes, synthesis, Properties, structure- single walled, Multiwalled, applications, classification of organomentallic compounds. Organometallic compounds of B, Si, Sn, Pb, Ga,As, Sb, Bi. Structures, Synthesis, Reactions for skill development and employability.

Unit – II **(08 Sessions)**

Nitrogen group Nitrogen activation, Boron nitride, Oxidation states of nitrogen & their interconversion PN & SN compounds Nos, & their redox chemistry.

Unit-III **(10 Sessions)**

Oxygen group Metal selenides & tellurides, oxyacids & oxoanions of S & N. Ring, Cage and Cluster compounds of P- block elements. Silicates, including Zeolites

Unit –IV **(10 Sessions)**

Halogen group Interhalogens, Pseudohalogen, synthesis, properties & applications, structure, oxyacids & oxoanions of Hallogens Bonding.
Noble gases Synthesis, properties, uses, structure & bonding with respect to VSEPR.

Course outcomes:

Students completing this course will be able to:
CO1: Understand various allotropes of carbon and their properties.
CO2: Analyze the oxidation states of nitrogen & their interconversion.
CO3: Develop skills to understand metal selenides & tellurides, oxyacids & oxoanions.
CO4: Understand synthesis and properties of halogen group and noble gases for employability at local and national level.

Suggested Readings:

1. Chemical application and group Theory: F.A. Cotton, 3rd edition (1999)
2. Advanced Inorganic Chemistry :F.A. Cotton, G. Wilkinson, C.A. Murillo, M. Bochmann 6th Edn. (2003)

Website Sources:

- http://www.chemguide.co.uk/
- https://freebookcentre.net/

Note: Latest edition of all the suggested readings must be used.

Mapping of Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	3	3	2	3	2	1	3	3	2	3
CO2	1	1	1	2	2	3	1	2	3	3	2	1
CO3	2	2	3	1	2	2	2	2	3	3	2	1
CO4	2	2	3	3	2	3	2	2	3	3	1	3

CO-Curriculum Enrichment Mapping
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship
CO1	3	2	1
CO2	3	2	2
CO3	3	1	2
CO4	3	3	1

IFTM University, Moradabad
Bachelor of Science (Hons) Chemistry Programme
B.Sc.(Hons) Chemistry III Year (V Semester)
BCHE(H)-509A: CARBOHYDRATE CHEMISTRY
Elective Course

Objectives: By going through the course, the student will gain an understanding of immense chemistry constituting carbohydrates. Chemistry of carbohydrates is not taught in most of academic environments in the country at large, even when carbohydrates are ever pervasive in all walks chemistry, materials development and biologically driven technological advancements. The course aims to provide a sound understanding of the fundamentals of the chemistry of carbohydrates, that will enable the student to carry forward.

Unit-I **(10 Sessions)**

Monosaccharides, synthetic aspects of rare sugars and Deoxysugars, aminosugars, glycalsugars protecting group strategies, glycosylation, glycosyl donors and acceptors, stereoselective glycosylation, glycosylation strategies for skill development – one pot glycosylation, iterative glycosylation. Structure, relevance and synthesis of some important carbohydrates such as GAGs.

Unit – II **(10 Sessions)**

Structures and conformational itineraries of monosaccharides; Reactions of monosaccharides: reactivity profiles at each carbon center; ring expansions and contractions; reactions at anomeric carbon and epimeric carbons..

Unit-III **(08 Sessions)**

Aspects of animal and plant polysaccharides, glycoproteins, proteoglycans and glycosaminoglycans; selected natural product synthesis originating from a sugar scaffold.

Unit-IV **(08 Sessions)**

Deoxy sugars; anhydrosugars; protecting group methods; chemical and enzymatic glycosylations to oligosaccharides; glycosidic bond stabilities; naturally-occurring oligo- and polysaccharides and their conformations; chiral auxiliaries and modifications of sugars to carbocycles and heterocycles.

Course outcomes:

Students completing this course will be able to:

CO1: Understand synthetic aspects of rare sugars and Deoxysugars, aminosugars and glycalsugars.
CO2: Learn about the structure and conformations of monosaccharides.
CO3: Develop skills to understand aspects of animal and plant polysaccharides etc. for employability at local and national level
CO4: Understand naturally-occurring oligo- and polysaccharides and their conformations.

Suggested Readings

1. Carbohydrates- the sweet molecules of life R. V Stick, Academic press, 2001.
2. Essentials of Carbohydrate Chemistry and Biochemistry, T. K. Lindhorst, Wiley VCH, 2000.

Website Sources:

- http://www.chemguide.co.uk/
- https://freebookcentre.net/

Note: Latest edition of all the suggested readings must be used.

Mapping of Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	3	3	2	3	2	1	3	3	2	3
CO2	1	1	1	2	2	3	1	2	3	3	2	1
CO3	2	2	3	1	2	2	2	2	3	3	2	1
CO4	2	2	3	3	2	3	2	2	3	3	1	3

CO-Curriculum Enrichment Mapping
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship
CO1	3	1	1
CO2	3	2	1
CO3	3	3	1
CO4	3	3	2

IFTM University, Moradabad
Bachelor of Science (Hons) Chemistry Programme
B.Sc.(Hons) Chemistry III Year (V Semester)
BCHE(H)-510A: Biomolecules
Elective Course

Objectives: To identify and study the basic chemistry of biomolecules. To recognize the connection between structure, functions and properties of biomolecules. To understand how biomolecules are engineered and are used in living systems.

Unit-I **(08 Sessions)**

Carbohydrates: Discovery and historical aspects, classification, configurational and conformational aspects of carbohydrates. Structure, properties and functions of homo and hetero-polysaccharides. Blood groups and bacterial polysaccharides. Glycoproteins, Cardioglycosides.

Unit – II **(08 Sessions)**

Lipids: Discovery and historical aspects, classification and types of lipids. Structure and properties of fatty acids, acyl glycerols, phospholipids, sphingolipids, glycolipids. Structure and function of steroids, prostaglandins, thromboxanes and leukotrienes. Composition and biological role of lipoproteins.

Unit-III **(10 Sessions)**

Amino acids and Proteins: Discovery and historical aspects, acid-base properties of amino acids. Non-protein amino acids. Peptide bond- structure and conformation. Biologically active peptides. Peptide synthesis – reactive ester method and modified Merrifield solid phase synthesis. Elucidation of primary structure of proteins. Secondary structure – α-helix, β-sheet, triple helical structure. Ramachandran plot. Structure of Insulin, Ribonuclease, Lysozyme, Myoglobin and Chymotrypsin. Quaternary structure.

Unit –IV **(10 Sessions)**

Nucleic acids: Discovery and historical aspects, structure of nitrogenous bases, nucleosides, nucleotides. Nature of genetic material and experimental proof. Isolation, fractionation and characterization of nucleic acids. Double helical structure of DNA, polymorphism of DNA (A, 5 B, Z forms), supercoiling of the DNA molecule; topoisomers and superhelices, higher orders of DNA structure - Chromatin Structure, histones and nucleosomes. Re-association kinetics, repetitive DNA sequences: tandem repeats (Satellites, minisatellites, and microsatellites), interspersed repeats (LINE, SINEs), single copy genes. RNA structure: Types of RNA, structure of mRNA, tRNA, SiRNA, microRNA with emphasis on importance of structure to its function.

Course outcomes:

Students completing this course will be able to:

CO1: Understand classification and properties of carbohydrates.
CO2: Learn about the classification and properties of lipids.
CO3: Develop skills to understand the classification and properties of amino acids for employability at local and national level.
CO4: Understand the classification and properties of nucleic acids.

Suggested Readings:

1. Lehninger Principles of Biochemistry 4 th Edn by David L. Nelson and Michael M. Cox, WH Freeman and Company.
2. Principles of Biochemistry by Geoffrey Zubay. McGraw Hill Publishers.
3. Biochemistry by Lubert Stryer. WH Freeman and Co.
4. Biochemistry and Molecular biology by William H. Elliott and Daphne C. Elliott. Oxford University Press.
5. Biochemistry 3rd Edn. by Donald J. Voet and Judith G. Voet. John Wiley and Sons.

Website Sources:

- http://www.chemguide.co.uk/
- https://freebookcentre.net/

Note: Latest edition of all the suggested readings must be used.

Mapping of Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	1	3	2	1	3	3	2	3
CO2	1	1	1	2	2	3	1	2	3	3	2	1
CO3	2	2	3	1	2	2	2	2	3	3	2	1
CO4	2	2	3	3	2	3	2	2	3	3	1	3

CO-Curriculum Enrichment Mapping
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship
CO1	3	1	1
CO2	3	2	1
CO3	3	2	1
CO4	3	2	2

IFTM University, Moradabad
Bachelor of Science (Hons) Chemistry Programme
B.Sc.(Hons) Chemistry III Year (V Semester)
BCHE(H)-511A: NATURAL PRODUCTS
Elective Course

This course provides a survey of natural products chemistry including biogenesis by enzyme-mediated pathways, structure determination, medicinal and biochemical significance and synthesis. It Provide an overview of the field of natural product chemistry. Also discuss the use of natural products as starting materials for medicines Its applications are important for the employability in the medicinal and pharmaceutical industries

UNIT-I **(09 Sessions)**

Amino acids and proteins:
Introduction of amino acids, classification, general synthetic methods for the preparation of amino acids, peptide synthesis, classification of proteins, primary, secondary ,tertiary and quaternary structure of proteins

UNIT-II **(09 Sessions)**

Alkaloids:
Occurrence, functions, nomenclature of alkaloids, structure and synthesis of coniine, piperine, atropine, cocaine, quinine, morphine

UNIT-III **(09 Sessions)**

Carotinoids and plant pigments:
Introduction, classification and structure of β- carotene
Classification of plant pigments, structure determination of anthocyanin and flavones

UNIT-IV **(09 Sessions)**

Purines and pyrimidines: Constitution and synthesis of uric acid, caffeine, adenine, guanine, uracil, thymine

Course outcomes:

Students completing this course will be able to:
CO1: Understand classification, synthetic methods for the preparation of amino acids and proteins.
CO2: Learn about the structure and synthesis of alkaloids.
CO3: Develop skills to understand the structure determination of carotinoids and plant pigments.
CO4: Understand the constitution and synthesis of purines and pyrimidines for employability at local and national level.

Suggested Readings:

1. Chemistry of Alkaloids: S.W. Pelytier.
2. Chemistry of Natural Products: Gurudeep Raj.
3. Total Synthesis of Natural Products, K.C. Nicolaou Vol I, Vol II

Web Sources:

- https://www.rsc.org/journals-books-databases/about-journals/npr/

- http://pubs.rsc.org/lus/natural-product-updates
- https://www.pdfdrive.com/chemistry-of-natural-products-books.html

Note: Latest edition of all the suggested readings must be used.

Mapping of Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	2	1	3	2	1	3	3	2	3
CO2	3	2	1	2	2	3	1	2	3	3	2	1
CO3	2	3	3	2	2	2	2	2	3	3	2	1
CO4	3	2	3	3	2	3	2	2	3	3	1	3

CO-Curriculum Enrichment Mapping
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship
CO1	3	1	1
CO2	3	2	1
CO3	3	1	1
CO4	3	2	1

IFTM University, Moradabad
Bachelor of Science (Hons) Chemistry Programme
B.Sc.(Hons) Chemistry III Year (V Semester)
BCHE(H)-512A: Chemistry of Drugs
Elective Course

This course provides a survey of natural products chemistry including biogenesis by enzyme-mediated pathways, structure determination, medicinal and biochemical significance and synthesis. It Provide an overview of the field of natural product chemistry. Also discuss the use of natural products as starting materials for medicines Its applications are important for the employability in the medicinal and pharmaceutical industries

UNIT-I **(09 Sessions)**

Structure and activity: Relationship between chemical structure and biological activity (SAR). Receptor Site Theory. Approaches to drug design. Introduction to combinatorial synthesis in drug discovery. Drugs based on a substituted benzene ring: Chloramphenicol, salmeterol, tolazamide, diclophenac, tiapamil, intriptyline.

UNIT-II **(09 Sessions)**

Drugs based on five-membered heterocycles: Tolmetin, spiralpril, oxaprozine, sulconazole, nizatidine, imolamine, isobuzole. Drugs based on six-membered heterocycles: Warfarin, quinine, norfloxacin and ciprofloxacin, methylclothiazide, citrine, terfenadine.

UNIT-III **(09 Sessions)**

Drugs based on seven-membered heterocyclic rings fused to benzene: Chlordiazepoxide, diazepam, diltiazem. Drugs based on heterocycles fused to two benzene rings: Quinacrine, tacrine.

UNIT-IV **(09 Sessions)**

Drugs based on five-membered heterocycles fused to six-membered rings: Acyclovir, methotrexate. New Chemical Entities as Clinical agents Synthetic: Ritonavir, erbumine, Natural: Hamamelitannin, pinophilin A & B.

Course outcomes:

Students completing this course will be able to:

CO1: Develop skills to understand relationship between chemical structure and biological activity for employability at local and national level.
CO2: Learn about the drugs based on five-membered heterocycles.
CO3: Understand drugs based on seven-membered heterocyclic rings fused to benzene.
CO4: Understand the constitution and synthesis of drugs, Acyclovir, methotrexate etc. for employability in pharmaceutical industries.

Suggested Readings:

1. A. Burger, Medicinal Chemistry, Vol. I-III, (1995) Wiley Interscience Publications, New York.
2. W. O. Foye, Principles of Medicinal Chemistry, 3rd Edition (1989), Lea & Febiger/ Varghese Publishing House, Bombay.

3. D. Lednicer and L. A. Mitscher, The Organic Chemistry of Drug Synthesis, (1977) Vol. I- III, Wiley Interscience.
4. A. Kar, Medicinal Chemistry, (1993) Wiley Eastern Ltd., New Delhi.
5. N. K. Terrett, Combinatorial Chemistry, (1998) Oxford Univ. Press, Oxford.
6. Daniel Lednicer Stretegies for organic drug synthesis and design (2009), John Wiley & Sons, New York.

Web Sources:

- http://www.chemguide.co.uk/
- https://freebookcentre.net/

Note: Latest edition of all the suggested readings must be used.

Mapping of Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2	2	1	3	2	1	3	3	2	3
CO2	3	2	1	2	2	3	1	2	3	3	2	1
CO3	2	3	3	2	2	2	2	2	3	3	2	1
CO4	3	2	3	2	3	1	2	2	3	3	1	3

CO-Curriculum Enrichment Mapping
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship
CO1	3	1	1
CO2	3	2	1
CO3	3	1	1
CO4	2	3	2

IFTM University, Moradabad
Bachelor of Science (Hons) Chemistry Programme
B.Sc.(Hons) Chemistry III Year (V Semester)
BCHE(H)-551-CHEMISTRY PRACTICAL

Objectives: Chemistry lab includes basic laboratory operation, separation and purification of organic compounds for honors students. Skill development to identify simple and fractional distillation, precipitation and crystallization, sublimation, solid-liquid and liquid-liquid extraction, and chromatography and role in entrepreneurship and employability.

(20 Sessions)

1. Estimation of Copper by gravimetric method.
2. Estimation of Nickel by gravimetric method.
3. Synthesis of hydrogel by co-precipitation method.
4. Synthesis of metal nanoparticles.
5. Determination of saponification value of an oil or Fat.
6. Determination of Iodine value of an oil or fat.
7. Preparation of Aspirin/Ibuprofen.
8. Preparation of Antacid.
9. Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide
10. Photoreduction of benzophenone to benzopinacol in the presence of sunlight.

Course outcomes:
Students completing this course will able to:
CO1: Estimate metal ions in a solution using gravimetric analysis.
CO2: Skill development to understand the synthetic process of nano materials for employability at local and national industrial sector.
CO3: Learn the synthesis of drugs.

Suggested readings:

1. A.I. Vogel: Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.
2. A.I. Vogel: Quantitative Chemical Analysis, Prentice Hall, 6th Edn.
3. A.I. Vogel: Textbook of Practical Organic Chemistry, Prentice Hall, 5th Edn.
4. F. G. Mann & B. C. Saunders: Practical Organic Chemistry, Orient Longman (1960).MUniversity.

Web Sources
- http://www.freebookcentre.net/Chemistry/InOrganic-Chemistry-Books.html
- http://www.freebookcentre.net/Chemistry/InOrganic-Chemistry-Books.html
- http://onlinelabs.in/chemistry

Note: Latest edition of all the suggested readings must be used.

Mapping of Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	3	1	2	2	3	3	2	3
CO2	3	3	2	2	2	3	2	2	3	3	2	3
CO3	3	3	3	2	1	1	3	2	3	3	2	3

CO-Curriculum Enrichment Mapping (Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship
CO1	3	3	1
CO2	3	3	2
CO3	3	3	2

IFTM University, Moradabad
Bachelor of Science (Hons) Chemistry Programme
B.Sc. (Hons) Chemistry III Year (VI Semester)
BCHE(H)-601: PHYSICAL CHEMISTRY

Objectives: To develop basic skills to understand concepts regarding the physical properties and molecular structure. To derive the expressions for Schrödinger wave equation and its importance. To study the concept, interaction of radiation with matter and Laws of photochemistry and role in employability.

Unit – I **(09 Sessions)**

Physical Properties and Molecular Structure:
Optical activity, polarization – (Clausius-Mossotti equation), orientation of dipoles in an electric field, dipole moment, induced dipole moment, measurement of dipole moment-temperature method and refractivity method, dipole moment and structure of molecules, magnetic properties paramagnetism, diamagnetism and ferromagnetism.

Unit – II **(09 Sessions)**

Quantum Mechanics:
Schrödinger wave equation and its importance, postulates of quantum mechanics, particle in a one dimensional box., calculation of energy levels from wave functions, Hybrid orbitals – sp, sp^3, sp^2, calculation of coefficients of A.O's used in sp and sp^2 hybrid orbitals and interpretation of geometry.

Unit – III **(09 Sessions)**

Spectroscopy:
Introduction: electromagnetic radiation, regions of the spectrum.
Rotational *Spectrum-*
Diatomic Molecules:
energy levels of a rigid rotor (semi-classical principles), selection rules, determination of bond length, qualitative description of non-rigid rotor, isotope effect.
Infrared Spectrum:Energy levels of simple harmonic oscillator, selection rules, determination of force constant and qualitative relation of force constant and bond energies, effect of anharmonic motion& isotope on the spectrum, idea of vibrational frequencies of different functional groups.

Unit – IV **(09 Sessions)**

Photochemistry:
Interaction of radiation with matter, Laws of photochemistry: Grothus–Drapper law, Stark – Einstein law, Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non- radiative processes (internal conversion, intersystem crossing), quantum yield.

Course outcomes:
Students completing this course will able to:
CO1: Develop basic and advance concepts of the physical properties & molecular structure for employability at **local and national** level.

CO2: Skill development to derive mathematical expressions for different energy levels from wave functions.
CO3: Explain the Infra Red spectra of diatomic molecules.
CO4: Explain the concept of Jablonski diagram depicting various processes occurring in the excited state.

Suggested Readings:

1. Text Book of Physical Chemistry by S. Glasstone.
2. Advanced Physical Chemistry by Gurudeep Raj.
3. Modern Electrochemistry J.O. M. Bockris and A. K. M. Reddy,Plenium Press New York.
4. Physical Chemistry: Atkins, Oxford University Press, New York.
5. Physical Chemistry, I.N.Livine: Tata McGraw Hill Publication New Delhi.

Web Sources:

- http://www.freebookcentre.net/Chemistry/Chemistry-Books-Online.html
- https://guides.lib.umich.edu/c.php?g=282900&p=1885122

Note: Latest edition of all the suggested readings must be used.

Mapping of Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	3	3	3	2	2	3	2	1	2
CO2	2	3	3	3	3	3	3	2	3	2	2	2
CO3	1	2	3	3	3	3	2	2	3	3	2	2
CO4	2	2	3	3	3	3	2	1	3	3	2	2

CO-Curriculum Enrichment Mapping
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship
CO1	3	2	1
CO2	3	2	2
CO3	3	2	1
CO4	3	1	2

IFTM University, Moradabad
Bachelor of Science (Hons) Chemistry Programme
B.Sc.(Hons) Chemistry III Year (VI Semester)
BCHE(H)-602: -POLYMER CHEMISTRY

Objectives: To develop skills for polymeric materials and their classification and to learn about different mechanisms of polymerization along with polymerization techniques To determine chain length of polymers based on their kinetic mechanism To learn about different methods of finding out average molecular weight of polymers and transition temperature (Tg) and crystalline melting point (Tm) Determination of Tg and Tm.

Unit – I (**09 Sessions)**

Introduction and nomenclature:

Characteristic, Classification, Nomenclature of Polymer, Functionality, Physical Properties of Polymer, Mechanism of Polymerization (Addition Polymerization) and application in industries and employability.

Unit-I **(09 Sessions)**

Molecular Weight Determination:

Molecular weight, Determination of molecular weight of polymers by osmotic pressure and viscosity method and its practical significance, Viscometry, Chemical and geometrical structure of Polymers.

UNIT-III **(09 Sessions)**

Characterization:

Glass-transition temperature (T_g) of polymer, factors that affect the value of T_g,$T_g$and molecular weight, melting point,Importance of T_g,Brief idea of crystallinity.

Unit-IV **(09 Sessions)**

Processing of Polymers:

Processing of Polymers (Calendaring, Die casting, Film casting, Moulding), High Performance Polymers (PPS, PES, PEEK, Polyamides), Classification and application of composites. Importance of polymer in employability in research and development.

Course Outcomes:

Students completing this course will able to:

CO1: Understand the importance of macromolecules/polymers in day to day life and apply their knowledge in sustainable development.

CO2: Development of skills to apply the learned fundamental instrumental techniques in the polymer characterization for employability at local and national level.

CO3: Explain crystalline melting temperature and glass transition temperature, including the flow properties of polymer melts and polymer solutions, with respect to temperature and molecular weight both.

CO4: Acquire knowledge of processing of polymers, high performance polymers and new polymer related applications.

Suggested Readings:

1.Text Book of Polymer Science, F. W. Billmeyer, Wiley Science New York.
2. Principles of Polymerization, J. Odien, John Wiley, Singapore
3.Principles of Polymer Science, P. Bahadur and N. V. Shashtri, Narosa Publishing House, New Delhi.
4. Polymer Sciences, V.R. Gowarikar and J. Sridhar, Wiley Eastern New Delhi.

Web Sources

- https://guides.lib.umich.edu/c.php?g=282900&p=1885122
- http://www.freebookcentre.net/Chemistry/Chemistry-Books-Online.html

Note: Latest edition of all the suggested readings must be used.

Mapping of Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	3	2	3	2	2	3	2	2	2
CO2	3	2	3	3	2	3	2	3	3	3	2	3
CO3	2	2	3	3	2	3	2	2	3	2	1	2
CO4	2	2	3	3	2	3	2	2	3	3	2	3

CO-Curriculum Enrichment Mapping
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship
CO1	3	2	3
CO2	3	3	2
CO3	3	3	2
CO4	3	3	3

IFTM University, Moradabad
Bachelor of Science (Hons) Chemistry Programme
B.Sc.(Hons) Chemistry III Year (VI Semester)
BCHE(H)-603:FUEL CHEMISTRY

Objectives: The main objective is to develop basic skills for scientific and technical understanding of fuel. Handling of hydrocarbon fuels and lubricants. Students will learn the emerging alternative & renewable fuels. This will enable students to be industry ready to contribute effectively in the field of petroleum chemistry and technology and skill development for employability.

Unit-I **(09 Sessions)**

Energy sources

Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value.

Unit-II **(09 Sessions)**

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, requisites of a good metallurgical coke, Coal gasification (Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent refining for entrepreneurship & employability.

Unit-III **(09 Sessions)**

Petroleum and Petrochemicals: Composition of crude petroleum, Refining and different types of petroleum products and their applications.

Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels.

Unit-IV **(09 Sessions)**

Lubricants: Classification of lubricants, lubricating oils (conducting and non-conducting)Solid and semisolid lubricants, synthetic lubricants.

Properties of lubricants (viscosity index, cloud point, pore point) and their determination. Role of lubricants in employability in research and industries.

Course Outcomes:

Students completing this course will able to:

CO1: Development of skills to learn about the various fuels and their classification.

CO2: Understand the various industrial applications of coal.

CO3:Learn the chemistry of petroleum fuel technology and its applications for employability at local and national level

CO4: Understand the classification, properties and refining processes for lubricants.

Suggested Readings:

1. E. Stocchi: *Industrial Chemistry*, Vol –I, Ellis Horwood Ltd. UK.
2. P.C. Jain, M. Jain: *Engineering Chemistry*, DhanpatRai& Sons, Delhi.

3. B.K. Sharma: *Industrial Chemistry,* Goel Publishing House, Meerut.

Web sources

- https://onlinelibrary.wiley.com/doi/book/10.1002/9781118796214
- http://www.freebookcentre.net/Chemistry/Chemistry-Books-Online.html

Note: Latest edition of all the suggested readings must be used.

Mapping of Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	1	3	3	3	3	3	1	3
CO2	2	2	3	3	1	3	3	1	3	3	1	3
CO3	3	3	3	3	1	3	2	1	3	3	1	3
CO4	2	3	3	3	2	3	3	2	3	3	2	3

CO-Curriculum Enrichment Mapping
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship
CO1	3	2	1
CO2	3	2	2
CO3	3	3	1
CO4	3	3	3

IFTM University, Moradabad
Bachelor of Science (Hons) Chemistry Programme
B.Sc. (Hons) Chemistry III Year (VI Semester)
BCHE(H)-604: COSMETIC CHEMISTRY
Elective Course

Objectives: Cosmetic chemistry will provide students with the opportunities to develop professional skills and fundamental concepts driving cosmetic science.To focuses on the needs of the cosmetic industry and its consumers, in addition to providing students with the critical and evaluative skills for entrepreneurship & employability.

Unit –I **(09 Sessions)**

Raw Materials for Cosmetics

Surfactants (basic, mild anionic, amphoteric, non-ionic and cationic), shampoo and bath additives (thickeners, foam stabilizers, conditioning agents, emollients and sequestering agents), oil components (mineral, natural and synthetic oils).

Unit –II **(09 Sessions)**

Hair Dyes (Preparation and properties)

Temporary, semi-permanent and permanent hair dyes, dye removers and stability testing of dyes for Skill development and employability.

Unit – III **(09 Sessions)**

Skin Care Products (Preparation and Properties)

Formulation of skin care products (stability and microbiological testing of skin care products), Skin cleansers: anhydrous oily cleansers, super fatted bar soaps, astringents/toners, bar soaps. Moisturisers, anti-aging products and sun screen products.

Unit –IV **(09 Sessions)**

Colour Cosmetics, perfumes and oral care products (Preparation and properties)

Lip colour, nail polish, face powders, foundation, blushers, eye shadow, mascara, eyeliners. Perfumes and deodorants: Natural and synthetic perfumes, fragrance, fixative and solvents. Oral Care products: Toothpaste formulation, oral rinses, anti-caries agents.

Course Outcomes:

Students completing this course will able to:

CO1: Gain knowledge about the raw materials used to prepare cosmetic products.

CO2: Learn about the preparation and properties of various kinds of hair dyes.

CO3: Development of skills to formulate and characterize various skin care products for employability at local and national level.

CO4: Learn practical skills in the area of cosmetics, perfumes and oral care products required to scientifically design and develop these products.

Suggested readings

1. Chemistry and Technology of the Cosmetics and Toiletries Industry, S. D. Williams, W. H. Schmitt.
2. The Chemistry of Fragrances: From Perfumer to Consumer, Charles Sell.

3. Chemical Technology of Cosmetics, Kirk-Othmer, John Wiley & Sons.

Web Sources:

- https://sp-sg.libguides.com/c.php?g=377339&p=6724406
- https://chemistscorner.com/top-10-book-cosmetic-science-book-resources/

Note: Latest edition of all the suggested readings must be used.

Mapping of Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	3	2	3	2	3	3	3	2	3
CO2	2	2	3	3	2	3	3	3	3	3	2	3
CO3	2	3	3	3	2	3	2	3	3	3	2	3
CO4	2	2	3	3	2	3	2	3	3	3	3	3

CO-Curriculum Enrichment Mapping
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship
CO1	3	3	3
CO2	3	3	3
CO3	3	3	3
CO4	3	3	3

IFTM University, Moradabad
Bachelor of Science (Hons) Chemistry Programme
B.Sc. (Hons) Chemistry III Year (VI Semester)
BCHE(H)-605:ORGANOMETALLICS AND BIO-INORGANIC CHEMISTRY
Elective Course

Objectives: Main Objectives of this course is to classify the different types of transition-metal derived organometallic compounds. To develop skills to prepare main-group and transition-metal derived organometallic compounds. Students will know about the stability and reactivity of the various types of organometallic compounds. Also toapply the appropriate characterization technique to the analysis of organometallic compounds.Toknow and demonstrate the utility of the organometallic compounds to the synthesis of drugs, especially by catalytic methods and role in entrepreneurship and employability.

Unit - I **(09 Sessions)**

Chemistry of 3d metals

Oxidation states displayed by Cr, Fe, Co, Ni and Co.

A study of the following compounds (including preparation and important properties);

Peroxo compounds of Cr, $K_2Cr_2O_7$, $KMnO_4$, $K_4[Fe(CN)_6]$, sodium nitroprusside, $[Co(NH_3)_6]Cl_3$, $Na_3[Co(NO_2)_6]$ and its importance in employability in research and manufacturing sector.

Unit –II **(09 Sessions)**

Organometallic Compounds

Definition and Classification with appropriate examples based on nature of metal-carbon bond (ionic, s, p and multicentre bonds). Structures of methyl lithium, Zeiss salt and ferrocene. EAN rule as applied to carbonyls. Preparation, structure, bonding and properties of mononuclear and polynuclear carbonyls of 3d metals.p-acceptorbehaviour of carbon monoxide and role in employability in research and development.

Unit – III **(09 Sessions)**

Bio-Inorganic Chemistry

A brief introduction to bio-inorganic chemistry. Role of metal ions present in biological systems with special reference to Na^+, K^+ and Mg^{2+} ions: Na/K pump; Role of Mg^{2+} ions in energy production and chlorophyll. Role of Ca^{2+} in blood clotting, stabilization of protein structures and structural role (bones).

Unit – IV **(09 Sessions)**

Polynuclear and heteronuclear aromatic compounds:

Properties of the following compounds with reference to electrophilic and nucleophilic substitution: Naphthalene, Anthracene, Furan, Pyrrole and Thiophene.

Course outcomes:

Students completing this course will able to:

CO1: Understand the reactivity stability and other properties of organometallic compounds.

CO2: Describe bond modes and confer typical organometallic reactions, explain their mechanisms.

CO3: Development of skills in understanding the role of organometallic compounds in biological systems for employability at local and national level.

CO4: Explain properties such as electrophilic and nucleophilic substitution for polynuclear and heteronuclear aromatic compounds.

Suggested Readings:

1. James E. Huheey, Ellen Keiter& Richard Keiter: *Inorganic Chemistry: Principles ofStructure and Reactivity,* Pearson Publication.
2. G.L. Miessler& Donald A. Tarr: *Inorganic Chemistry,* Pearson Publication.
3. J.D. Lee: *A New Concise Inorganic Chemistry,* E.L.B.S.
4. F.A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry*, John Wiley & Sons.
5. I.L. Finar: *Organic Chemistry* (Vol. I & II), E.L.B.S.
6. R.T. Morrison & R.N. Boyd: *Organic Chemistry,* Prentice Hall.
7. Peter Sykes: *A Guide Book to Mechanism* in *Organic Chemistry,* Orient Longman.
8. ArunBahl and B. S. Bahl: *Advanced Organic Chemistry,* S. Chand.

Web Sources:

- https://www.pdfdrive.com/organometallic-organometallic-chemistry-e10520936.html
- http://www.freebookcentre.net/Chemistry/OrganoMetallic-Chemistry-Books.html

Note: Latest edition of all the suggested readings must be used.

Mapping of Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	3	2	3	2	2	3	3	2	2
CO2	2	3	3	3	2	3	2	2	3	3	2	1
CO3	2	2	3	3	2	3	3	3	3	3	2	2
CO4	1	2	3	3	3	3	3	1	3	3	2	2

CO-Curriculum Enrichment Mapping
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship
CO1	3	2	2
CO2	3	2	1
CO3	3	3	1
CO4	3	2	1

IFTM University, Moradabad
Bachelor of Science (Hons) Chemistry Programme
B.Sc.(Hons) Chemistry III Year (VI Semester)
BCHE(H)-607A: Quantum Chemistry
Elective Course

Objectives: Students should be able to improve their knowledge of the basic information of quantum chemistry; postulates of quantum mechanics and Schrödinger equation for skill development.

Unit-I **(08 Sessions)**

Quantum Mechanics:

Black body radiation (Concept only) Wave-particle duality, light as particles: photoelectric and Compton effects; electrons as waves and the deBroglie hypothesis; Uncertainty relations (without proof).

Unit–II **(08 Sessions)**

Wave function:

Postulates of Quantum Mechanics, Schrodinger time-independent equation; nature of the equation, acceptability conditions for the wave functions and probability interpretations of wave function Vector representation of wave function. Orthonormality of wave function.

Unit-III **(10 Sessions)**

Concept of Operators:

Elementary concepts of operators, eigenfunctions and eigenvalues; Linear operators; Commutation of operators, commutator and uncertainty relation; Expectation value; Properties of Hermitian operator; Complete set of Eigenfunctions. Expansion of Eigenfunctions.

Unit-IV **(10 Sessions)**

Particle in a box:

Setting up of Schrodinger equation for one-dimensional box and its solution; Comparison with free particle eigenfunctions and eigenvalues. Properties of PB wave functions (normalisation, orthogonality, probability distribution); Expectation values of x, x^2, px and px^2 and their significance in relation to the uncertainty principle; Extension of the problem to two and three dimensions and the concept of degenerate energy levels.

Course outcomes:

Students completing this course will able to:

CO1: Understand the concepts of black body radiation and wave-particle duality.

CO2: Develop skills to describe the concepts of quantum mechanics and Schrodinger time-independent equation for employability at local and national level.

CO3: Understanding the concept and role of different operators in quantum mechanics.

CO4: Explain the particle in a box model using Schrodinger equation.

Suggested Readings:

1. Maron, S. & Prutton, Physical Chemistry.
2. Ball, D. W. Physical Chemistry, Thomson Press.
3. Mortimer, R. G. Physical Chemistry, 2nd Edition, Elsevier.

Web Sources

- https://guides.lib.umich.edu/c.php?g=282900&p=1885122
- http://www.freebookcentre.net/Chemistry/Chemistry-Books-Online.html

Note: Latest edition of all the suggested readings must be used.

Mapping of Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	1	2	3	2	2	3	3	2	2
CO2	2	3	3	3	2	3	2	2	3	3	2	1
CO3	2	2	3	3	2	3	3	3	3	3	2	2
CO4	1	3	3	3	3	3	3	1	3	3	2	2

CO-Curriculum Enrichment Mapping
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship
CO1	3	2	1
CO2	3	2	1
CO3	3	2	1
CO4	3	3	2

IFTM University, Moradabad
Bachelor of Science (Hons) Chemistry Programme
B.Sc.(Hons) Chemistry III Year (VI Semester)
BCHE(H)-608A: Computational Chemistry
Elective Course

Objectives: The computational techniques help to predict the structure and properties of molecules, but other uses of computers in chemistry such as data modeling and signal processing will also be covered for development of employability skills.

Unit-I **(08 Sessions)**

Molecular Mechanics and Minimization of Multi-Dimensional Functions: molecular mechanics and the methods used to find the minimum-energy structure of a molecule.

Unit–II **(08 Sessions)**

Initial Value Problems and Molecular Dynamics: basic aspects of the integration of differential equations, Cerius to run molecular trajectories and predict thermodynamic functions.

Unit-III **(10 Sessions)**

Semi-Empirical Electronic Structure Theory: theory of the electronic structure of molecules, Huckel theory and advanced semi-empirical treatments of the MOPAC and ZINDO codes.

Unit-IV **(10 Sessions)**

Ab Initio Electronic Structure Theory: basis sets in ab initio theory, some methods for inclusion of electronic correlation, Cerius/GAUSSIAN program.

Course outcomes:

Students completing this course will able to:

CO1: Understand the concepts of molecular mechanics and minimization of multi-dimensional functions for employability at local and national level.
CO2: Develop skills to describe the basic aspects of the integration of differential equations.
CO3: Understanding the theory of the electronic structure of molecules.
CO4: Explain the Ab Initio electronic structure theory.

Suggested Readings:

1. David S. Sholl and Janice A. Steckel, Density Functional Theory: A Practical Introduction (John Wiley and Sons, 2009).
2. Mathematical Methods for Science Students, G. Stephemen, ELBS.
3. Chemical Thermodynamics, R.C. Reid.

Web Sources

- http://departments.icmab.es/leem/siesta/Documentation/Manuals/manuals.html
- http://blogs.cimav.edu.mx/daniel.glossman/data/files/Libros/Exploring%20Chemistry%20With%20Electronic %20Structure%20Methods.pdf
- http://ambermd.org/tutorials/

Note: Latest edition of all the suggested readings must be used.

Mapping of Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	1	2	3	2	2	3	3	2	2
CO2	2	3	3	3	2	3	2	2	3	3	2	1
CO3	2	2	3	3	2	3	3	3	3	3	2	2
CO4	1	3	3	3	3	3	3	1	3	3	2	2

CO-Curriculum Enrichment Mapping
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship
CO1	3	2	1
CO2	3	2	1
CO3	3	3	1
CO4	3	2	1

IFTM University, Moradabad
Bachelor of Science (Hons) Chemistry Programme
B.Sc.(Hons) Chemistry III Year (VI Semester)
BCHE(H)-609A: Combinatorial Chemistry
Elective Course

Objectives: To introduce the concept of combinatorial chemistry and the increasingly important role of solid phase synthesis, reagents and scavengers in contemporary organic synthesis for development of employability skills.

Unit-I **(08 Sessions)**

Introduction to Combinatorial Synthesis: Introduction; Merrifield synthesis of peptides; mix and split for combinatorial synthesis of peptides; deconvolution; orthogonal libraries.

Unit–II **(08 Sessions)**

Combinatorial Synthesis on the solid phase: Advantages; Resins: type and properties; Linkers; Selected Solid Phase Syntheses.

Unit-III **(10 Sessions)**

Combinatorial Synthesis in solution: Parallel synthesis; Indexed libraries; Dendrimers; Fluorous phase; impurity annihilation.

Unit-IV **(10 Sessions)**

Encoded methods for Combinatorial Synthesis: Chemical tags; radio frequency tags; multiple release via orthogonal linkers.

Course outcomes:

Students completing this course will able to:

CO1: Understand the combinatorial synthesis of peptides.
CO2: Develop skills to describe the combinatorial synthesis on the solid phase for employability at local, national or global level.
CO3: Understanding the combinatorial synthesis in solution.
CO4: Explain the Ab encoded methods for combinatorial synthesis.

Suggested Readings:

1. Molecular Modeling, Principles and applications -Andrew Leach (Longman) 1998.
2. Comprehensive Medicinal Chemistry vol.4 Corwin Hansch (1990) Pergaman press.
3. Organic Chemistry of drug design and drug action-RB. Silverman 2nd Ed. (2004) Elsevier
4. A Text book of Drug design and development IInd Edn. Povl.KrogsgaardLarsen Tommy L. and U Madsen (1996) Harwood Acad. Publishers.
5. Introduction to the Principles of Drug design and action. IVth Ed. H.John Smith (Taylor and Francis) 2010.

Web Sources

- http://www.chemguide.co.uk/
- https://freebookcentre.net/

Note: Latest edition of all the suggested readings must be used.

Mapping of Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	1	2	3	2	2	3	3	2	2
CO2	2	3	3	3	2	3	2	2	3	3	2	1
CO3	2	2	3	3	2	3	3	3	3	3	2	2
CO4	1	3	3	3	3	3	3	1	3	3	2	2

CO-Curriculum Enrichment Mapping
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship
CO1	2	2	1
CO2	3	2	1
CO3	3	3	1
CO4	3	3	1

IFTM University, Moradabad
Bachelor of Science (Hons) Chemistry Programme
B.Sc.(Hons) Chemistry III Year (VI Semester)
BCHE(H)-610A: Chemical Dynamics
Elective Course

Objectives: To give the student the level of understanding of reaction dynamics that is a foundation for molecular simulations and the interpretation of dynamics and kinetics experiments for development of employability skills.

Unit-I **(08 Sessions)**

Review of macroscopic kinetics: reaction order, molecularity, the Arrhenius equation. Potential energy functions and surfaces: intermolecular energy, origin of intermolecular forces, potential energy surfaces, reaction coordinate.

Unit–II **(08 Sessions)**

Microscopic kinetics: the total and differential reaction cross sections, the relationship between the rate constant and the reaction cross-section, the relationship between the threshold energy and the activation energy. Collision Theory: simple collision theory.

Unit-III **(10 Sessions)**

Review of statistical mechanics: partition functions, ideal monatomic gas, ideal diatomic gas, equilibrium constants. Transition state theory: assumptions, statistical mechanics formulation of transition state theory, thermodynamic formulation of transition state theory, structure of the transition state and the A factor, applications of transition state theory, isotope effects, tunneling.

Unit-IV **(10 Sessions)**

Reaction dynamics: collisions of real molecules, the Lennard-Jones potential, elementary scattering theory. Experimental reaction dynamics: bulb methods, reagent specification, product distributions, molecular beams, reagent specification, product detection.

Course outcomes:

Students completing this course will able to:

CO1: Understand the macroscopic kinetics properties of reactions.
CO2: Understand the microscopic kinetics properties of reactions.
CO3: Understand global statistical mechanics, partition functions, ideal monatomic gas.
CO4: Explain collisions of real molecules, Lennard-Jones potential, elementary scattering theory.

Suggested Readings:

1. Paul L. Houston, Chemical Kinetics and Reaction Dynamics, Dover Publications. (Recommended)
2. William L. Hase, Joseph Francisco, Jeffrey I. Steinfeld, Chemical Reaction Dynamics, Prentice Hall.
3. Raphael D. Levine, Molecular Reaction Dynamics, Cambridge University Press.
4. Tomas Baer, William L. Hase, Unimolecular Reaction Dynamics: Theory and Experiments, Oxford University Press.

Web Sources

- http://www.chemguide.co.uk/
- https://freebookcentre.net/

Note: Latest edition of all the suggested readings must be used.

Mapping of Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	3	3	2	2	3	3	2	2
CO2	2	3	2	3	2	3	2	2	3	3	2	1
CO3	2	2	3	3	2	3	3	3	3	3	2	2
CO4	1	3	3	3	3	3	3	1	3	3	2	2

CO-Curriculum Enrichment Mapping
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship
CO1	3	2	1
CO2	3	2	1
CO3	3	3	1
CO4	3	3	1

IFTM University, Moradabad
Bachelor of Science (Hons) Chemistry Programme
B.Sc.(Hons) Chemistry III Year (VI Semester)
BCHE(H)-611A: Industrial Chemistry
Elective Course

Objectives: After studying this course, student shall be able to understand the different aspects of industrial processes of fossil fuels in detail. Sensible use of limited resources of non-renewable energy and technology investment in improving the production of renewable cleaner energy sources. The analytical approach of this course is to enhance the reasoning and to understand the mechanical part of the industry for skill development and employability.

Unit-I **(08 Sessions)**

Fuel Chemistry: Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value. Coal: Introduction of coal, uses of coal (fuel and non-fuel) in various industries, Petroleum and Petrochemical Industry: Composition of crude petroleum, Refining and different types of petroleum products and their applications, Lubricants: Classification and properties of lubricants for skill development- (viscosity index, cloud point, pore point), lubricating oils.

Unit–II **(08 Sessions)**

Oils and Fats: Classification of oils, fat splitting, distillation of completely miscible and non-miscible oils, hydrogenation of oils, rancidity, saponification value, iodine number, acid value.

Unit-III **(10 Sessions)**

Food additives: A general study of food flavours, colours and preservatives, artificial sweeteners.

Unit-IV **(10 Sessions)**

Soap and synthetic detergent, preparation of soap and detergent, different types of soap and their composition, surfactants (LAS, ABS, LABS), detergent binders and builders.

Course outcomes:

Students completing this course will able to:

CO1: Understand the classification, composition of fuels and their calorific value.
CO2: Learn the classification and properties of oils & fats.
CO3: Describe the food additives for food flavours, colours and preservatives.
CO4: Demonstrate the preparation of soap and detergent for employability in industry sector at local and national level.

Suggested Readings:

1. Vermani, O. P.; Narula, A. K. (2004), Industrial Chemistry, Galgotia Publications Pvt. Ltd., New Delhi.
2. Bhatia, S. C. (2004), Chemical Process Industries, Vol. I & II, CBS Publishers, New Delhi.
3. Jain, P. C.; Jain, M. (2013), Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
4. Gopalan, R. Venkappayya, D.; Nagarajan, S. (2004), Engineering Chemistry, Vikas Publications.
5. Sharma, B. K. (1997), Engineering Chemistry, Goel Publishing House, Meerut.

Web Sources

- http://www.chemguide.co.uk/
- https://freebookcentre.net/

Note: Latest edition of all the suggested readings must be used.

Mapping of Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	2	1	3	2	2	3	3	2	2
CO2	3	3	2	3	2	3	2	2	3	3	2	1
CO3	2	2	3	3	2	3	3	3	3	3	2	2
CO4	1	3	3	3	3	3	3	1	3	3	2	2

CO-Curriculum Enrichment Mapping
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship
CO1	3	2	1
CO2	3	2	1
CO3	3	3	2
CO4	3	3	2

IFTM University, Moradabad
Bachelor of Science (Hons) Chemistry Programme
B.Sc.(Hons) Chemistry III Year (VI Semester)
BCHE(H)-612A: Biology for Chemists
Elective Course

Objectives: To study the structure and organization of cell membrane and cell wall, process of membrane transport and membrane models for skill development. To understand the DNA structural organization and biochemical composition of genetic material for employability.

Unit-I **(08 Sessions)**
Molecules of life: Amino acids and proteins, Carbohydrates-polysaccharides, lipids, cell membranes and nucleic acids.

Unit–II **(08 Sessions)**
Structure and function: Protein structure, Ramachandran plot, protein folding: DNA/RNA structures, various forms (a, b, c, z) of DNA, t-RNA structure, transcription and translation, gene expression and DNA binding protein-zinc-finger protein.

Unit-III **(10 Sessions)**
Metabolism and Energetics: Glycolysis, citric acid cycle, oxidative phosphorylation and transport through membranes. Enzyme kinetics, inhibition, drug action.

Unit-IV **(10 Sessions)**
Metalloenzymes: Hydrolytic and redox enzymes: Carbonic anhydrase and superoxide dismutase. Oxygen uptake proteins: Hemerythrin and hemocyanin.

Course outcomes:
Students completing this course will able to:
CO1: Understand the structure and organization of cell membrane and cell wall.
CO2: Learn the structure and function of protein, DNA & RNA for employability at local and national level.
CO3: Describe the glycolysis, citric acid cycle, oxidative phosphorylation and transport through membranes.
CO4: Explain the hydrolytic and redox enzymes, Carbonic anhydrase and superoxide dismutase.

Suggested Readings:
1. L. Stryer, Biochemistry, 5th Edition, (2002) Freeman &Co. New York
2. D.L. Nelson and M.M. Cox, Lehninger Principles of Biochemistry 3rd Edition ((2002) McMillan North Publication
3. D. Voet, J. G. Voet, Biochemistry 3rd Edition (2004), Wiley International Publication.
4. I. Bertini, H. B. Gray, S. J. Lippard, J.S. Valentine, 1st South Asian Edn., (1998) Viva Books Pvt. Limited, New Delhi
5. M. B. Smith, Organic Synthesis, (1998) Mc Graw Hill Inc, New York

Web Sources
- http://www.chemguide.co.uk/
- https://freebookcentre.net/

Note: Latest edition of all the suggested readings must be used.

Mapping of Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	2	1	3	2	2	3	3	2	2
CO2	2	2	2	3	2	3	2	2	3	3	2	1
CO3	2	2	3	3	2	3	3	3	3	3	2	2
CO4	1	3	3	3	3	3	3	1	3	3	2	2

CO-Curriculum Enrichment Mapping
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship
CO1	3	2	1
CO2	3	3	1
CO3	3	1	1
CO4	3	3	1

IFTM University, Moradabad
Bachelor of Science (Hons) ChemistryProgramme
B.Sc.(Hons) Chemistry III Year (VI Semester)
BCHE(H)-651: CHEMISTRY PRACTICAL

Objectives: Development of skills to understand the objective of their chemical experiments, properly carry out the experiments, and appropriately record and analyze the results. Students will be able to use standard laboratory equipment, modern instrumentation, and classical techniques to carry out experiments.

PRACTICALS

(20 Sessions)

1) Determination of rate constant of acid catalyzed hydrolysis of an ester.
2) Determination of order of hydrolysis of an ester by sodium hydroxide.
3) Verify Beer – Lambert Law for $KMnO_4$ / $K_2Cr_2O_7$ and determining the concentration of the given solution of the substance from absorption measurement.
4) Preparation of a Rubber Ball from Rubber Latex and its importance in employability in research and manufacturing sector.
5) Preparation of casein glue from milk and testing of its activity.
6) Preparation of talcum powder/face cream.
7) Preparation of nail polish and nail polish remover
8) Preparation of shampoo.
9) Paper chromatographic separation of
   Fe^{3+}, Al^{3+} and Cr^{3+} OR Ni^{2+}, Co^{2+}, Mn^{2+} and Zn^{2+}
10) Preparation of any of the following complexes
    I. Tetraamminecarbonatocobalt (III) nitrate
    II. Tetraamminecopper (II) sulphate
    III. Potassium trioxalatoferrate (III) trihydrate

Course outcomes:

Students completing this course will able to:

CO1: Understand the qualitative and quantitative analysis.

CO2: Perform the synthetic process of commercial chemical materials like cosmetics for employability at local and national level.

CO3: Skill development to prepare transition metal complexes.

CO4: Determine rate constant/order in hydrolysis of ester. Determine concentration of the given solution using Beer–Lambert Law.

Suggested readings:

1. A.I. Vogel: Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.
2. A.I. Vogel: Quantitative Chemical Analysis, Prentice Hall, 6th Edn.
3. A.I. Vogel: Textbook of Practical Organic Chemistry, Prentice Hall, 5th Edn.
4. F. G. Mann & B. C. Saunders: Practical Organic Chemistry, Orient Longman (1960).M University

Web Sources:

- https://sp-sg.libguides.com/c.php?g=377339&p=6724406
- https://chemistscorner.com/top-10-book-cosmetic-science-book-resources/

Note: Latest edition of all the suggested readings must be used.

Mapping of Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	2	3	2	2	3	3	2	3
CO2	2	2	3	3	2	3	2	3	3	3	2	3
CO3	3	2	3	3	2	3	2	2	3	3	3	2
CO4	1	3	3	3	3	3	2	2	3	3	2	2

CO-Curriculum Enrichment Mapping
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship
CO1	3	3	1
CO2	3	3	3
CO3	3	2	2
CO4	3	2	2